Saliva Secretion and Oral Flora in Prolonged Nasogastric Tube-Fed Elderly Patients

Arthur Leibovitz MD[1], Galina Plotnikov MD[1], Beni Habot MD[1], Mel Rosenberg PhD[2], Andi Wolf DMD[2], Refael Nagler DMD MSc PhD[3], Eran Graf Phd[4] and Refael Segal MD[1]

[1] Geriatric Medical Center, Shmuel Harofe Hospital, Beer Yaakov, Israel
Affiliated with Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel
[2] School of Dental Medicine, Tel Aviv University, Ramat Aviv, Israel
[3] Dental Medicine School, Technion, Haifa, Israel
[4] Chemistry Laboratory, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel

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Abstract

Background: In a previous study we showed that prolonged nasogastric tube feeding is associated with pathogenic oral flora.

Objective: To reexamine the impact of prolonged nasogastric tube feeding on the oral microbiota and to explore the salivary flow and composition in elderly patients in long-term care.

Methods: We compared a group of elderly patients fed by nasogastric tube with a control group of elderly patients in long-term care who are fed orally. Bacteriologic studies were performed by culturing samples from the oropharynx. Saliva studies included quantitative and biochemical analysis of basal and stimulated salivary flow.

Results: Bacteriologic studies performed in 90 patients revealed a significantly higher prevalence of gram-negative bacteria in nasogastric tube-fed patients (73% vs. 13%, $P < 0.001$). It is emphasized that *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* were commonly and exclusively isolated from the oral flora of the nasogastric tube-fed patients ($P < 0.001$, $P < 0.05$). In the saliva studies performed on 23 nasogastric tube-fed and 21 control patients, basal and stimulated salivary flow was not significantly different in the two groups, however the ratio of stimulated to basal flow was reduced in the nasogastric tube-fed group ($P < 0.05$). Significant differences were also found in the concentrations of sodium, amylase, phosphor and magnesium. Noteworthy was the concentration of uric acid, the main non-enzymatic antioxidant of saliva, which was significantly lower in nasogastric-tube fed patients ($P < 0.002$).

Conclusions: These findings suggest that prolonged nasogastric tube feeding is associated with pathologic colonization of the oropharynx and with alterations in the saliva that are related to the risk of aspiration pneumonia. Further research is called for, as well as a thorough revision of the existing oral cleansing procedures in these patients.

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Increasing numbers of elderly patients with oropharyngeal dysphagia require tubal enteral feeding in order to prevent aspiration and to maintain adequate nutrition and hydration [1]. Decisions as to whether or not to tube feed are fraught with medical and ethical concerns, reflecting the paucity of the evidence regarding this procedure [2]. Moreover, several studies have reported that not only does tube feeding not reduce aspirations but is itself associated with increased risk for aspiration pneumonia [3,4].

Aspiration of infected oral content – i.e., saliva and gram-negative bacterial pathogens – into the lower respiratory tract is the main cause of pneumonia [5,6]. Few if any studies have addressed the impact of prolonged nasogastric tube feeding on the oral flora and salivary secretion. What are the potential consequences of not chewing, and of the lack of mechanical clearance that is provided by the passage of food, for the oral flora and salivary secretion? In a recently published study we showed that the nasopharyngeal habitat of frail elderly patients fed by nasogastric tube or cutaneous gastrostomy is colonized by pathogenic bacteria not found in orally fed patients [7]. These findings point to the importance of mastication and swallowing in preventing colonization and raise the question of a possible impact of prolonged nasogastric tube feeding on the salivary flow and its composition. Exploring this issue could throw light on factors related to aspiration pneumonia.

The aims of this investigation were to reconfirm our previous results by culturing samples from the oropharynx of patients on nasogastric feeding and to study the flow and the composition of the saliva in these patients.

Methods

The study group consisted of residents of skilled nursing care wards who had been on nasogastric feeding for at least 1 month. The control group included age and gender-matched patients on independent feeding. Only patients in stable medical condition for at least 4 weeks entered the study. Excluded from both groups were subjects with advanced cancer of any kind, patients with Sjögren's syndrome, and those after irradiation to the head and neck. Also excluded were patients who had received any antibiotic treatment during the 4 week period prior to the study.

