INCIDENCE OF DENTAL CARIES IN TUBE-FED CHILDREN AND TUBE-FED CHILDREN RECEIVING ORAL FEEDING THERAPY: A RETROSPECTIVE ANALYSIS

A Thesis

by

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ABSTRACT

Caries profile of tube-fed (TF) children and caries incidence in TF children receiving oral feeding therapy was analyzed. Partial or complete feeding; feeding diagnoses; modified DMF-T/dmf-t at first and last visit; modified DMF-T/dmf-t at first and last dental visits with concurrent oral feeding; recall interval; and treatment methodologies were recorded. Significant differences in caries distribution between 45 partial and 30 completely TF patients was seen at first and last dental visits, $p = 0.027$ and $p = 0.001$, respectively. Significant change in caries was noted for 22 patients undergoing concurrent feeding therapy, $p = 0.020$. Median recall frequency was 6 months and 27 patients had multiple diagnoses. For dental treatment, general anesthetic had 21 occurrences in contrast with 2 sedations and 1 use of nitrous oxide. Partial TF children should be monitored for caries development and TF children undergoing concurrent feeding therapy are at significant risk for caries development.

ACKNOWLEDGEMENTS

I could never attempt to explain the debt and appreciation I have for my faculty that empowered me daily. So, I won’t try. I can say that the training I have received and interactions with my faculty have completely changed my professional and personal life goals. I sincerely appreciate the guidance, mentorship, and friendship given to me by Dr. Carolyn Kerins, Dr. Alton McWhorter, and Dr. David Hale through out this process. This research project was only possible because of the interdepartmental teamwork anchored by Julie Cook, MS CCC-SLP in the Speech Therapy department at Children’s Medical center. Your guidance, explanations, and editing were crucial to help this dentist understand a different discipline.

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INTRODUCTION

It is inevitable that pediatric dentists will encounter patients with medical and nutritional problems related to feeding. Pediatricians have reported feeding disorders in 25%[1, 2] to 45%[3] of healthy children and 80% of children with developmental delay.[1, 2, 4] Causes of feeding problems are heterogeneous in etiology.[5-7] They can be anatomic, functional, or related to chronic illness with food nutritional requirements exceeding a child's ability to feed.[8] Therapy is targeted at both the severity and etiology of the disorder. This literature review focuses on current therapies employed by professionals treating these disorders, the research in this area, and a need for further dental research within this population.

Therapies for mild disorders may include parental training, nutritional education, interactive coaching, and suggestions for preparing food.[9] A child with a moderate disorder such as feeding inefficiency, may be effectively managed with caloric supplementation via glucose polymer feeds.[10] However, a child with a severe degree of oral-motor dysfunction can have multiple medical consequences,[5, 6, 10] necessitating adjunctive methods of feeding. [5, 8, 11, 12]

Adjunctive methods include tube feeding which is an advanced medical therapy intended to help increase the nutritional intake of children with severe feeding disorders.[10] A common type of tube feeding is accomplished via operative gastrostomy, where a gastrostomy tube (GT) is surgically placed into a child's stomach.[10, 13, 14] Additional tube feeding options include placing a fine-bore nasal gastric tube (NGT) through a child's nostril and positioned into the stomach. This method is generally reserved for short-term nutritional supplementation.[10] Common disorders that often require tube placement include failure to thrive, inadequate caloric intake, severe dysphagia, gastric esophageal reflux, and digestion problems associated with neurological impairment.[10, 13, 15, 16] These disorders require multifaceted medical treatment and the aforementioned adjunctive methods of feeding via GT and NGT, elevate the complexity of management.

Tube feeding is associated with a multitude of social, medical and psychological dilemmas. Multiple psychological and social concerns from the parental perspective have been reviewed. These issues include: inability to find public places to feed, separation from family members due the medical complexity of feeding, inability to find childcare, and numerous issues with sleep deprivation with nighttime feeding.[17] Medical sequelae with tube feeding are also reported in the literature.[15, 18] Studies have shown major complications in 17.5% of children who underwent gastrostomy.[15] Complications included persistent granulation tissue at the stomal site, peritonitis, gastronomy site infection, leakage, diarrhea, vomiting[13] and increased symptomatic gastric esophageal reflux.[15, 18] Many of these complications required corrective surgical intervention.[8, 15] While tube feeding ensures a child will receive adequate nutrition to grow and thrive,[19, 20] it can also result in numerous psychological and behavioral complications. A child's hunger-driven motivation to eat is decreased, rendering them unable to establish a link between eating and satisfying hunger.[6, 8] In addition, these patients are deprived of one of the five senses – taste. The decreased quantity of positive oral stimuli can result in a pathologic food refusal. Moreover, oral aversion is prompted as the child may become hypersensitive to any stimuli presented to the mouth due to past unpleasing oral experiences, now associating it as chronic noxious stimuli.[8, 20, 21] These children can be highly resistant to oral feeding and maintain dependence on tube feeding resulting with an oral acceptance ranging from only a few textures to complete food refusal.[22] These multiple medical, social, and behavioral adverse effects highlight the importance of decreasing tube dependence and increasing oral feeding.

