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SimpleLine II
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Post extraction implants is a predictable treatment as well as the procedure of internal sinus floor elevation with osteotome in the maxilla. While these treatments are often made separately, this report presents a case where these two procedures are performed at the same time with one year of follow up evaluation.

**KEY WORDS:** Dental implants, maxillary sinus, extraction, sinus augmentation

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**INTRODUCTION**

Several studies have shown that after tooth extraction alveolar resorption occurs, beginning on day 14 post extraction and rise to a loss of more than 20% of the vestibular cortical within the first 12 weeks. An alternative treatment to maintain crestal bone and prevent reabsorption is the immediate installation of implants, reducing the treatment time with less surgery and morbidity, providing excellent aesthetic results and reduced cost of treatment.

The elevation of the maxillary sinus floor with osteotome by via transcrestal in healed sites is viable to install an implant when there is deficiency of bone vertically, thus avoiding having surgery with window in the lateral wall of the sinus, treatment technique was by Tatum in 1977 and published in 1986. Summers in 1994 modified this technique finding that bone condenses improving primary stability of the implant.

Tözüm reports that the sinus elevation through the socket must be made a month after extraction and install the implants at 4 months. However, in 1999 Fugazzotto reported for the first time can make the internal sinus elevation at the time of extraction with regeneration bone and wait to install the implant once it has matured for regeneration. On the other hand, Kolhatkar and McCrea report immediate implant post extraction by the osteotome sinus lift with a high success rate.

Generally immediate implant procedures post extraction and internal sinus floor elevation are usually done separately, few reports have described these procedures in the same surgery, reason by which a case is presented with one year follow where you can demonstrate the advantages of this procedure.

**CASE REPORT**

A healthy 33 year old female patient presented to the author’s clinic for implant therapy and was evaluated clinically and radiographically. Tooth 25 (FDI Numbering System) (Figures 1 and 2) was determined to be fractured and non-restorable. Radiographic analysis determined the proximity of the maxillary sinus to about 2 mm. The proposed treatment plan involved performing an...
immediate implant post-extraction with sinus lift via transalveolar elevation. Oral prophylaxis and scaling and root planing were performed the patient was medicated with preoperative antibiotics. The procedures were performed under local anesthesia with flapless extraction of tooth #25 using periotomes and straight elevators. The socket was carefully debrided and flushed with sterile saline before initiating implant placement. A periodontal probe was inserted into the depth of the socket and moved in a circular fashion to confirm the integrity of the socket walls using tactile sensation. The sinus floor was carefully displaced using appropriately sized osteotomes (Figure 3), performing the Valsalva maneuver to detect any oroantral communication. Intraoperative radiographs were taken to confirm sinus floor elevation (Figure 4) to the desired extent. A 4.2 x 13 mm dental implant (MIS IMPLANT, Israel) was then placed with a torque of 35 Ncm, culminating with the remaining soft tissue suture for primary closure of the socket (Figure 5). The
patient healed without complication. A second-stage procedure was completed 6 months later to achieve the reconstruction of the papillae and proper emergence profile (Figure 6) for the final restoration (Figure 7). Figure 8 shows a 12 month post-surgical radiograph with increased radiopacity in the area immediately apical to the implant fixture and no crestal bone resorption.

**DISCUSSION**

When the extraction socket is allowed to fully heal, longer treatment time is required, and bone loss may occur. Furthermore, the healed bone may generally be softer and pneumatization of the maxillary sinus reduces the remaining bone.\(^1\) Resorption occurs because the remaining bone becomes nonfunctional by loss of blood supply to the periodontal ligament.\(^1\) An alternative to prevent reabsorption is immediate dental implant implantation,\(^1,4,5,7\) although Araujo as well as Van Kesteren reported that placement of an implant in the fresh extraction site does not prevent alveolar bone remodeling that occurred in the walls of the socket.\(^1\) However, it appears as a predictable treatment even in infected areas, with survival of 92% to 100%.\(^9,10,12\) This procedure can be flaplessly performed, although some have found that this is associated with gingival recession.\(^13\) This technique may be applied to incisors, premolars and molars, with the latter being more challenging.\(^3,13,14\) A key factor for achieving success is the primary stability and immobility of the same.\(^9\) Systematic reviews show considerable long term stability of the implant, considering it as a safe, minimally invasive, with a success rate comparable to traditional techniques.\(^4,15-17\) This background is reflected in the surgery flapless performed, achieving a minimally invasive approach with good primary stability, performing primary closure of the socket only with soft tissue suture which was maintained for the atraumatic extraction, achieving minimal discomfort for the patient. Boyne and James made the first record of the side window to the maxillary sinus floor to increase bone. If the remaining bone was sufficient (\(>\) 4 mm) to ensure the primary stability of implants could be inserted simultaneously.\(^10\)
However, Fugazzotto reported a 97.8% success over a period of three years when the internal sinus lift is performed at the time of extraction. Also Luchetti reports a case where installed a post extraction implant with dilators, but this had a communication with the maxillary sinus, succeeding at 3 years follow-up.11

In implants placed in fresh socket with sinus elevation, Artzi reported a bone gain of 4.3 mm with a 7.8 mm residual bone and Barone report a gain between 3-5 mm9 coinciding with the case reported in this paper where a gain of approximately 4.5 mm was achieved.

