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Salivary bacteria and oral health status in children with disabilities fed through gastrostomy

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Objectives. This study examined caries level, amount of calculus, and oral microbial environment in gastrostomy tube (GT)-fed children compared with healthy children and children with disabilities orally fed (PO).

Study design. The study group consisted of 12 GT-fed children and the two control groups consisted of 16 children with disabilities orally fed and 17 healthy children. DMF-T/dmf-t index, calculus index, *Mutans Streptococci* (MS), Lactobacilli (LB) levels and salivary buffer capacity were examined.

Results. DMF-T/dmf-t index was significantly lower in the tube-fed group. Calculus index was highest in the tube-fed group. MS and LB levels were the lowest in the tube-fed children. Correlation was found between MS and DMF-T/dmf-t.

Conclusions. Tube-fed children demonstrated significantly higher calculus levels and less caries, MS, and LB levels then healthy children or children with disabilities eating PO.

Introduction

Percutaneous endoscope gastrostomy (PEG) is a tube placed in the stomach in order to feed an individual who is incapable of oral food intake. PEG is suggested for children with swallowing difficulties due to neurological disorder, children with inadequate calorie intake or children with special feeding requirements, or malabsorption[1].

Children with neurodevelopment disabilities such as cerebral palsy (CP) or muscular dystrophy frequently have associated gastrointestinal comorbidity including oral-motor dysfunction leading to feeding difficulties, prolonged feeding times, increased risk of aspiration, and malnutrition[2].

Gastrostomy tube (GT) feeding has been shown to yield a weight gain[3], reduce feeding time, and improve quality of life for those children[4], without increasing the risk for respiratory complications[3].

Dental calculus is mineral deposits on tooth surface. The mineralisation process occurs if the fluid phase of the dental plaque is supersaturated with calcium, phosphate, and carbonate in a pH above 5.5 for a long time[5]. This condition is more common in patients who are tube fed, and their plaque has no fermentable carbohydrates, and lower pH[6].

Although inverse relations between calculus and caries had been reported, caries occurring in an acidic environment and calculus in an alkaline one, supporting data have been inconclusive[6]. Some studies have shown only a slight inverse relationship[7], and other did not find significant association[8].

Littleton *et al.*[9] found dental plaque from individuals nourished via GT considerably less acidogenic than dental plaque from orally fed (PO) individuals. Moreover, they demonstrated that the pH was less acidic and that plaque samples from individuals nourished via GT had little tendency to generate acid when exposed to glucose, fructose or sucrose[10].

Klein *et al.*[11] found significantly higher amount of calculus accumulation in patients fed through GT than those fed PO, with the same oral hygiene levels, without any difference in the amount of plaque and debris. Their studies verified that 68% of the calculus was formed within the first 30 days after

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gastrotomy insertion in that group. Dicks and Banning[12] also found that calculus formation was significantly more rapid in the tube-fed groups, even with good oral hygiene. This phenomenon can be due to lack of mastication in those patients[6].

Carbohydrates are essential for the survival and thriving of the oral flora. Lack of oral nutrition as in tube-fed patients will change the microenvironment of the oral bacteria[13]. Plaque samples from tube-fed individuals had lower MS counts and less frequent positive cultures of LB and filamentous bacteria than those of patients fed through the mouth[10,14].

Gastrostomy tube-fed children with a history of aspiration pneumonia (AP) have significantly more calculus than GT children who have no such history, suggesting a relationship between calculus and AP. Professional calculus removals do not cause AP during the procedure[14].

This study compares oral status of children fed via GT with healthy children and children with disabilities eating PO, evaluating the differences in DMF-T/dmf-t index, calculus index, salivary buffer capacity and MS, and LB levels.

Materials and methods

The study protocol was approved by the Institutional Human Subjects Ethics Committee of the Hebrew University, Hadassah School of Dental Medicine, Jerusalem, Israel. Informed consent was obtained from all parents or legal guardians of participating children.

Sample selection

Twelve children fed through gastric tube (GT) comprised the study group. The children suffered from diverse neurological impairment and were instituted at the Alyn Hospital, Pediatric & Adolescent Rehabilitation Center, Jerusalem (Alyn).

All the children in the study group were constantly fed through gastric tube; most of them were fed in that manner since birth and throughout their entire life, more than a year at the least (mean 2.86 years).

Two control groups were selected: The first group, of 16 children, also instituted in Alyn hospital, was fed PO. Subjects were not matched by type of disability but had physical or intellectual impairment compromising their independent daily life activities. The second control group was comprised of 17 healthy children, medication free, who received treatment at the Pediatric Dentistry Department in the Hadassah School of Dental Medicine in Jerusalem. Children receiving antibiotic therapy at the time of the study or in the previous 2 weeks were excluded. The study and the control groups from Alyn received the same oral hygiene regimen of twice-daily tooth brushing with fluoride containing toothpaste.