Transitioning to oral feeding requires numerous therapies to meet the diverse etiology and presentation of children with advanced feeding disorders.[5-7, 23] Additionally, treatment goals may change while new behaviors are encountered,[6] as not every child will become 100% orally fed. Few scientific studies evaluating treatment for this population exist[5] and no uniform standard treatment protocol is exclusively confirmed in the tube-fed transition literature. However, at present this transition is accomplished via various inpatient and outpatient programs,[6, 24] all with differing amounts of behavior, pharmacological and oral feeding therapies.[5, 8, 19, 25]

Weaning a child from tube feeding is a major challenge for all parties involved including parents and health care specialists.[8] Moreover, the heterogeneous nature[5, 6] and origin[7] of these feeding problems necessitates that best treatment be accomplished by multiple providers.[5, 23, 26, 27] Thus, the standard of care for tube-fed children advocates the use of an interdisciplinary team of medical professionals which include a gastroenterologist, registered dietitian, behavioral psychologist, and occupational and/or speech language pathologist. This team makes decisions on oral feeding, tube feeding, types of food, and overall nutritional goals.[3-5, 8, 11, 12, 23, 24, 27] Generally the providers' roles are as follows: the registered dietician provides nutrient balance and manages caloric redistributions; the physician is monitoring the overall well-being of the child and medical intervention when needed; the psychologist provides a behavior perspective on feeding disorders, strategizing mealtime structure, feeding schedules, appetite manipulation, and parental training;[12] and the speech language pathologist aids in planning and providing feeding therapy[28] to facilitate the development of oral motor feeding skills, using behavior modification techniques to desensitize the oral cavity.[12, 29]

This desensitization is accomplished by an oral normalization program where a feeding therapist provides graded sensory sensation, escalating through touch, taste, and texture.[26] The therapist must determine the safest and most efficient types and texture of foodstuffs for a child to eat while maintaining adequate nutrition and hydration and maintain weight.[12] This can necessitate the use of high calorie foods, which can be of particular interest to a dentist. Depending on the nutrition needs and therapy goals, a child with a feeding problem is commonly treated by multiple daily exposures to any of the following foods: infant formula, fruit juices, runny pureed fruits, mashed fruits, naturally thick nectars, juice thickened with sherbet, milk thickened with pudding, milkshakes, graham crackers, vanilla wafers, cheese puffs and veggie sticks.[29] Most of these foods, including many infant formulas can be considered cariogenic due to the high amount of dietary sugar.[30, 31] Frequency and amount of dietary sugar exposure has been shown to be the very a significant factor in caries development.[32, 33, 29, 32] Dietary sugars found in food and some formula[13] are metabolized by anaerobic oral bacteria to form organic acid that dissolve tooth enamel and initiates the caries process.[32, 34] In patients with feeding issues, the duration of exposure to sugars must also be considered due to the extended oral phase of swallowing. Thus prolonged oral exposure to dietary sugars from food or formula increase the potential for caries development. Interestingly, no studies in the dental literatures have looked at feeding therapy as a possible caries risk factor.

Numerous topics related to the oral health of tube-fed patients have been studied in the literature.[13, 14, 16, 35-40] The most explored aspect in tube-fed individuals is calculus formation and its relationship to overall health. Multiple studies have documented higher rates of calculus formation in patients fed via tube.[13, 16, 36-39] Perhaps of more clinical importance is that in tube-fed patients, it has been demonstrated that 71% of calculus formation present at 3 months was formed in the first 30 days.[38] Additional studies following a similar design but incorporating aggressive oral hygiene failed to demonstrate a significant decrease in calculus accumulation in individuals fed by tube vs individuals orally fed.[41]

From these studies, it is clear that calculus presents a challenge for tube-fed patients and their providers. Nevertheless, advances in calculus control have been found by Brown et al., showing a 56% reduction in calculus using an anticalculus dentifrice when compared to a cavity control toothpaste.[16] Considering both the excessive amounts of calculus present in tube-fed children and that g-tube feeding has been associated with reduced salivary flow and bacterial salivary overgrowth,[16] it is appropriate that multiple other studies have investigated the bacterial flora of both the oral environment and the calculus in tube-fed patients.[16, 40]

A comparison of 27 GT-fed children vs 27 orally fed children with special health care needs showed that the significantly higher amounts of calculus and plaque puts the GT child's health at risk, documenting a relationship between GT driven calculus and its ability to harbor a clinically significant level of bacteria known to cause aspiration-pneumonia. This risk is elevated in GT-fed children as they tend to be more oral aversive and require professional cleaning and removal of calculus in the dental office. The study concludes that GT-fed children are more likely to experience aspiration-pneumonia.[9] In addition to the pathogenicity of supraginvial calculus and plaque bacterial flora, the content of the subgingival flora has been explored to gain insight about the relationship between periodontal pathogens and oral feeding.[40] The composition of subgingival microorganisms in GT-fed patients and healthy controls has been found to be the same for putative periodontal pathogens. The only statistically significant difference noted is lower amounts of *streptococcal* species. Nonetheless, results suggest that oral food consumption has very trivial effect on the composition of subgingival microbiota.[40]

In addition to bacteria composition, the buffering capacity of the plaque and calculus has been investigated by multiple studies focusing on properties of the oral cavity's dental plaque content in tube-fed individuals.[39, 40] An early study analyzing tube-fed individuals focused on the pH change of plaque in response to a sucrose challenge. Samples were acquired from the following populations: tube-fed only, soft diet, or finely diced diet. Their findings concluded that plaque collected from strictly tube-fed individuals was less acidogenic when compared to plaque collected from individuals fed by mouth. Of particular importance is the commentary by the authors concerning plaque samples collected from 12 patients fed via Levin nasal tube. Plaque samples from those who had recently transitioned from Levin nasal tube feeding to complete oral feeding showed a pH decrease of nearly 2 while the mean pH in Levine tube-fed only patients stayed at a more neutral 6.1. Although these findings represent a small sample size, it is evident that carbohydrate presence after transitioning from tube feeding lowered the pH of the mouth favoring an environment of caries formation.

