



# Comparison of Oral Findings in Special Needs Children With and Without Gastrostomy

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## Abstract

**Purpose:** The objective of this study was to compare aspiration pneumonia (AP)-associated microflora, calculus, and oral hygiene/care seeking behaviors in special health care needs children (SC) with gastrostomy (GT) and without.

**Methods:** Twenty-seven GT SC, ages 3 to 12 years old and matched for age and gender with 27 non-GT SC, were examined by 2 trained investigators who recorded calculus and gingival inflammation and reconciled differences. Plaque was obtained using preweighed dry paper points and saliva sampled using sterile pipettes and cultured using standard bioassay procedures in a hospital laboratory. Parent/caretakers completed a medical and oral health questionnaire.

**Results:** No significant differences were noted for age, gender, weight, primary diagnosis, vomiting, constipation, or swallowing disorder, but GT children received 4 medications vs 1 for non-GT and were significantly more likely to have had AP, need special feeding, and drool ( $P \leq .05$ ). Oral health measures were not significantly different for brushing frequency, dentifrice use, brushing problems, frequency of dental care, or gingival inflammation, but GT patients had significantly more plaque and calculus. GT patients had significantly more *Haemophilus influenzae*, with trends toward more gram negative enteric rods, pseudomonas, and *Streptococcus pneumoniae* and higher concentrations in several GT-patients and little or none in non-GT patients. GT SC had significantly less  $\beta$ -streptococci than non-GT patients ( $P \leq .05$ ).

**Conclusions:** GT SC had significantly more of 1 AP-associated organism than non-GT SC and significantly more calculus and plaque, in spite of similar care seeking and hygiene behaviors. (*Pediatr Dent.* 2004;26:283-288)

**KEYWORDS:** GASTROSTOMY, CALCULUS, ORAL HYGIENE, PNEUMONIA

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Damage to the developing central nervous system (CNS) can result in organ system dysfunction, including gastrointestinal tract (GIT) dysfunction, which can appear as oral-motor dysfunction, gastroesophageal reflux (GER), delayed gastric emptying, and constipation.<sup>1</sup> These problems contribute to feeding difficulty and respiratory distress,<sup>2-4</sup> so afflicted children are often not fed orally to avoid aspiration pneumonia (AP), dehydration, and malnutrition.

Gastrostomy (GT) is a surgical procedure that places an external tube into the stomach and indicated for children who:

1. have difficulty swallowing;
2. are categorized as failure to thrive;
3. have inadequate caloric intake;

4. have feeding disorders;
5. are severely disabled with poor nutritional status; or
6. have upper GIT obstruction.<sup>5</sup>

After gastrostomy surgery, catch-up growth occurs, so the procedure is done frequently.<sup>6</sup>

GER is esophageal exposure to gastric fluids and associated with persistent growth retardation or respiratory signs in GT patients, especially those with neurological dysphagia. In children, placement of GT has been associated with reduced lower esophageal sphincter pressure and development of GER,<sup>7</sup> but also has been associated with AP.<sup>8</sup>

AP is a major cause of morbidity among the elderly who are hospitalized or in nursing homes<sup>9,10</sup> and is a leading cause of their death.<sup>11</sup> AP is entry of infectious pharyngeal contents

into lower airways<sup>7</sup> and a multifactorial phenomenon. Aspiration will only lead to pneumonia if aspirate is pathogenic to the lungs or host resistance is compromised.<sup>12,13</sup>

Pharyngeal bacteria is the major source of infection in AP.<sup>14</sup> Bacteriology of AP suggests that a combination of oropharyngeal colonization by bacterial pathogens and microaspiration of saliva containing them may be the most common cause of AP.<sup>11,12,14-20</sup> The organisms responsible for AP reflect the oropharyngeal flora of anaerobes: *Bacteroides*, *Fusobacterium*, *Porphyromonas*, and *Peptostreptococcus*.<sup>8</sup> Colonization of pharyngeal mucosa by respiratory pathogens is a transient phenomenon, and adult subjects are considered colonized with respiratory pathogens only if the following are isolated: *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, *Haemophilus influenzae*, *Klebsiella pneumoniae*, *Serratia marcescens*, *Proteus mirabilis*, and *Escherichia coli*.<sup>14</sup>