Whole salivary flow, basal and stimulated (using 4% citric acid), were collected 2 hours after breakfast, as described by Sreebney [8]. Saliva samples were frozen and chemical analyses were performed at the laboratory of the Tel Aviv Sourasky Medical Center.

Cultures were performed by sampling the oropharynx with swabs, taken from the base of the tongue dorsum by rubbing the buccal mucosa with a sterile cotton swab that was then placed in transport medium. The sampling was performed in the morning hours before breakfast and before the daily oral cleansing procedure. Routine oral hygiene for nasogastric tube-fed patients was performed before meals three times a day by cleansing the oral cavity with lemon-glycerine wadding sticks (impregnated with a

solution of glycerine-citric acid, lemon flavoring, sodium benzoate 0.1%; Lemogil, Pollak Ltd, Kfar Saba, Israel).

Cultures were inoculated within 1 hour of collection on blood, MacConkey's, and chocolate agar plates, and were aerobically incubated at 35°C. Gram-negative bacteria and *Staphylococcus aureus* were identified using the BBL Crystal enteric/Nonfermenter ID System (Becton Dickinson, MD, USA). Only moderate to heavy bacterial growth was considered positive.

Statistical analysis was performed using the SPSS software. Descriptive presentation of the data was followed by comparative statistical processing using Student's *t*-test or chi-square test. Pearson's coefficient was used for correlation studies. $P < 0.05$ was considered significant.

Results

Oral microbiota

Ninety patients participated in this section of the study. Forty-five patients were on nasogastric feeding for an average period of 20.8 ± 32 months (range 1–160 months). The control group consisted of 45 orally fed patients, residents of the same long-term care wards. Table 1 shows the isolation rates of pathogenic gram-negative organisms and of *Staphylococcus aureus*. A significantly higher rate of isolation of pathogenic bacteria was found in patients on nasogastric feeding than in those on oral feeding (73% vs 13%, $P < 0.001$). *Pseudomonas aeruginosa* was found in 32% of the patients on nasogastric feeding, but in none of those fed orally ($P < 0.001$). *Klebsiella pneumoniae* was also cultured in the nasogastric patients only ($P < 0.05$). *Staph. aureus* was cultured with similar occurrence (9%) in both groups. No correlation was found between the length of time on nasogastric feeding and the isolation of a pathogenic bacterium. No correlation was found with co-morbid diseases, such as diabetes and coronary obstructive pulmonary disease, and the presence of pathogenic microbiota. However, a correlation was found between the presence of dementia and a positive bacterial culture ($P < 0.02$).

When dental status was examined, no significant difference was found between the two study groups except for the fact that no subject in the nasogastric group wore dentures. There was no correlation between the presence of dentures or residual dentition and oral pathogenic microbiota.

Salivary secretion and biochemical analysis

Salivary flow rate measurements and chemical analyses were performed in 44 subjects recruited from the 90 patients who participated in the microbiologic study. Included in this section were those with a minimal cooperation level required for this procedure. These 44 patients included 23 nasogastric fed patients and 21 control patients. Table 2 presents demographic and medical details of both groups. Neurologic disorders such as dementia and stroke were highly prevalent in the group of nasogastric tube-fed patients ($P < 0.005$). There was no significant difference between the two groups regarding the use of drugs that might have affected salivary flow.

Table 3 summarizes the results of the salivary secretion studies. Although not statistically significant, the basal secretion in patients

Table 1. Pathologic oral flora in nasogastric tube-fed patients in long-term care

	Patients on nasogastric feeding (n=45)	Patients on oral feeding (n=45)	*P*
Pathogenic Isolations	33 (73.3%)	6 (13.3%)	<0.001
Pseudomonas aeruginosa	14 (32%)	0	<0.001
Klebsiella pneumoniae	5	0	<0.028
Klebsiella – Other groups	3	2	
Escherichia coli	3	1	
Staphylococcus aureus	5	4	
Others*	7	1	<0.029
Mixed culture **	5	2	

* Others: *Proteus* (n=1), *Serratia* (n=2), *Enterobacter* (n=1), *Citrobacter* (n=1), *Morganella morganii* (n=1), *Providencia* (n=1).