Currently, the only study to include caries rates in tube-fed individuals was completed by Hidas et al., comparing: (i) a decayed, missing, filled or treated (DMF-T/dmf-t) index; (ii) calculus index; (iii) *Mutans Sreptococci* (MS) and *lactobacilli* (LB) levels; and (iv) salivary buffering capacity in only 12 GT-fed children, 16 orally fed children with disabilities and 17 healthy children. Results demonstrated significantly higher calculus levels, less caries, lower MS and LB levels in GT only fed patients.[37] These studies indicate that the presence of fermentable carbohydrates leads to lower acid buffering and higher MS and LB levels, overall adding evidence to the well-established relationship between high sucrose diet and levels of MS and LB in the carious process.[40, 42] It appears that because of the introduction of a high sucrose diet, a child transitioning from tube feeding would possess an oral environment favoring the carious process and is thus at a higher risk for tooth decay.

The American Academy of Pediatric Dentistry (AAPD) has developed a caries-risk assessment tool (CAT) to aid in determining preventative and restorative treatments. This tool evaluates a patient's age, biological factors, protective factors, level of patient/parent cooperation, and clinical findings to determine if that patient is at low, moderate or high-risk for dental caries. The current risk assessment tool places a child with special health care needs at moderate risk for dental caries;[43] however, no distinction is made for children fed via tube. Moreover, no dental guidelines for treatment or frequency visits currently exist for tube-fed children.[36]

Given the significant morbidities associated with both tube placement and tube maintenance, and also the negative effects of tube feeding on the oral cavity and general health, it is clear that attaining oral feeding is of overriding importance to these patients. Consequently, the benefits of oral feeding therapy, as a means to achieve tube independence and successive oral feeding seems to outweigh any potentially cariogenic practices it may employ. Therefore, children receiving feeding therapy or partially tube-fed children are at a higher risk for caries, and need a pediatric dental home whereby the treating dentist can take a more active role in caries prevention.

To date, one study has examined caries prevalence in a pediatric tube-fed population. No studies make any distinction of a partially oral fed population, and no studies have looked at the effects of oral feeding therapy as a potential caries risk factor. Therefore, the aim of this study is to gather a caries profile of tube-fed and partially tube-fed children and to determine the caries incidence after attempted oral feeding transition has occurred.

CHAPTER II

SUMMARY AND CONCLUSIONS. INCIDENCE OF DENTAL CARIES IN TUBE-FED CHILDREN AND TUBE-FED CHILDREN RECEIVING ORAL FEEDING THERAPY: A RETROSPECTIVE ANALYSIS

Pediatric dentists often encounter patients with medical and nutritional problems related to feeding. Pediatricians have reported feeding disorders in 25%[1, 2] to 45%[3] of healthy children and 80% of children with developmental delay.[1, 2, 4] Causes of feeding dysfunction are heterogeneous in etiology[5-7] and can be anatomic, functional or related to chronic illness with food nutritional requirements exceeding a child's ability to orally feed.[8] A child with a severe degree of oral-motor dysfunction can have multiple medical consequences,[5, 6, 10] necessitating adjunctive methods of feeding[8, 5, 11, 12] to increase nutritional intake[10] which impacts dental care.

These adjunctive methods include tube feeding via operative gastrostomy, where a gastrostomy tube (GT) is surgically placed in to a child's stomach[10, 13, 14] or placement of a fine-bore nasal gastric tube (NGT) through a child's nostril into the stomach.[10] Disorders that often require tube placement include failure to thrive, inadequate caloric intake, severe dysphagia, gastric esophageal reflux, and digestion problems associated with neurological impairment[10, 13, 15, 16] While tube feeding ensures nutritional demands are met, it also elevates the complexity of management.

Management complications arise from a multitude of social, medical, dental, and psychological dilemmas associated with tube feeding.[13, 15, 16, 17, 18, 21, 36, 38, 41] Some typical consequences of tube feeding with direct impact on the patient include caregiver sleep deprivation, family separation,[17] gastronomy site infection, diarrhea,[15, 18] vomiting,[13] increased calculus formation,[13, 16, 36-39] aspiration pneumonia[13] and promotion of oral aversion.[6, 8, 20, 21] These adverse effects highlight the importance of decreasing tube dependence and increasing oral feeding.

Transitioning to oral feeding is accomplished via various inpatient and outpatient programs,[6, 24] with differing amounts of behavior, pharmacological and oral feeding therapies.[5, 8, 19, 25] The heterogeneous nature[5, 6] and origin[7] of these feeding problems necessitates that treatment be accomplished by multiple providers.[5, 23, 26, 27] Thus, the standard of care for tube-fed (TF) children advocates the use of an interdisciplinary team of medical professionals which may include gastroenterologists, registered dietitians, behavioral psychologists, and occupational and/or speech language pathologists. This team makes decisions on oral feeding, tube feeding, types of food, and overall nutritional goals.[3-5, 8, 11, 12, 23, 24, 27] For example, the speech language pathologist aids in planning and providing feeding therapy[28] using behavior modification techniques to desensitize the oral cavity.[12, 29]

Desensitization is accomplished by an oral normalization program where a feeding therapist provides graded sensory sensation, escalating through touch, taste and texture[26] while maintaining adequate nutrition and weight.[12] This may require the use of high calorie foods, which can be of particular interest to a dentist. Depending on nutritional needs and therapy goals, a child with a feeding problem is commonly treated by multiple daily exposures to any of the following foods: infant formula, fruit juices, thin pureed fruits, mashed fruits, naturally thick nectars, juice thickened with sherbet, milk thickened with pudding, milkshakes, graham crackers, vanilla wafers, cheese puffs and veggie sticks.[29] These foods are considered cariogenic due to the high amount of dietary sugar.