GT feeding is associated with poor oral hygiene and low salivary flow; the latter predisposes to overgrowth of salivary bacteria which, when mixed with food or liquid, provide a substantial inoculum to the lungs if aspirated.<sup>8</sup> When saliva with a high bacterial concentration is aspirated, pathogens enter the lungs.<sup>12,15</sup> Reducing oral organisms may reduce AP-associated morbidity in GT children.<sup>8</sup>

Previous research documents excessive accumulation of calculus in GT patients.<sup>21</sup> Plaque accumulation is less significant in GT patients than in orally fed patients and is less acidogenic,<sup>22</sup> and GT patients often fail to develop dental caries.<sup>23,24</sup> A study of oral hygiene in nursing home residents showed very poor oral hygiene to be a factor influencing oropharyngeal bacterial pneumonia.<sup>14</sup> These authors concluded that reduced saliva flow allows oral microflora to become more pathogenic and increases the potential for AP.

Increased calculus accumulation, presence of potential respiratory pathogens, medical disability of GT patients, and increased experiences with AP, when considered together, invite inquiry into the relationship between oral and systemic health in GT patients. Since the increased occurrence of fever of unknown origin and respiratory infections in older GT patients is well established, it is logical to investigate similar relationships in younger patients.

The purposes of this investigation were to:

1. measure oral parameters, lifestyle factors, health status, and AP-related microorganisms present in GT and matched controls; and
2. assess the relationship between health behaviors, microorganisms, plaque, and calculus and history of AP.

## Methods

### Sample selection

A convenience sample of 26 subjects for this institution-approved study was estimated by power analysis and drawn from clinic rosters of GT SC followed at Columbus Children's Hospital (CCH). Each child:

1. was 3 to 12 years of age;
2. had documented swallowing difficulties;
3. had GT for at least 1 year;
4. had enough teeth erupted for scoring; and
5. was receiving daily oral hygiene from a caretaker.

The case control group was also drawn from SC followed at CCH, but without GT and matched for age, gender, and race. Subjects were not strictly matched by type of disability but included if they had a physical or intellectual diagnosis compromising independence in activities of daily living. Diagnoses included mental retardation, cerebral palsy, autism, and attention deficit hyperactive disorder.

### Questionnaire

A questionnaire addressing medical, demographic, and oral characteristics of GT subjects was developed from a literature review and consultation with the physician-director of the GT clinic, piloted with parents for ease and accuracy of completion, and modified. The questionnaire was administered to the parent/primary caretaker at examination. The principal investigator answered questions that arose during questionnaire completion and reviewed each instrument when completed. Missing data (medical interventions, hospitalizations, and other procedures) were gleaned by the principal investigator from medical records of the CCH Patient Information Department.

### Clinical examination

All study and case control children were examined by the principal investigator and trained dental assistant. The dental examination included:

1. dentition charting;
2. gingival inflammation assessment using the Gingival Index of Loe and Silness, calculus surface index, and the Oral Hygiene Index-Simplified of Green and Vermillion.

Examinations were done in a dental operatory using explorer and mirror. The trained dental assistant also rated subjects, and discrepancies between the 2 examiners were reconciled to a single rating for each measure before discharging the patient. A plaque sample was obtained by scraping plaque from facial surfaces of mandibular anterior teeth with a scaler (canine to canine, inclusive) and transferring plaque to preweighed paper points which were then placed in preweighed vials.

