The impact of bariatric surgery upon oral health is becoming an increasingly important health issue in the medical profession. It has not been until recently that nutrient deficiencies caused by bariatric surgery have been linked to diseases of the mouth such as periodontal disease. More research is needed in this area and should be coupled with a multidisciplinary approach to help educate both medical professionals and patients in how to recognize and prevent oral disease after bariatric surgery.

**Introduction**

Bariatric surgery impacts nutritional status. Nutrient deficiencies affect oral health and correlate to periodontal disease. Obesity rates in the United States are estimated at 64% of the adult population and body mass indices of greater than 30 (weight kg/height m²) have reached epidemic proportions. Whereas weight reducing medications, diet, and exercise are not always successful, bariatric surgery is a notably successful treatment option. With more than a 600% increase in the number of surgeries performed during the last decade, three bariatric surgeries are in the forefront. These three surgeries are (1) laparoscopic adjustable band, a small gastric pouch is created with an adjustable band allowing for adjustment of nutrient intake; (2) roux-en Y gastric bypass (RYGBP), staples are used producing a smaller stomach in which nutrient intake is restricted due to the size of the pouch; and (3) biliopancreatic diversion with or without a duodenal switch (BPD/DS). The jejunoileal bypass, first presented in the 1950’s has been discarded due to many of its side effects.

Whereas these surgeries have proven to be very effective in maintaining weight loss, they are not without concern. A substantial portion of the small intestine is by passed resulting in nutrient deficiencies that are a result of malabsorption. Whereas improving the quality of life in individuals, bariatric surgery can have undesirable effects that lead to anemia, skin disorders, neurological complications, edema, and visual disorders as a result of nutrient deficiencies and malabsorption of nutrients. The focus of this article will be on one of those unintended side effects, periodontal disease.

Although more prevalent in developing countries, periodontal disease affects 30% to 50% of adults in the US. This disease was first documented by Perlstein and Bisssada in 1977 when they discovered obesity in rodents increased inflammation and was significantly associated with the onset of periodontitis. Later research into periodontal disease has been found to have associations with bacteria, foods high in acid (acidogenic), and foods high in sugar (cariogenic) and can lead to destruction of soft tissue, inflammation of gums, edentulous, and xerostomia (Table 1).

Other factors such as diabetes, tobacco, and alcohol can lead to or increase incidence for periodontal disease. Stress has also been shown to be a possible factor leading to oral health problems by increasing plaque buildup and gingivitis. These factors can change the health of the oral cavity; however, behavioral changes such as poor oral hygiene or inadequate dietary intake are more likely to have a positive effect on periodontal disease than metabolic changes such as type II diabetes or atherosclerotic plaque buildup.

This review examines the effects of bariatric surgery and its impact on periodontal disease.

**Foundation of Common Nutrient Deficiencies**

Protein, vitamin, and mineral deficiencies are common in postoperative gastric bypass patients even though recommendations to use vitamin and mineral supplements are addressed before the surgery. Medical practitioners and researchers are discovering major nutrient deficiencies in individuals 20 years after their surgery. To help combat these deficiencies, a preoperative standardized nutrient evaluation is being suggested in the hopes of preventing major complications such as periodontal disease. Whereas numerous nutrients may be deficient preoperatively, some nutrients commonly found to be deficient in bariatric patients are calcium, vitamin D, folate, iron, and vitamin B12.

Due to the nature of bariatric surgery, the restrictive, malabsorptive, and a combination restrictive and malabsorptive
surgery can lead to nutrient deficiencies causing periodontal disease. Gastric banding surgery is a restrictive surgery mainly responsible for restricting energy intake due to the reduction of the gastric pouch; jejunoileal bypass, although not readily performed anymore, is a truly malabsorptive surgery in which nutrients are severely deficient in the preoperative patient and RYGBP and BPD are a combination of restrictive and malabsorptive surgery in which poor food choices and intolerance to foods play a major role in nutrient deficiencies.