** Mixed culture: two to three different bacteria.

Table 2. Demographic and medical characteristics

	Nasogastric tube-fed patients	Orally fed patients
No. of patients	23	21
Average age	82.4 ± 9.5	82.4 ± 7.5
Men/Women	17/6	16/5
Duration of nasogastric feeding (months)	14.3 ± 13.42	
Diseases		
Diabetes mellitus	6 (26%)	4 (19%)
Ischemic heart disease	7 (30%)	8 (38)
Hypertension	10 (44%)	8 (38%)
Stroke*	14 (61%)	4 (19%)
Congestive heart failure	6 (26%)	6 (29%)
Depression	2 (9%)	2 (10%)
Dementia*	21 (91%)	8 (38%)
Parkinson	9 (39%)	3 (14%)
Medications**		
Beta-blockers	3 (13%)	1 (5%)
Diuretics	1 (4%)	2 (10%)
Antidepressants	1 (4%)	1 (5%)
Antipsychotics	1 (4%)	3 (14%)
Antiparkinson	3 (13%)	1 (5%)

Percentages are rounded to the nearest whole number.

* $P < 0.05$

** Medications that might affect salivary secretion.

Table 3. Results of saliva flow studies

	Nasogastric tube-fed patients	Orally fed patients	*P*
Basal secretion	0.59 ± 0.60	0.36 ± 0.21	NS
(range)	(0.1–3.0)	(0.1–1.0)	
Stimulated secretion	0.84 ± 0.78	0.78 ± 0.47	NS
(range)	(0.1–4.0)	(0.1–2.0)	
Stimulation ratio	64.2% ± 72%	137% ± 135%	0.036

Salivary secretion was measured for 1 minute without (basal) and with citric acid 4% (stimulated). Figures represent average range of secretion in ml/min and standard deviation.

with nasogastric feeding was slightly higher. The stimulated secretion was not different between the groups. However, the stimulation ratio (the ratio between stimulated and basal salivary flow) was significantly lower in the nasogastric tube-fed patients ($P < 0.05$).

Table 4 shows the results of the biochemical components of the saliva. A significantly higher concentration of sodium was observed in the nasogastric group, both basal and stimulated ($P < 0.008$ and $P < 0.001$, respectively). Accordingly, the concentration of chloride was also higher in this group ($P < 0.05$). Amylase concentration was also higher in the nasogastric group ($P < 0.05$, only basal). In contrast, patients on nasogastric feeding had lower concentrations of phosphorus ($P < 0.003$), magnesium ($P < 0.04$ only basal) and, interestingly, uric acid ($P < 0.002$). Highly significant correlations ($P < 0.001$) were found for each of the biochemical measurements between their values in the basal and in the stimulated saliva.

Table 4. Biochemical salivary components in patients on nasogastric feeding and oral feeding

	Nasogastric tube-fed patients	Orally fed patients	*P*
Glucose			
–	2.1 ± 2.3	4.3 ± 6.8	
+	1.2 ± 1.1	3.2 ± 6.6	
Blood urea nitrogen			
–	7.3 ± 4.3	7.0 ± 4.0	
+	5.7 ± 3.3	7.7 ± 5.7	
Na			
–	19.0 ± 9.0	8.0 ± 7.0	0.008
+	20.6 ± 10.0	8.1 ± 5.0	0.000
K			
–	33.0 ± 7.0	34.0 ± 10.0	
+	26.0 ± 5.0	29.0 ± 10.0	
Cl			
–	37.0 ± 9.0	28.0 ± 12.0	0.026
+	29.0 ± 9.0	22.0 ± 6.6	0.026
Ca			
–	1.0 ± 0.8	1.2 ± 1.0	
+	1.6 ± 0.7	1.8 ± 1.5	
P			
–	3.5 ± 1.3	5.2 ± 6.8	0.001
+	2.7 ± 1.0	0.1 ± 4.3	0.003
Magnesium			
–	0.19 ± 0.12	0.44 ± 0.45	0.04
+	0.19 ± 0.08	0.37 ± 0.62	
Uric acid			
–	0.45 ± 0.26	0.94 ± 0.43	0.000
+	0.26 ± 0.17	0.74 ± 0.59	0.002
Protein			
–	18.5 ± 6.6	18.4 ± 6.5	
+	15.5 ± 3.9	15.8 ± 8.0	
Amylase			
–	490.0 ± 354	261.0 ± 171	0.045
+	339.0 ± 215	237.0 ± 160	

(-) = basal saliva, (+) = stimulated saliva
All data in SI units.
For analysis of amylase the saliva was diluted x 10,000.
Values are presented with standard deviation.