### Salivary sampling and laboratory procedures

A 0.5-ml sample saliva sample was taken from under the tongue using a sterile pipette and transported to the laboratory within a half-hour of collection to maximize organism viability. A CCH Clinical Laboratory certified technician performed analysis of pulmonary pathogens using standard bioassay and plating procedures. Microfloral analysis determined CFUs of *H influenzae*, *Haemophilus parainfluenzae*, *S pneumoniae*, *S aureus*,  $\beta$ -*Streptococcus*,

**Table 1. Comparison of Characteristics of GT Study Children and Matched Comparison Children**

| Characteristic                       | GT study group (N=27) |    | Comparison group (N=2) |    | P value |
|--------------------------------------|-----------------------|----|------------------------|----|---------|
| Subject age in months                | 89±35                 |    | 92±29                  |    | NS      |
| Subject sex                          | M                     | F  | M                      | F  | NS*     |
|                                      | 18                    | 9  | 18                     | 9  |         |
| Weight (kg)                          | 24±11                 |    | 25±12                  |    | NS      |
| Primary medical diagnosis            | Yes                   | No | Yes                    | No | NS      |
|                                      | 21                    | 6  | 12                     | 15 |         |
| Current medications<br>(mean number) | 22                    | 5  | 26                     | 1  | .002    |
|                                      | (4.7±3)               |    | (1.3±1.1)              |    |         |

\* $P > .05$  using  $\chi^2$ ; all other variables analyzed by  $t$  test.  
NS=Not significant

**Table 2. Medical Characteristics of GT and Comparison Groups**

| Characteristic            | GT study group (N=27) |    | Comparison group (N=27) |    | P value ( $\chi^2$ ) |
|---------------------------|-----------------------|----|-------------------------|----|----------------------|
| Pneumonia                 | 15                    | 12 | 3                       | 24 | .001                 |
| Vomiting                  | 27                    | 0  | 2                       | 25 | .000                 |
| Constipation              | 19                    | 8  | 3                       | 24 | .000                 |
| Swallowing disorder       | 26                    | 1  | 2                       | 25 | .000                 |
| Special feeding needed    | 20                    | 7  | 0                       | 27 | .001                 |
| Feeding frequency altered | 1                     | 26 | 27                      | 0  | .000                 |
| Drooling                  | 16                    | 11 | 24                      | 3  | .01                  |

*Moraxella catarrhalis*, enteric gram negative rods, *Pseudomonas* species, *Fusobacterium*, *Prevotella*, *Porphyromonas*, *Bacteroides*, *Clostridium*, and *Peptostreptococcus* species.

#### Statistical analysis

Data were entered on a computer and analyzed using SPSS software. The analysis consisted of basic descriptive statistics, chi-square analysis,  $t$  tests and Wilcoxon rank sum tests, where

appropriate. Specific tests used are indicated for each set of results.

## Results

### GT and comparison groups

Twenty-seven subjects in each group were entered into the study. Table 1 confirms that GT and control groups were well matched for major criteria of age, gender, race, and major medical diagnoses, with no statistical differences ( $\chi^2/t$  test,  $P < .05$ ). The GT group took almost 4 times more medications than controls and, while both groups took CNS medications, additional medications in the GT group were mainly digestive, respiratory, and antimicrobial due to the GT child's immobility and GER/GT-related GIT and respiratory ailments.

### Medical findings in the GT and comparison groups

Table 2 shows GT subjects were significantly more likely to experience pneumonia, vomiting, and constipation and have a swallowing disorder than controls. In addition, GT children had significantly more oral motor problems, such as swallowing and drooling and more related compensatory management considerations related to feeding (eg, special diet, altered eating frequency) than controls ( $\chi^2$ ,  $P < .01$ ).