Dietary sugars found in food and some formula[13] are metabolized by anaerobic oral bacteria to form organic acids that dissolve tooth enamel and initiate the caries process.[32, 34] The frequency and amount of dietary sugar exposure has been shown to be a significant factor in caries development.[32, 33 29, 32] Duration of sugar exposure must also be considered in these transitioning patients due to the extended length of the oral phase of swallowing in these patients. Therefore, due to prolonged oral exposure to a high sucrose diet, a child transitioning from tube feeding possesses an oral environment that favors the carious process and is thus at a higher risk for tooth decay.

Interestingly, no studies in the dental literatures have looked at feeding therapy or partial tube feeding as a possible caries risk factor. The American Academy of Pediatric Dentistry Caries-Risk Assessment Tool places a child with special health care needs at moderate risk for dental caries;[43] however, no distinction is made for children fed via tube. To date, one study has examined caries prevalence in a pediatric TF population.[37] Additionally, no dental guidelines for treatment or visit frequency currently exist for TF children.[36] Therefore, the aim of this study was to gather a caries profile of TF and partially TF children and to determine the caries incidence while attempted oral feeding transition has occurred.

Materials and Methods

Approval for access to patient information was obtained from the Institutional Review Board at the University of Texas Southwestern Medical Center and site specific approval from Children's Medical center in Dallas, Texas. A patient population was generated by searching patient rosters of both the dental and speech therapy clinics at Children's Medical Center for the following ICD-9-CM codes: dysphagia (ICD-9-CM 787.2), feeding difficulties (ICD-9-CM 783.3), esophageal reflux (ICD-9-CM 530.81), failure to thrive (ICD-9-CM 783.41), short stature (ICD-9-CM 783.43), lack of normal physiological development, unspecified (ICD-9-CM 783.4), feeding difficulties and mismanagement (ICD-9-CM 783.3), feeding evaluation & feeding re-evaluation (ICD-9-CM 92610), dysphagia therapy (ICD-9-CM 92526), dental caries (ICD-9-CM 521) and other dental caries (ICD-9-CM 521.09). All TF patients that maintained at least two visits in the dental clinic were included in the sample population. A dental caries experience profile was determined by analyzing the following variables: feeding related diagnoses; caries presence at the new patient exam and the last dental visit using a modified DMF-T/dmf-t score which excluded natural exfoliation and treatment not related to caries; recall frequency in dental clinic; the use of pharmacological behavior management including nitrous oxide, oral conscious sedation; and general anesthetic treatment methodologies. Data was stratified by the type of tube feeding: partial or completely tube-fed. In patients who received oral feeding therapy, a modified DMF-T/dmf-t score was recorded at the first and last dental visits where concurrent oral feeding therapy was noted in the medical chart. Excel (Excel 2011, Microsoft Corp., Redmond, Washington) and SPSS (SPSS 20.0, IBM Corp., Armonk, New York) were used to analyze data. This analysis included summary data representing the caries profile of all the TF patients, a Mann–Whitney U test comparing total caries presence between partial and completely TF patients, and a Wilcoxon Signed-Rank test for tube feed patients receiving feeding therapy (TFPRFT).

Results

The final sample consisted of 75 TF patients. Data was not normally distributed, and therefore descriptive and non-parametric statistics were utilized. Median modified

DMF-T/dmf-t at the first and last visit of all TF patients was 0 for both samples with an interquartile range of 0 and 2, respectively (Figures 1 and 2).

Of all patients, 45 were partially TF and 30 were completely TF. Concurrent feeding therapy was observed in 23 TF patients. Median modified DMF-T/dmf-t and interquartile range was 0 for the first and last dental visits of completely TF patients (Figure 3 and 4). Partially TF exhibited a 0 median modified DMF-T/dmf-t for both the first and the last dental visits with an interquartile range of 1 and 10, respectively (Figure 5 and 6). Caries distribution significantly differed between partial TF and completely TF patients at both the first ($p = 0.027$) and last dental visits ($p = 0.001$). A significant difference in caries presence was observed between first and last visits where oral feeding therapy was observed ($p = 0.02$) (Table 1).

Multiple feeding related diagnoses were seen in 27 patients with 106 total diagnoses listed: feeding difficulties (29%), esophageal reflux (27%), dysphagia (27%), failure to thrive (12%), feeding difficulties and mismanagement (4%), and lack of normal physiologic development, unspecified (2%) (Figure 7). General anesthetic was the most employed behavior management modality with 21 noted uses followed by 2 sedations and only 1 attempt with nitrous oxide (Figure 8). The median recall visit frequency was 6 months.