Clinical examination

Information about medical history and medication for the study GT group and the control group was collected from the medical records at Alyn Hospital, Pediatric & Adolescent Rehabilitation Center. Comparable data were collected for the healthy control group from a questionnaire filled by the parents.

All study and control children were examined by the same investigator (A.H).

The dental examination included:

1. Dentition charting and DMF-T/dmf-t index
2. Calculus surface index and oral hygiene index (Simplified from Green and Vermillion[15]).

Examinations were conducted using an explorer and a dental mirror.

Salivary sampling and laboratory procedure

Whole saliva sample was collected from the ventral part of the tongue and the oral vestibulum using a sterile cotton pallet. Collection time was morning, at least 2 h after eating. The saliva analysis was performed using standard bioassay and plating procedures on a Caries Risk Test (CRT) (CRT; Ivoclar Vivadent Inc. Amherst, NY, USA) used to determine the MS and LB count in saliva by means of selective culture media. The CRT kits were incubated at 37°C for 48 h. Enumeration of bacterial growth was conducted as semi-quantities ranking according to manufacturers instructions.

Salivary buffer capacity was assessed using PH indicators from CRT (Ivoclar Vivadent Inc.) and was evaluated using a color scale provided by the manufacture.

Statistical analysis

Data were analysed using SPSS software Chicago, Illinois, USA. The analysis consisted of basic descriptive statistical analysis assays; Chi-squared analysis, Student's *t*-tests, ANOVA test, Mann–Whitney test (comparing two groups) and Kruskal–Wallis test (comparing three groups). Significance level was set at $P \leq 0.05$. Bonferroni correction of the significance level for multiple pair wise comparison $P \leq 0.017$ was used when comparing the three groups.

Results

Twelve tube-fed children (8 boys and 4 girls) comprised the study group, ages 1.5–10 years with a mean age of 4.04 (±2.7) years. There were two control groups: a group of Alyn patients – 16 children (11 boys and 5 girls) with neurological disabilities who were not tube fed. Their ages ranged from 1.5 to 7.5 years, mean age 4.4 (±1.9) years. The second control group was of 17 healthy children (10 boys and 7 girls) age range 1–9 years with a mean age 4.35 (±2.5) years. GT and control groups were well matched for age and gender with no statistical differences (χ^2/*t*-test, $P < 0.05$).

DMF-T/dmf-t index

Table 1 and Fig. 1 demonstrate the DMF-T/dmf-t index that was the highest in the healthy control group (mean 4.07), and the lowest in the study group (mean 0). There was a statistically significant difference ($P \leq 0.05$) between the study group and each of the two control groups.

Table 1. DMF-T/dmf-t index.

Mean	DMF index
Study hospitalised GT	0
Control hospitalised PO	2.43
Control healthy PO	4.07

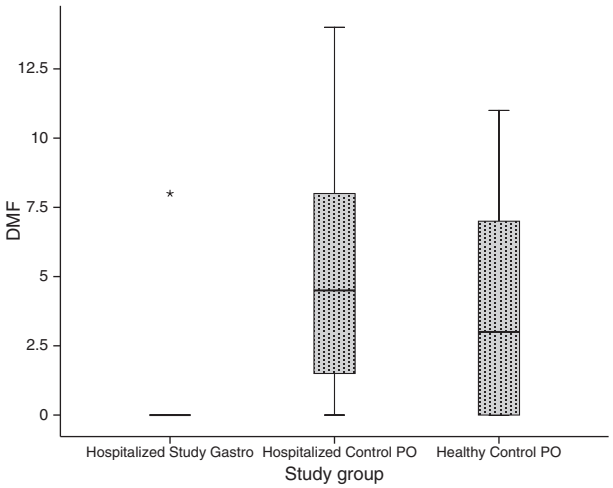

Fig. 1. DMF-T/dmf-t index.

Calculus index

Calculus index was calculated according to the Green and Vermillion simplified index[15]. Calculus index was the highest in the study group (mean 1.83). Seven (58%) of the 12 children in that group had maximal calculus index level. The lowest level of calculus index was found in the healthy control group: sixteen (94%) of the 17 children in that group had the minimum calculus index level (Table 2 and Fig. 2). Statistically significant difference ($P \leq 0.05$) was found between the three groups.

Streptococci mutans level

Amount of colony forming units (CFU) of MS was determined using a scale of 0–3 ranks using the CRT® bacteria, by comparing the medium with the model chart. MS levels were the lowest in children fed through gastrotomy, and 70% of them had the lowest level of CFU for MS = 0 (Fig. 3).

Table 2. Calculus index was calculated according to the Green and Vermillion simplified index.