**Table 3. Oral Health Factors as Related to Feeding and Pneumonia Status**

| Characteristic              | G-tube fed |            | Control     |            | P value |
|-----------------------------|------------|------------|-------------|------------|---------|
| Pneumonia history           |            |            |             |            |         |
|                             | Negative   | Positive   | Negative    | Positive   |         |
| Calculus score              | 4.9±8.8*   | 20.9±18.6* | 0.4±2*      | 0±0        | <.0001† |
| Plaque weight (mg)          | 1.7±0.7    | 1.6±0.8    | 1.1±0.9*    | 0.9±1.1    | .006†   |
| Gingival index              | 0.5±0.7    | 1.3±1.1*   | 0.7±0.8     | 0.3±0.6    | .11†    |
| Gingival overgrowth         | 9/12 (75%) | 8/15 (53%) | 15/23 (65%) | 3/3 (100%) | .50‡    |
| Brushing frequency          | 3.7±1      | 3.3±0.9*   | 3.8±0.7     | 3.7±0.6    | .06†    |
| No. of hygiene appointments | 2±2        | 1.3±1.5    | 2.3±2.5     | 0.3±0.6    | .53†    |

\*Significantly different from other cells.

†Wilcoxon rank sum.

‡chi-square.

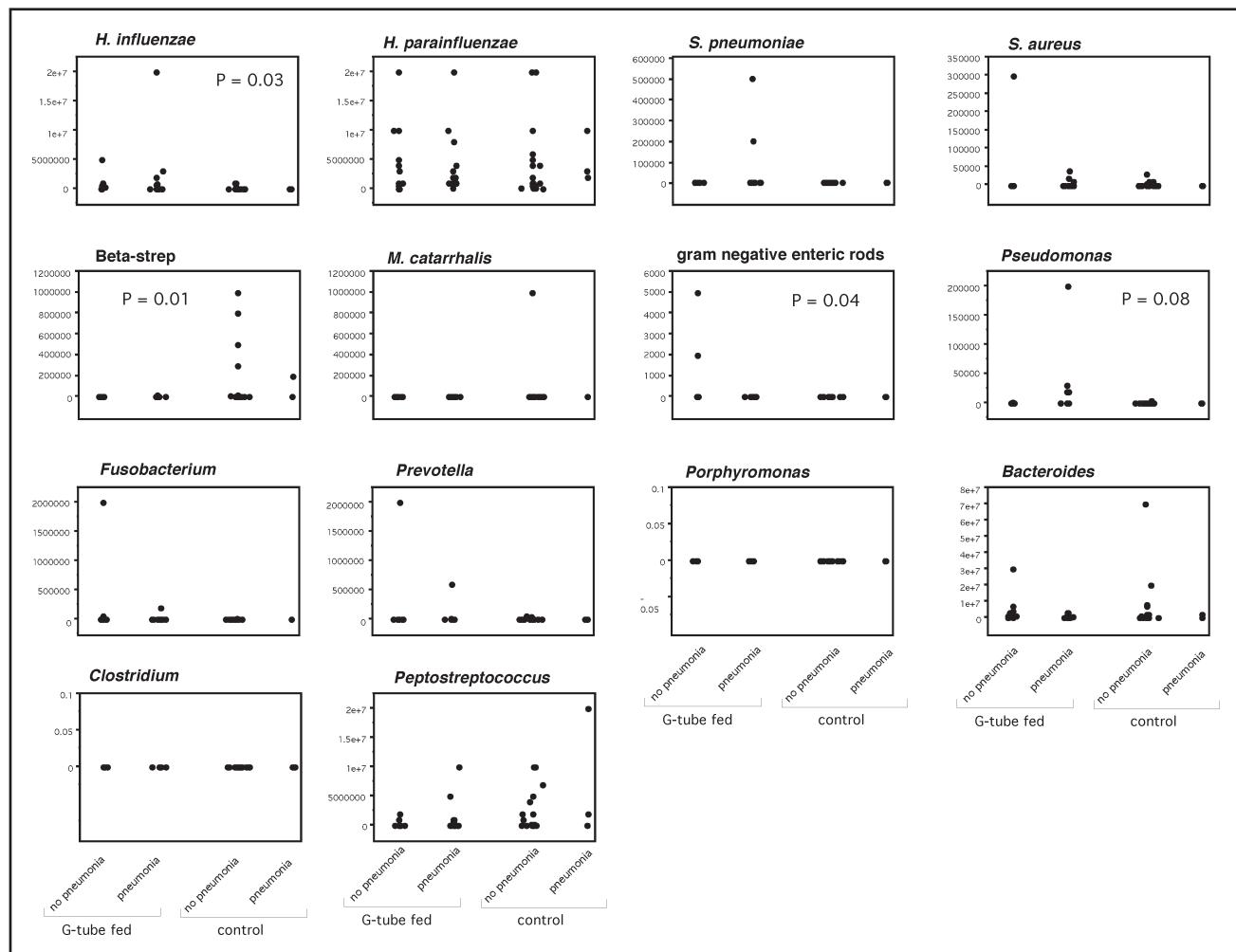


Figure 1. Levels of bacterial species or groups as related to feeding status and aspiration pneumonia history. Nonparametric statistical comparisons (Wilcoxon Rank Sums) were made for G-tube fed patients both with (N=15) and without (N=12) a history of pneumonia and for control subjects without history of pneumonia (N=24). Control subjects with a history of pneumonia were not included in the analysis due to a small sample size (N=3). *P* values less than 0.1 are shown.

### Oral health factors related to feeding and aspiration pneumonia

Table 3 shows reported oral health behaviors and findings from the examination and relates these to AP for GT and control groups, with and without AP. The GT group's brushing frequency was not significantly different from controls, but approached significance. The number of hygiene appointments was not significantly different between groups. Use of dentifrice, use of fluoridated dentifrice, and problems encountered during brushing (gag or bite reflex, bleeding) were also not significantly different between groups (nontabulated data).