Although energy restriction is the main goal following bariatric surgery, negative side effects can occur. Among these, but not limited to, are vomiting, nausea, diarrhea, esophageal reflex, dehydration, malnutrition, and deficiency of vitamins and minerals. The above effects are often due to patients overeating or eating too fast, not masticating food properly, and poor eating habits. These practices may lead to deficiencies in protein, vitamin D, iron, calcium, the fat soluble vitamins A, D, E, and K, folate, and vitamin B12\(^2,6,19\) (Table 2). The oral cavity is affected by these insufficiencies that may cause xerostomia, dental caries, periodontal disease, and/or dentin hypersensitivity.\(^1\)

**Influence of food on oral health**

The main cause of dental plaque is found to be bacteria forming on the teeth which, if not properly maintained, can lead to cavities and periodontal disease. Some bacteria such as Streptococcus mutans\(^7\) are found in no less than 90% of all reports of dental caries. Acid formation from bacterial carbohydrates along with acid produced from vomiting in the bariatric patient and a low oral pH results in demineralization of teeth enamel causing dental caries. Gingivitis and periodontal disease can be the result of neglected oral healthcare leading to edentulous at an early age.

Educating bariatric patients on the importance of diet along with being aware of food components and their effect on oral health will encourage bariatric patients to change their eating habits to help prevent the cariogenic and acidogenic effect that food has on oral health. A multidisciplinary education program is needed to train bariatric patients and the public about the causes of oral disease and the foods they should eat to prevent it. Educating the public about the effects of some food items and their role in preventing disease, such as lowering cholesterol levels, decreasing and or eliminating saturated fat and trans fat, can help reduce the incidence of heart disease. Promoting these benefits needs to be encouraged.

The metabolism of carbohydrates yields glucose and the rapid breakdown of this nutrient also yields a high cariogenicity. To maintain weight loss after bariatric surgery, it is recommended to limit carbohydrates from grains to two servings a day. Milk is normally considered an anticariogenic food due to its ability to lower oral pH, however, when consumed frequently, milk can have a high cariogenic effect due to the lactose in milk. Decreasing milk intake can have a destructive effect as the calcium phosphate and casein found in milk and dairy products protect against demineralization.\(^14\) Carbohydrate intake from fruits and vegetables should be limited to two to three servings of each as part of the daily intake\(^18\) keeping in mind to limit those fruits and vegetables that are high in sugar. Noncitrus fruits that normally lower oral pH have also been shown to be a cariogenic food. In people who consume large quantities of fruit and maintain poor oral

### Table 1. Types of Periodontal Disease and Preventive Measures for the Bariatric Patient

<table>
<thead>
<tr>
<th>Type of periodontal disease</th>
<th>Symptoms</th>
<th>Preventive measures</th>
<th>Outcomes</th>
<th>Type of BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root surface caries(^6)</td>
<td>Decreased saliva flow</td>
<td>Fluoride treatment, avoid malnutrition, hydration</td>
<td>Malnutrition, salivary inflammation, dehydration, dry mouth</td>
<td>JI</td>
</tr>
<tr>
<td>Parotid hypertrophy(^13)</td>
<td>Swelling of parotid gland, demineralization of teeth</td>
<td>Limit food intake, fluoride therapy, improve oral hygiene, increase dental care</td>
<td>Reduce incident of emesis</td>
<td>RYGB</td>
</tr>
<tr>
<td>Dental caries(^14)</td>
<td>Xerostomia, gingivitis</td>
<td>Include cariostatic food, increase water consumption, stimulate saliva flow, increase brushing and flossing, use fluoride toothpaste</td>
<td>Decrease risk of dental caries, decrease demineralization</td>
<td>RYGB</td>
</tr>
<tr>
<td>Dentin hypersensitivity(^2)</td>
<td>Bleeding, plaque, tooth mobility, furcation involvement</td>
<td>Fluoride treatment, enforce proper nutrition</td>
<td>Prevent dental caries, prevent GER</td>
<td>LB</td>
</tr>
<tr>
<td>Alveolar bone loss, dental wear, dental caries(^15)</td>
<td>Dental erosion, increase probing depth</td>
<td>Enforce proper chewing techniques, enforce proper nutrition intake, increase dental care</td>
<td>Prevent bacteria plaque, prevent tooth loss, increase saliva flow</td>
<td>NA</td>
</tr>
</tbody>
</table>

BS, bariatric surgery; JI, jejunoileal bypass; RYGB, roux-en-Y; LB, lap band; GER, gastroesophageal reflux; NA, not available.