	Calculus			
	0	1	2	3
Study hospitalised GT	4	1	0	7
Control hospitalised PO	12	3	1	0
Control healthy PO	16	1	0	0

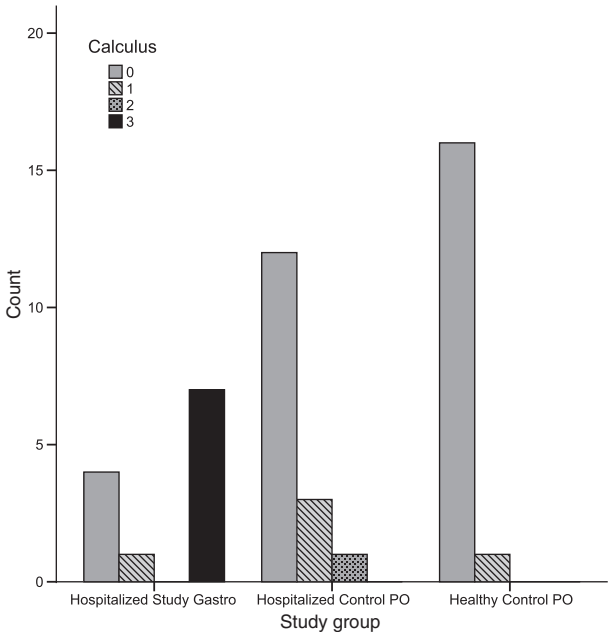

Fig. 2. Calculus index level.

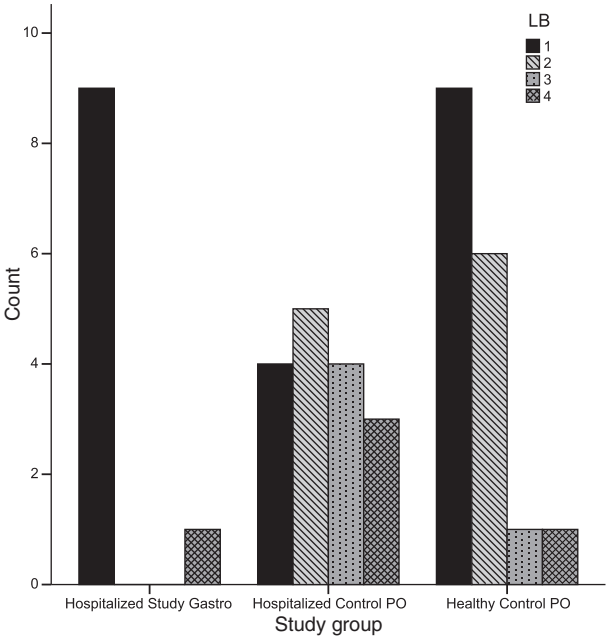

Fig. 4. LB level was the lowest in the study group and 90% had the lowest grade LB = 1.

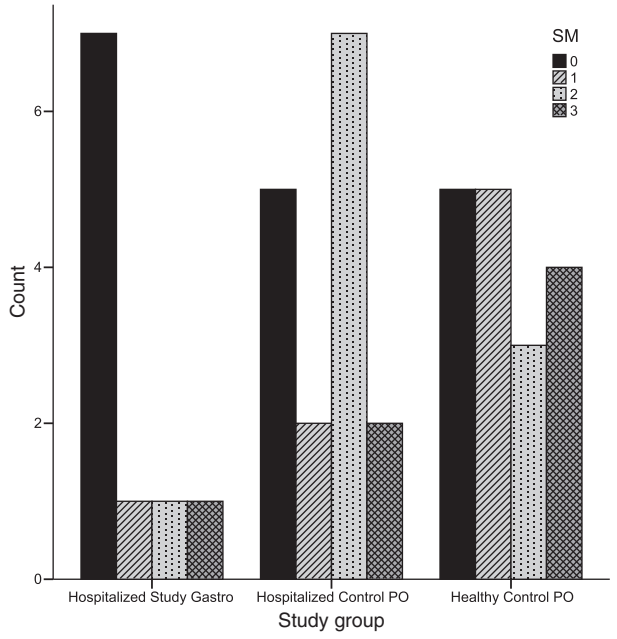

Fig. 3. MS level were the lowest in children fed through gastrotomy and 70% of them had the lowest level of CFU for MS = 0.

Lactobacilli level

Amount of CFU of LB was determined with a scale of 1–4 ranking using the CRT® bacteria by comparing the medium with the model chart. LB levels were the lowest in the study group, and 90% had the lowest grade LB = 1 (Fig. 4). A statistically significant difference ($P \leq 0.05$) was found comparing the two control groups with the study group.