Tables and Figures

Table 1. Modified DMF-T/dmf-t with concurrent oral feeding therapy

	Patient number																						
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
First visit	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	6	0	0	0	16	0	0	4
Last visit	6	10	8	0	0	0	0	8	20	0	0	1	0	3	0	10	15	0	14	26	0	0	6

*p = 0.02 for change in median caries presence between visits

Figure 1. Caries distribution at first dental visit of all tube-fed patients

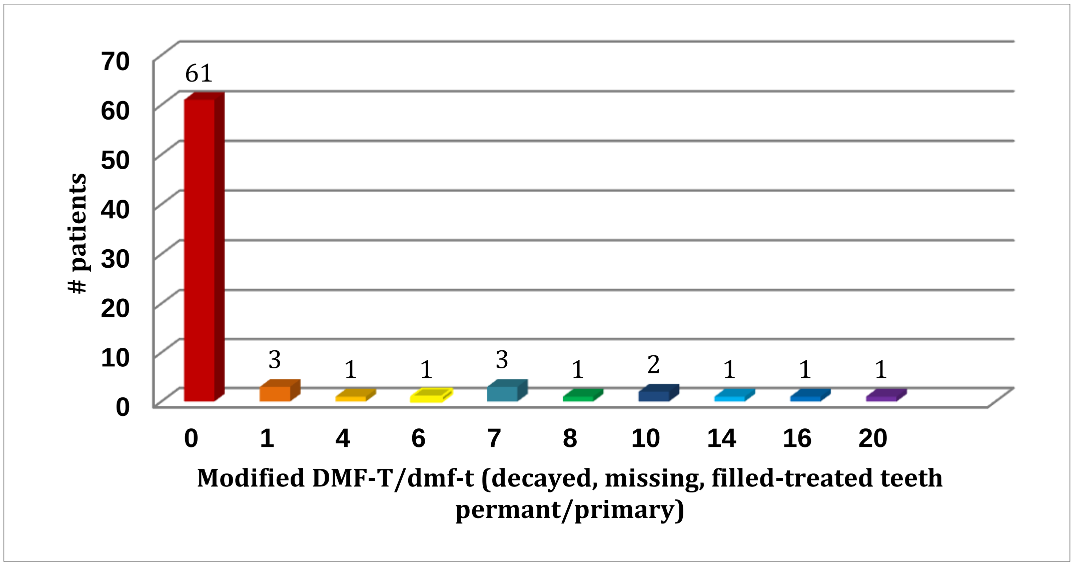


Figure 2. Caries distribution at last dental visit of all tube-fed patients

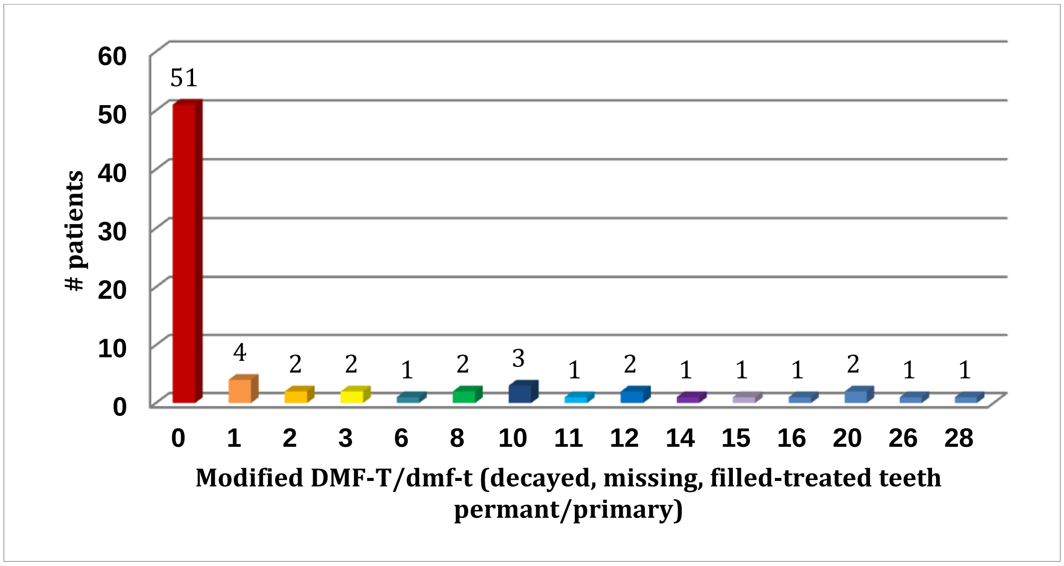


Figure 3. Caries distribution at first dental visit of completely tube-fed patients

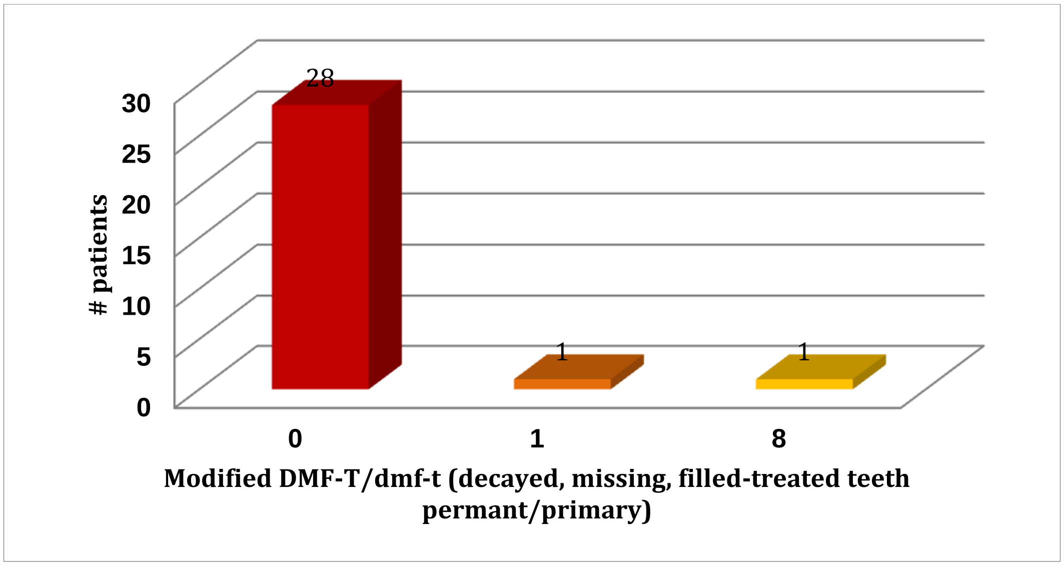


Figure 4. Caries distribution at last dental visit of completely tube-fed patients