Discussion

The main finding of our study was the significantly higher rate of potentially pathogenic bacteria cultured from the oral cavity of patients on long-term nasogastric feeding. Noteworthy was the presence of *Pseudomonas aeruginosa* that was commonly and exclusively isolated in this subgroup. These results reconfirm our previous findings. In addition, significant differences were found in salivary flow and composition between the two groups.

Aspiration of pathogens from previously colonized oropharynx is the primary route by which organisms gain entrance to the lungs and may cause aspiration pneumonia [5,6,8]. However, little is known about the oral health and salivary aspects of the frail elderly, who are usually not included in epidemiologic studies because of their condition [9,10]. The oral microbiota in the subgroup of prolonged nasogastric tube-fed elderly patients has scarcely been investigated. Early studies reported on the tendency of gram-negative bacteria to colonize the oropharynx of elderly patients [11,12] but mentioned that nasogastric tube-fed patients were not included because of the small numbers at that time [11]. Another study mentioned the presence of gram-negative bacteria in surgical patients with nasogastric feeding for a short time (48–72 hours) [13]. However, these were not comparative studies. Gram-negative bacteria such as *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* are uncommon in the mouths of healthy persons [14]. What is the reason for this high prevalence of gram-negative bacterial colonization in the oropharynx of patients on nasogastric feeding? The fact that these bacteria were only rarely isolated from the orally fed patients in our study suggests that natural oral feeding itself may be a factor in preventing their colonization. In the absence of mastication and food passage, coupled with altered saliva composition, the oropharynx of nasogastric feeding patients could be devoid of its natural protective mechanism. A recent publication emphasized the importance of these elements to the oral clearance for the preventing of pathogenic oropharyngeal colonization in the elderly [15]. The presence of an abiotic surface, such as the nasogastric tube itself, should also be considered a possible contributing factor to creating an ecosystem prone to gram-negative bacteria colonization. The possibility that dentures of any kind are the source of oral pathogenic flora in nasogastric tube-fed patients is unlikely since we found no association between dental status and isolation of bacteria in both patient groups.

Alterations of normal salivary flow and composition may also be related to the colonization of the oropharynx by gram-negative bacteria [16]. Indeed we found significant differences in the composition of saliva in the nasogastric patients. The reduced amount of uric acid in this subgroup is of particular interest since it may be related to the presence of pathogenic flora. We found a significant negative correlation between the levels of uric acid and presence of *Pseudomonas* ($P < 0.05$). Uric acid is the main non-enzymatic antioxidant in saliva [17,18]. The antioxidants have an antimicrobial effect [19], and were also recently reported to be

particularly related to *Pseudomonas* [20]. The presence of *Pseudomonas* and its products in the oropharynx may also be associated with increased lung vulnerability due to lipid peroxidation of the surfactant [21] and to impaired tracheal ciliary activity [22]. Moreover, it should be noted that both these effects are attenuated by antioxidant activity. Thus, the lower concentration of uric acid that we found in the saliva of patients with nasogastric feeding and the resultant reduced antioxidant activity could also contribute to the risk of pneumonia. This point warrants further research. The significantly higher sodium content in the saliva of patients fed by nasogastric tube also deserves further investigation.

Basal flow of saliva was not diminished in patients on prolonged nasogastric feeding. This conflicted with our early presumptions that were based on the lack of stimulators such as mastication. However, we found a reduced stimulated ratio that could be related to some acinar atrophy related to lack of mastication.

Taken together, these findings indicate that prolonged nasogastric feeding is associated with alterations both in the flora of the oral cavity and in the biochemical content of the saliva. These changes could be related to the risk of aspiration and aspiration pneumonia in long-term care elderly patients fed by nasogastric tube.

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Correspondence: Dr. R. Segal, Geriatric Medical Center, Shmuel Harofe Hospital, P.O. Box 2, Beer Yaakov 70350, Israel.
Phone/Fax: (972-8) 925-8641
email: rsegal@post.tau.ac.il