### Table 2. Nutrient Deficiencies Leading to Periodontal Disease

<table>
<thead>
<tr>
<th>Vitamin/Mineral</th>
<th>Symptom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C(^20)</td>
<td>Bleeding gums</td>
</tr>
<tr>
<td>Zinc(^20)</td>
<td>Glossitis, cheilitis</td>
</tr>
<tr>
<td>Riboflavin(^4)</td>
<td>Glossitis</td>
</tr>
<tr>
<td>Niacin(^4)</td>
<td>Cheeks/tongue red/painful</td>
</tr>
<tr>
<td>Folic acid(^2,21)</td>
<td>Irritation of mouth</td>
</tr>
<tr>
<td>Calcium(^22,23)</td>
<td>Bone demineralization/ alveolar bone loss</td>
</tr>
</tbody>
</table>
hygiene habits, the fruit can have a higher cariogenicity. Citrus fruits may cause tooth erosion due to the high acid content.11

Obesity influence on periodontal disease

It has been determined that nutrition plays a significant role in the onset of obesity and periododontal disease, with obesity being regarded as the second most prevalent factor in periodontal disease. Recent studies have shown that this association is founded on the belief that fat tissues, which secrete numerous particles such as interleukin-6, and tumor necrosis factor-α are responsible for the formation of systemic inflammation.24 The adipokines, leptin, resistin, and adiponectin25 along with the newly researched adipokine, chemerin9, have also been shown to be responsible for the inflammatory response seen in periodontal disease. Adipose tissues release many hormones and cytokines that have similar pathways shown in the pathophysiology of periodontal disease. Based on research, the patient’s preoperative dental status needs to be established for comparison purposes postoperatively.

Psychological factors such as stress may contribute to obesity and periodontal disease. Pataro et al.26 found that the psychological factors associated with bariatric surgery can cause stress levels to increase contributing to higher levels of oral health disease in this population group. Joshipura et al. and Johannson et al. suggested a connection between obesity and inflammation of the periodontal tissue leading them to believe that the two are bidirectional.27 Oxidative stress may also play a role not only in periodontal disease, but also in obesity showing a direct correlation between the two. Krol et al. showed an increase in reactive oxygen species along with suppression of antioxidant action in periodontal tissue. An imbalance of the two may be responsible for increased inflammation in the periodontal tissue. Further research needs to affirm this and is essential in relating these two factors to periodontal disease.

Saliva flow rates

The mouth is a vital element of the gastrointestinal tract, which can be negatively affected by bariatric surgery. Few studies have been performed on the side effects of weight loss surgery and dental health; however, saliva flow is known to be an important factor in the prevention of oral diseases. The oral cavity needs to defend itself against diseases of the mouth and does so with the assistance of saliva, to defend tooth enamel, as well as odontoblasts and dental pulp to defend the internal portions of the tooth.28 Saliva has many functions that are important in maintaining the integrity of the oral cavity. Saliva aids in swallowing, speech, digestion, and taste; maintains the health of the oral mucosa; acts as a dilution factor to clear substances from the oral cavity; and with the assistance of calcium and phosphorus remineralizes the teeth.28 It is also needed to act as a buffering agent to protect against acid, plaque buildup from food and beverages, protect against tooth erosion from wine and cola beverages, and also protects against strong acids from vomiting.