Clinical examination found significantly more calculus in the GT group (17/27) compared to only 1 of 27 controls, with a mean score of  $20.9 \pm 18.6$  for GT subjects with AP vs  $4.9 \pm 8.8$  for GT subjects without AP ( $\chi^2$ , Wilcoxon rank sum,  $P=.001$ ). The GT group had significantly more plaque than controls ( $\chi^2$ , Wilcoxon rank sum,  $P=.006$ ). Gingival overgrowth was similar in both groups.

### Microbiology

The distribution of microorganisms was assessed by the number of colony-forming units grown (Figure 1). The distribution of microorganisms among 3 groups (controls without AP=24 subjects, GT with AP=15 subjects, and GT without AP=12 subjects) was analyzed using the Wilcoxon sum ranks test. Due to the low incidence of AP in controls (only 3 reported having had AP within 3 years), they were not included as a fourth group in the analysis (although portrayed in the figure for completeness). Significant differences were noted for:

1. *H influenzae*, which was significantly higher in the GT with AP group;
2. *β-Streptococcus*, which was significantly higher for controls without AP; and
3. gram negative enteric rods which were higher for GT subjects without AP. *Pseudomonas* species another AP-related organism, approached significance in GT subjects with AP.

Although not tabulated, patients with calculus were significantly more likely to:

1. experience vomiting;
2. have problems with swallowing and drooling;
3. have GT;
4. receive oral hygiene from caregivers;
5. eat fewer times per day;
6. have difficulty with consumption of fluids ( $\chi^2, P < .05$ ).

Problems with brushing such as gagging, clenching, and bleeding were not significantly related to presence of calculus.

## Discussion

This study looked at factors related to calculus accumulation in GT children. Some authors recommend calculus removal in GT patients, and oral hygiene is recommended to decrease the accumulation of calculus, but effectiveness is not well established by evidence for either. Because oral accumulations are typically associated with increased bacterial load, periodic removal of calculus and maintenance of oral hygiene might decrease the risk of AP. To the contrary, professional calculus removal may flood the respiratory tract with a pathogen-rich mixture. It may be better to leave calculus, or effect removal only when protection of the oropharynx can be assured. This is a clinical dilemma for dentists treating GT patients and prompted this study.