Buffer capacity

The Buffer capacity of the saliva was measured with a pH paper that separated the salivary buffer capacity to high, medium and low (CRT®-Vivadent Inc.). Statistically significant differences ($P \leq 0.05$) were found between the two control groups and the study group.

Data evaluation

There was a correlation between the appearance of MS and the DMF-T/dmf-t index, with a correlation coefficient of 0.632. A higher DMF-T/dmf-t was in correlation with a high MS count.

DMF-T, D, calculus index, LB, and buffer capacity had statistically significant differences ($P \leq 0.05$) between the three groups. There were no statistically significant differences between the two control groups in all measured values ($P \geq 0.05$). There were statistically significant differences ($P \leq 0.05$)

in DMF-T and in calculus index between the study and the healthy control groups. There were statistically significant differences ($P \leq 0.05$) in DMF-T, D, M, and F, calculus index, LB, and buffer capacity between the study group and the Alyn control group.

Discussion

This study compared the oral status – caries activity, amount of calculus, buffer capacity, and the MS and LB levels in a group of GT fed-tube children compared with that of healthy children and children with disabilities eating PO.

Calculus accumulation was compared between two groups with disabilities: one with GT and the other orally fed in the same institute. Both groups received the same oral hygiene care. Yet, the GT group had higher calculus level. Our data support previously described findings that GT-fed patients have more calculus accumulation under the same oral hygiene regimen[12,14,16,17]. According to the literature, when plaque pH is above 5.5, the plaque fluid becomes supersaturated and tends to deposit mineral[5]. Calculus formation probably occurs when plaque pH remains above the critical level for a prolonged period[5], a situation occurring in patients who are tube fed, and their plaque is not exposed to fermentable carbohydrates[6]. In this study, tube-fed children had accumulation of calculus without active caries or bacteria that are part of the acid manufacturing process. Calculus index was the highest in the tube-fed study group (mean 1.83), and lowest in the healthy control group with a statistically significant difference between the groups.

There is a correlation between the occurrence of SM in the plaque and that in saliva[18,19]. Elevated MS counts on affected teeth are correlated to higher bacterial count in the saliva[20–22]. In accordance with the literature[14], this study found that GT children had lower DMF-T/dmf-t than healthy children or children with disabilities eating through the mouth. The GT group also demonstrated a lower level of MS and LB counts. Similar lower levels of SM and LB were found with correlation to low DMF-T in Down's syndrome children[23] and in healthy ones[24]. The explanation lies in the dependence of microbacteria on carbohydrates normally consumed orally.

A relationship was found between the presence of SM and the DMF-T/dmf-t index but not between the amount of SM and level DMF-T/dmf-t, probably because caries is a multifactorial disease that depends on different variables including oral hygiene, diet, bacteria virulent, and host resistance[25].

Clinical implications

Because there is a relationship between aspiration pneumonia history and the presence of calculus[14] it is important to establish protocols for follow-up visits that will take into account both the rapid calculus accumulation[11] and the low caries activity that were found in this study.

1. Because there is a relationship between calculus level and aspiration pneumonia but not between aspiration pneumonia and calculus removal itself[14], we recommend that GT-fed children will be scheduled for frequent calculus removal visits. This may reduce the frequency of aspiration pneumonia.
2. Fewer radiographs may be needed in the follow-up visits because of the low caries activity, as recommended for low risk children[26].

The number of tube-fed patients in this study was small, although all the tube-fed children at Alyn were included in the study. The sample size is an inherent drawback of this study, but the statistical data in itself are compelling.

Frequent calculus removal reduces the risk of spontaneous aspiration pneumonia. Dental treatments of children with compromised airway reflexes involve a risk for aspiration which might be a life-threatening event. According to the literature, the posture of these children during dental treatment is important in preventing aspiration. In addition, it is recommended to limit the water spray during treatment and maximise the use suction. Occasionally, general anaesthesia may be indicated for achieving high quality

treatment with maximum protection. Still current guidelines regarding the recommended frequency of dental follow-up visits for GT-fed children are needed[27].

Conclusion

1 GT children have significantly lower DMF-T/dmf-t index than children with disabilities or healthy children eating PO.
2 GT children are significantly more likely to have calculus.
3 *Mutans Streptococci* and LB counts were the lowest in the GT children group.
4 Correlation was found between presence of MS and DMF-T/dmf-t index.

What this paper adds

- This is one of only a few studies that examines the relationship between GT-fed children, their oral status and treatment needed. GT children have significantly lower DMF-T/dmf-t index and significantly more calculus than children with disabilities or healthy children eating PO.

Why this paper is important to paediatric dentists

- Dental treatment of children with compromised airway reflexes involves a risk for aspiration which might be a life-threatening event. This study helps in emphasising the need for a protocol for follow-up visits that will take into account both the rapid calculus accumulation and the low caries activity found in the study.

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