The primary roles of saliva are to provide quality and quantity of the fluid protecting the oral cavity.23 Hyposalivation, which occurs frequently in the bariatric patient, can cause xerostomia, affording the mouth the inability to cleanse and protect itself. Dry mouth can also cause increased infection of the oral cavity.29

When the quality of the saliva is poor resulting from inferior dietary choices of the bariatric patient, the mouth is unable to act as a buffering agent. Not only can this lead to dental caries and tooth decay, but problems with speech, mastication, and swallowing may occur. Reduced saliva flow in bariatric patients has been attributed to their decrease in water intake.

The gastric pouch of bariatric patients is significantly reduced resulting in minimal food intake. It is important for the bariatric patient to receive nutrients from food rather than consuming fluids such as water, which leads to satiety, and causes food intake to be restricted. To defend against these problems, saliva testing is available to assist the medical professional in assessing changes in the mouth, enabling earlier diagnosis of periodontal disease.30

Alveolar bone loss

Calcium and vitamin D have been routinely noted as being deficient in postoperative bariatric patients. The deficiency of these two micronutrients can result in osteoporosis or metabolic bone disease29 possibly affecting the jaw. Calcium deficiency can cause bone deterioration due to the body’s need to absorb calcium into the kidneys for normal functioning. Vitamin D deficiency can result in hypocalcemia decreasing the strength of the cortical and trabecular bones. Fleischer et al. studied30 adults who had undergone bariatric surgery with the results showing that there was a 9.2% decrease in mineral femoral and an 8% reduction in hip density related to weight loss.29 The damage to these bones affects the maxilla and mandible bones. If these bones are influenced by nutrient deficiencies, than tooth loss and weakening of the periodontal structure can occur. This is especially prevalent in the patient who has undergone RYGBP, as this surgery bypasses the major site of calcium reabsorption interfering with absorption of calcium26 and ultimately affecting the alveolar bone. If the patient has osteoporosis, this may enhance the progression of bone loss. If periodontitis is present, alveolar bone loss may also be enhanced.15

Vomiting and gastroesophageal reflux are also common in patients who have undergone RYGBP. The high amount of acid that comes into contact with the teeth can cause erosion and tooth loss not associated with bacteria. Chemical erosion of the teeth can be the result of intrinsic factors (increased gastric juice or decreased saliva production), extrinsic factors (high acidic foods or beverages), environmental factors (chemical, chlorinated pools), or medications, including supplements.29

Bariatric patients need to eat frequently and if proper eating habits and proper oral hygiene are not practiced, then dental problems will ensue. Choosing the proper foods so as to limit bacteria production is paramount in preventing periodontal disease. Often those who have bariatric surgery have improper chewing abilities and need to be encouraged to increase their chewing time to enhance digestion.13,31 Their chewing ability will be dependent on their dental status, whether or not they have teeth and if they have dental hypersensitivity. Without proper oral hygiene, bacteria can form and dental erosion can occur. A positive result of bariatric surgery is improved self confidence and self-esteem stimulating healthier eating habits and improved oral hygiene.
due to misdiagnosing, underreporting, or unrecognized reporting of periodontal disease in the bariatric population. Bariatric patients, one could surmise that there is an underreporting of deficiencies preoperatively and postoperatively to compare deficiencies. Due to the recorded number of deficiencies caused by improper dietary habits of the bariatric patient need continued research with emphasis on oral health. The implications of diet and oral health are inadequately relayed to the medical profession. The evaluation of bariatric patients needs to be continuous as declining oral health is a result of months or years of nutrient deficiencies with some not showing up until years after surgery (Table 3). Most of the studies showed at least a 5-year lapse in time for vitamin and mineral deficiencies.