A previous longitudinal study of GT adults<sup>22</sup> found that calculus accumulated more rapidly than in a matched sample of disabled patients, in spite of a good oral hygiene program. This cross-sectional study of 2 well-matched samples found similar results, with GT children having more calculus, in spite of personal and professional hygiene interventions similar to controls (Table 3). This study confirms other investigations in that the presence of a GT predisposes one to calculus formation, but also suggests that personal oral hygiene procedures to reduce calculus are ineffective.

The microbiological investigation attempted to discern a role for both bacteria and calculus in AP. Previous work in older and debilitated adults found elevated levels of respiratory pathogens in GT patients. Several pathogens were found in higher levels in GT subjects in this study (Figure 1). The authors could not establish a consistent relationship between any other organism and calculus. This may be because of the cross-sectional nature of this investigation, small sample size, or the complex nature of pediatric AP. The curious finding of low *β-Streptococcus* in GT patients may be the result of low oral intake of substrate on which these organisms depend, predominance of other flora as a result of calculus, or just be a spurious finding due to the small sample. Another curious finding was the higher levels of plaque in GT patients than in controls. Dicks and Banning<sup>22</sup> concluded that GT calculus could not be blamed on calcification of plaque because, in their study, hygiene was excellent, yet calculus accumulated in GT patients.

This study's 2 subsamples had essentially the same oral hygiene habits and used dentifrice in a similar way, but differed in frequency of feeding. The GT patients ate less often. It may be that lack of oral function allowed the small, orally introduced substrate to support plaque growth and, thus, calculus formation. The authors' method of plaque sampling was simplistic yet consistent, but a more stringent sampling protocol may have yielded differing results.

The highly significant relationship between GT-driven calculus and AP is perhaps the most important finding and the first time such a relationship has been reported in children. This suggests that calculus may harbor a clinically significant level of pathogens, seeding AP in GT patients. This study suggests that calculus puts the child's systemic health at risk. The GT patient will eventually grow calculus and succumb to AP, whether or not good home care is provided. Frequent professional calculus removal does not seem to aggravate AP (Table 3) and would reduce calculus, a highly significant risk factor for AP in this study. However, more research is needed to replicate these findings with a larger sample and longitudinal research design before more frequent professional visits can be advocated for this population of children.

## Conclusions

1. GT subjects were more likely to experience AP as well as other symptoms of GT feeding than comparison children.
2. GT children were significantly more likely to have calculus.
3. Calculus was significantly related to AP.
4. Dental visit frequency had no relationship to AP.
5. *H influenzae*, gram negative enteric rods, and *β-Streptococcus* were the 3 organisms whose occurrence among groups differed significantly.

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The procedures, possible discomforts or risks, as well as possible benefits were explained fully to the human subjects involved, and their informed consent was obtained prior to the investigation.

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## ABSTRACT OF THE SCIENTIFIC LITERATURE



### PREVALENCE OF DENTAL INJURIES IN PRESCHOOL CHILDREN

Dental injuries to the primary dentition are important because of the possible sequelae to developing permanent teeth and occlusion. From previous published works, it is clear that much more attention has been given to the permanent tooth trauma. A recent study reported the prevalence of traumatic dental injuries in preschool children by sex and type. A total of 1,545 children ages 0 to 6 were examined for this study and traumatic injuries were identified in 36% of the children. The largest percentage of injuries was presented in 3- to 4-year-old children with no differences between males and females. Single-tooth trauma injuries were predominantly in all age groups. Crown fractures represented 83% of the dental trauma injuries.

**Comments:** These findings emphasize that primary tooth trauma is a relatively common occurrence. It also important that awareness is raised among parents and educators about the prevention of primary tooth trauma. JYL

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37 references

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