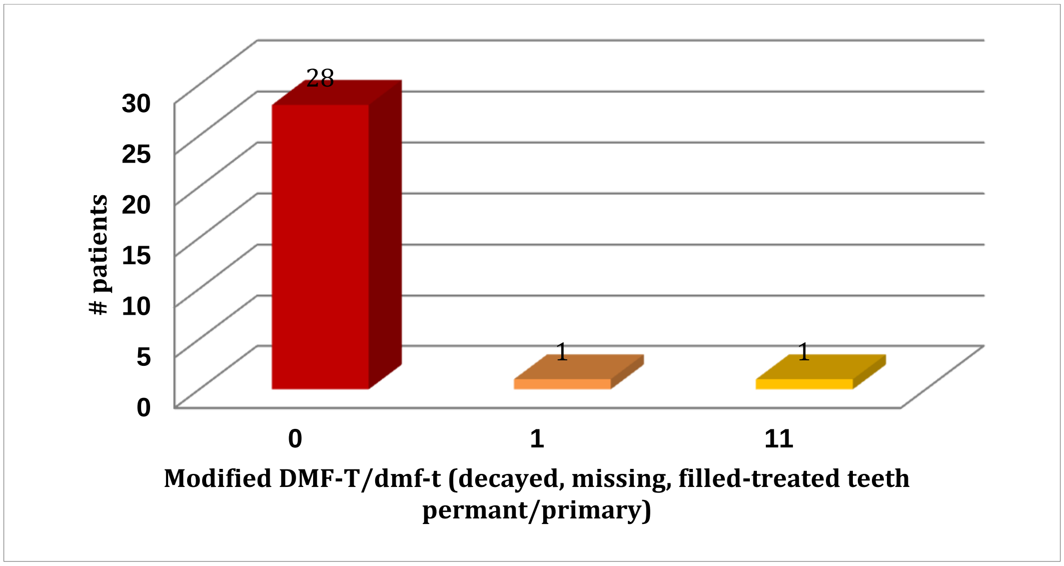


Figure 5. Caries distribution at first dental visit of partial tube-fed patients

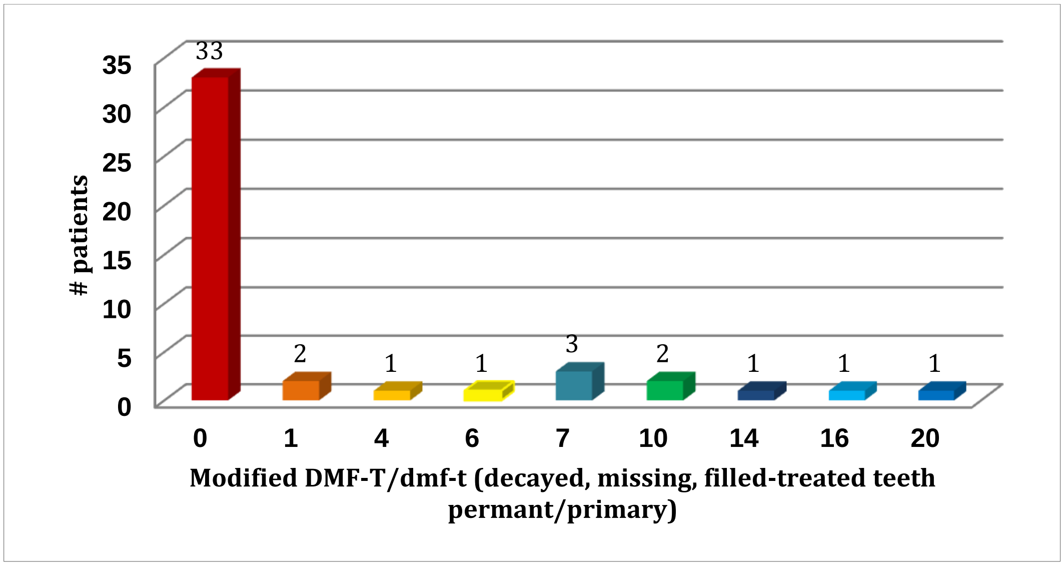


Figure 6. Caries distribution at last dental visit of partial tube-fed patients

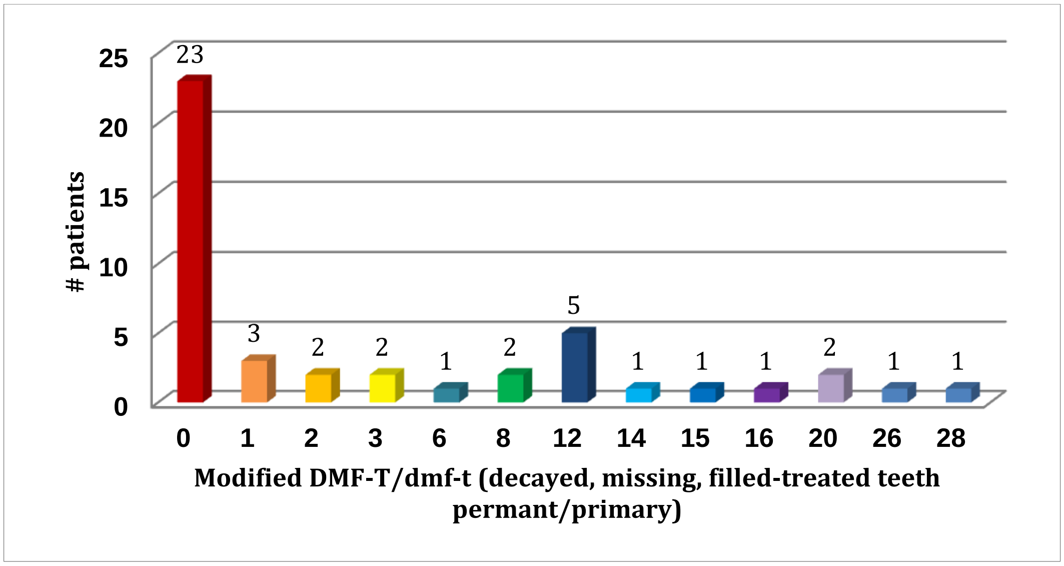


Figure 7. Distribution of feeding diagnoses

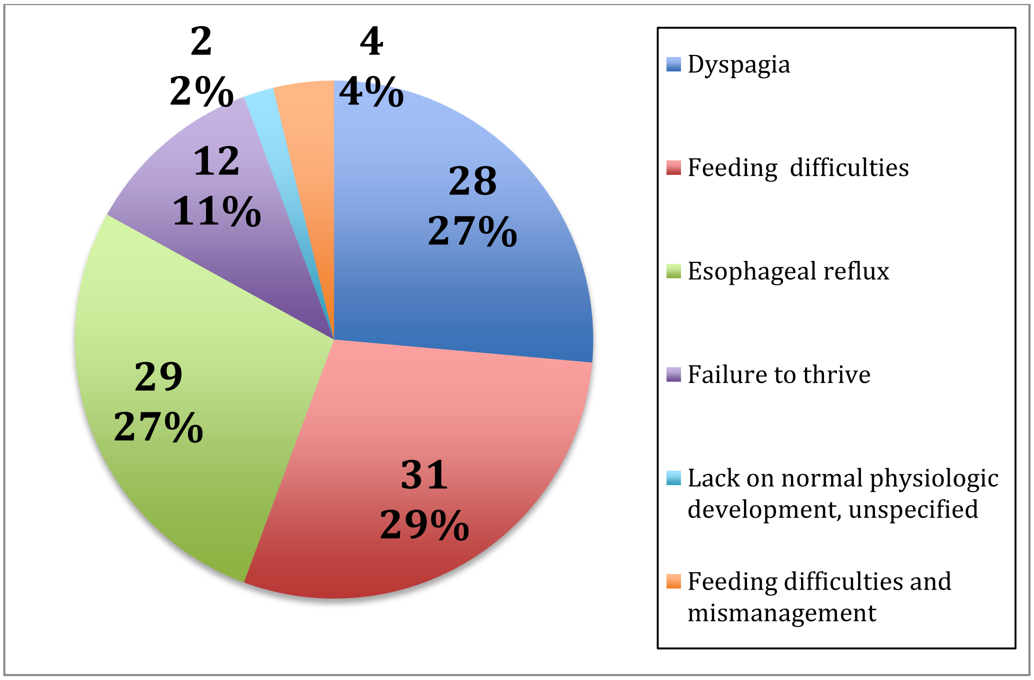
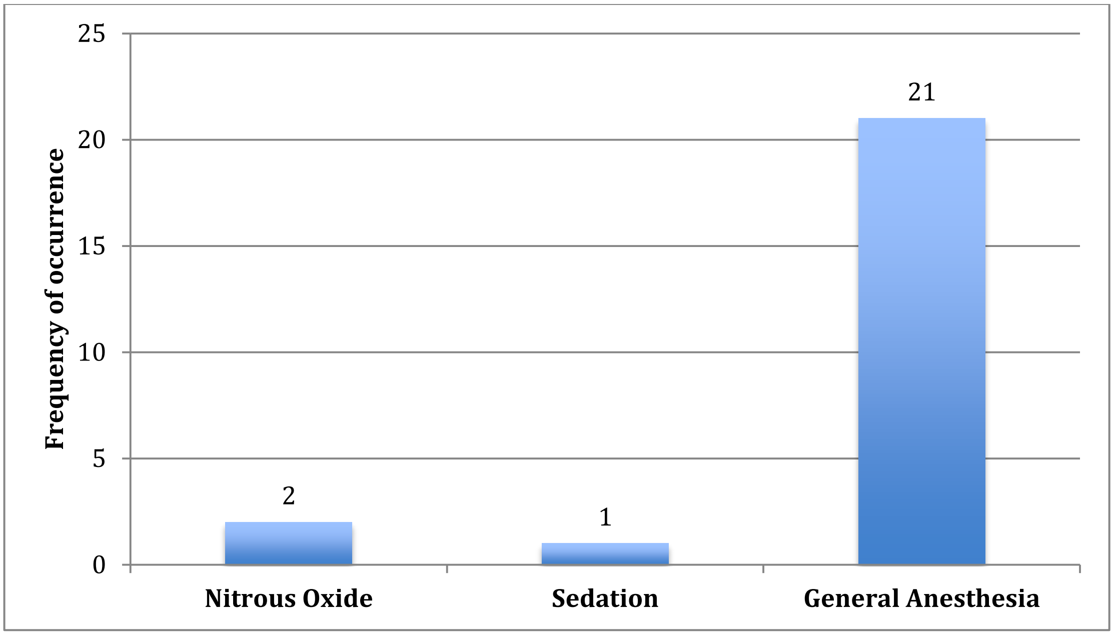


Figure 8. Distribution of behavior management modalities



Discussion

This study explored the carious experiences of TF children and aspects of their management that potentially places this population at risk for caries. Historically, most literature has focused on the significant amount of calculus formation and its associated negative sequelae on overall health.[13, 16, 36-39] These studies were conducted without a partial or complete TF distinction and as such, have concluded that this population is at a low risk for caries.[37]

The majority of this present study's results are in agreement with previous literature reporting of low caries risk. The 0 median modified DMF-T/dmf-t seen in all TF patients at the first and last visits and the small interquartile range illustrate that as a whole, TF patients in this study are at a low risk for caries with nearly 2/3 of all patients failing to demonstrate caries development between visits. However, further examination of the results show a need to differentiate the specific population subsets so that the majority of patients rather than all should be considered low risk for caries formation.