Table 3. The Incidence of Periodontal Disease in Bariatric Patients—Postoperative Case Studies

<table>
<thead>
<tr>
<th>Author/year</th>
<th># of patients</th>
<th>Average age of participants (years)</th>
<th>Percent of patients showing periodontal disease</th>
<th>Initial prevalence of periodontal disease (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heling/2006</td>
<td>113</td>
<td>40 + 10.24</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>Marsicano/2012</td>
<td>52</td>
<td>39.6 + 9.6</td>
<td>73.1</td>
<td>16.9</td>
</tr>
<tr>
<td>Marsicano/2011</td>
<td>24</td>
<td>40.5 + 9.7</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>Pataro/2012</td>
<td>72</td>
<td>34.8 + 9.40</td>
<td>91.7</td>
<td>6</td>
</tr>
</tbody>
</table>

Discussion

The results of this review have found that nutrient deficiencies caused by improper dietary habits of the bariatric patient need continued research with emphasis on oral health. The implications of diet and oral health are inadequately relayed to the medical profession. The evaluation of bariatric patients needs to be continuous as declining oral health is a result of months or years of nutrient deficiencies with some not showing up until years after surgery (Table 3). Most of the studies showed at least a 5-year lapse in time for vitamin and mineral deficiencies.

Recommendations for bariatric patients include, but are not limited to that patients should undergo a standard routine health evaluation before surgery to note any deficiencies; patients who had RYGBP need continuous examinations to prevent deficiencies due to the surgery being malabsorptive in nature, however, all patients should be concerned as dietary intakes are restricted in all patients; morbidly obese individuals who undergo bariatric surgery should be evaluated for vitamin and mineral deficiencies.

With the increase in bariatric surgery in the United States, a longitudinal and prospective study should be completed preoperatively and postoperatively to compare deficiencies before and after surgery. Due to the recorded number of bariatric patients, one could surmise that there is an underreporting of periodontal disease in the bariatric population due to misdiagnosing, underreporting, or unrecognized nutrient deficiencies.

Care should be taken to monitor the bariatric patient since this is a relatively new surgical procedure and research needs to be done to monitor the long-term effects especially with the increase in an aging population. Strategies to prevent and treat deficiencies need to also be researched especially with regard to calcium and vitamin D and their role in bone health and periodontal disease.

Conclusion

The synergistic relationship between bariatric surgery and proper dietary patterns is necessary to prevent periodontal disease. Researchers and scientists have known for centuries the value nutrition possesses in promoting the integrity of the oral cavity, but only recently has the importance of this knowledge extended to the bariatric patient. It is this knowledge that can help to avoid many oral diseases such as periodontitis and gingivitis.

Many patients who undergo bariatric surgery become nutrient deficient and are prone to diseases such as periodontal disease. To prevent these diseases, the bariatric patient must be schooled in the importance of proper dietary intake. Identifying anticariogenic foods, limiting cariogenic foods, and choosing foods that lower the oral pH, will prevent bacterial growth. This will limit poisons, produced by plaque, preventing the teeth and the alveolar bone from deteriorating. The selection of foods that do not lead to demineralization are normally more nutritious and contain the vitamins and minerals that are typically deficient in the bariatric patient as noted in the body of this manuscript.

Educating the bariatric patient on the importance of consuming a diet that encourages healthy food selections and healthy dietary patterns is imperative. It needs to be known that diet can influence periodontal health by limiting the onset of infection rather than it being the prime etiologic influence.

Quality of life improves after bariatric surgery in most patients and at least for a time in others, resulting in a healthier lifestyle relating to lower incidence of periodontal complications. Even though poor dental health is not life-threatening, it can be responsible for the formation of systemic diseases. Diet has long been known to influence oral health by altering the vulnerability of one to infection rather than it being the initial cause.

Additionally, the onset of periodontal disease could be responsible for the loss of satisfaction obtained from mastication and perhaps lead to diminished socialization due to lack of self-confidence. An emphasis on proper nutrition along with proper oral healthcare should be the main concern of bariatric professionals and dental professionals. Having a combined approach, this parallel relationship can prevent oral diseases and must be included in follow-up visits with the bariatric patient. Lastly, encouraging continued education and research and having available a multidisciplinary medical team, the incidence of periodontal disease among bariatric patients can be lessened.

The Academy of Nutrition and Dietetics in its position article on oral health and nutrition states that, “The integration of oral health and nutrition health promotion and disease management, including screening assessment, education and counseling as part of treatment provided by dietetics practitioners and oral health professionals supports collaborative, comprehensive and cost effective care.” Whereas this
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References


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