It is clear that the substantial majority of the caries free population are contained within the 30 completely TF sample. Only two patients from this group showed any carious lesions and one patient exhibited an increase in caries between the first and last visits. This is in contrast with the partial TF population, where nearly 50% of all patients displayed development of carious lesions between first and last visits. Although the median modified DMF-T/dmf-t was the same between both populations, the extreme difference in caries distribution between partial and completely TF population was found to be statistically significant at both first and last visits. This is likely because in the partial TF sample a modified DMF-T/dmf-t score of at least 10 was seen in 5 patients at the first visit and 12 at the last visit. From these findings it can be generalized that a partial TF population has a dissimilar caries experience in comparison with completely TF patients and should be differentiated in regards to dental management of all TF patients.

Missing from the foregoing literature is the aspect of dental management in TF patients in the time period where a patient is participating in oral feeding therapy. The results of this study indicate that patients receiving feeding therapy are at a potentially higher risk for carious development with over 1/2 of all patients developing caries between visits. Comparison with the literature is problematic, since this has not been studied specifically. However, one previous study has examined plaque samples from patients who recently transitioned from nasal tube feeding to complete oral feeding in comparison with completely TF patients. Plaque samples from those who recently transitioned showed a pH decrease near 2 while the mean pH in TF only patients stayed at a more neutral 6.1.[39] Although, both studies represent a small sample size, it is evident that oral feeding while transitioning from tube feeding can lower pH of the mouth favoring an environment of caries formation.

A median 6-month recall frequency was observed for all TF patients. This is expected since the standard recall frequency for children is typically 6 months and according to the American Academy of Pediatric Dentistry, intervals may be modified to meet unique requirements for special needs patients.[44] As aforementioned, no guidelines for recall visits exist for TF children and it has been suggested that quarterly scaling and polishing is an appropriate baseline recall rate for these children.[36] Results of this study do support these recommendations with only 4 of 24 patients on 3 month recall displayed an increase in caries between visits.

General anesthesia was the most common employed behavior management modality, used in nearly one-third of all patients to facilitate dental restorative treatment. Infrequently used were oral sedation and nitrous oxide. The gravity of this finding is illustrated by literature documenting the high cost of treatment under hospital administered general anesthetic coupled with the fact that general anesthesia is considered the least accepted behavior management modality from parents.[45] The frequency of general anesthetic use may be a reflection of several factors that classify these patients as poor candidates for in office procedures. These include the young age and low weight of failure to thrive patients, extreme oral defensiveness, inability to tolerate oral secretions and multiple other medical comorbidities associated with patients in this study.

Consequently, it is prudent to note some characteristics of patients and the hospital that could potentially influence results. Children's Medical Center is a major children's hospital and a national referral source for sick children. It follows that several patients included in this study have significant medical comorbidities that include congenital heart defects such as 22q11.2 deletion syndrome, hypoplastic left heart syndrome and Tetralogy of Fallot. Many of these conditions required treatment with digoxin, which has been correlated with increased caries in children.[46] Over one-third of patients in this study also demonstrated multiple feeding diagnoses increasing the overall complexity of medical management these children received. Additionally, literature has confirmed that underlying medical conditions influence the use of general anesthesia[47, 48] which likely supports the inclination towards dental rehabilitation in the operating room seen in these findings. Therefore, these results can best be extrapolated to a hospital dentistry environment where multiple providers treat medically complex patients.

This study could be improved by including a comparison of caries rates to both a healthy pediatric population and a special needs population without feeding disorders. Additionally, this study was unable to document oral feeding therapy diet specifics and medications at a regular frequency. To truly draw a correlation between oral feeding therapy and caries presence, a prospective randomized clinical trial documenting therapy diet, medication specifics, and caries presence before and after the initiation of feeding therapy is needed. Lastly, when considering retrospective chart reviews, analyzing more patients will increase the ability to generalize findings to clinical populations.

As health care delivery becomes more integrated among various disciplines, potential vulnerable populations can be better served. Dental providers can work in parallel with the multiple specialties managing partially TF children and TF children undergoing feeding therapy to help prevent the use of general anesthesia and other costly dental treatment. Consideration should be given to an initial specific anticipatory guidance session at the onset of feeding therapy; closer evaluation of diet and goals of partial oral feeding; and more frequent dental recall visits.

Conclusions

1. Completely TF patients appear to be at a low risk for caries development.
2. Partially TF patients are vulnerable to carious development and are more likely to develop caries than completely TF patients.
3. A TF child enrolled in concurrent feeding therapy should be considered at potentially higher risk for caries formation.
4. There is a need for research into feeding therapy and oral hygiene in TF patients.
5. Pediatric dentists should be more attentive to diet and feeding goals of TF patients.
6. The majority of TF patients with caries are likely to receive treatment under general anesthesia.

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