Kolhatkar9 presents a decision tree depending on the number of remaining walls of the socket, to decide if done or not filling bone along with the breast lift, but McCrea10 in his series of cases does no filling with biomaterials, as such as in our case, considering that it should be less than 2 mm gap. A year evaluation function of the final crown is achieved see the integrity and stability of the implant, checked with radiographic evaluation where a radiopaque image is between the apex of the implant and the maxillary sinus, not observing any resorption.

This report shows the effectiveness of implant installation immediately post-extraction and is shown together with the lifting of internal sinus and the socket this with an infectious process, using osteotomes for the same light socket. Resulting in a minimal invasive procedure, reducing the total treatment time, and postoperative patient discomfort because it is performed without raising any flap.

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Disclosure
The author reports no conflicts of interest with anything mentioned in this article.

References

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BioXclude™

Case Courtesy of Dan Holtzclaw, DDS, MS, Austin, TX

- BioXclude over grafted socket
- 2 weeks postoperative
- 5 months postoperative

Case Courtesy of Paul S. Rosen, DMD, MS, Yardley, PA

- Intrabony defect
- BioXclude placement
- 6 month postoperative radiograph

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- Reduces inflammation at the wound site
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- Tightly adapts over bone graft and proximal walls
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Background: Oral lichen planus (OLP) is a chronic inflammatory disease of unknown etiology. Recent literature links high levels of oxidative stress markers, like malondialdehyde (MDA), and OLP. An antioxidant combination of phloretin and ferulic acid has been shown to reduce oxidative stress. We conducted a double-blinded, placebo-controlled randomized clinical trial to test the efficacy of this combination in managing OLP and to explore the link between oxidative stress and OLP.

Methods: Thirty-three OLP patients with persistent or non-responsive symptoms and lesions were given either a placebo or test gel. Symptoms (VAS), lesion scoring, and oxidative stress levels were measured using salivary 8-hydroxydeoxyguanosine (8-OH-dG) and MDA were measured at baseline, 2 weeks, and 4 weeks.

Results: VAS and OLP lesion scores for the test group (n = 17) decreased at 2 and 4 weeks from baseline, and 8-OH-dG decreased 17.9% at 4 weeks from baseline, although MDA increased at 4 weeks from baseline. Differences were not statistically different from the placebo group (n = 16) at any time point (p >0.05) except for MDA at 4 weeks (p <0.05).

Conclusions: The topical combination antioxidant gel did not differ from a placebo in any of the parameters measured, but patients did not report any severe flare-ups and had better patient acceptance compared to topical steroids. A non-significant reduction in 8-OH-dG was noted in the test group. To our knowledge, this is the first study to report on salivary 8-OH-dG and MDA levels in patients with oral lichen planus undergoing treatment.

KEY WORDS: Oral lichen planus, antioxidants, oxidative stress, malondialdehyde, 8-hydroxy-2’-deoxyguanosine
INTRODUCTION

Lichen planus is a disorder of T-cell-mediated chronic inflammation of stratified squamous epithelium\(^1\) presenting with a wide range of clinical manifestations with oral lichen planus (OLP) being the second most common manifestation after cutaneous lichen planus. OLP is generally categorized into 3 forms: reticular, erythematous, and ulcerative.\(^2\) The most common mode of management for OLP patients is topical corticosteroids; however, even with treatment, only a small percentage (0-29%) of patients achieve complete remission while most (25-63%) achieve only partial remission.\(^3\) An important reason for management and monitoring of OLP lesions is the potential malignant transformation into squamous cell carcinoma. A recent systematic review reported an incidence of 1.09% suggesting that the risk of malignant transformation is very low in the more common forms of OLP.\(^7\)

Although the exact etiology is currently unknown, recent literature indicates there is an association between patients with OLP and higher levels of oxidative stress which is an imbalance of the body’s oxidant/anti-oxidant mechanism. Reactive oxygen species (ROS) and true free radicals cause damage of several cellular components and are counteracted by anti-oxidants. Cross-sectional studies found a significantly higher level of MDA, one of 2 major end-products of lipid peroxidation, in the saliva\(^8\) and serum of untreated OLP patients compared to healthy controls\(^9\) but, to our knowledge, no pre- and post-treatment studies have been conducted using MDA as the oxidative stress marker. Other studies found significantly higher levels of salivary 8-OH-dG, a marker for oxidative damage to DNA, compared to healthy controls in another type of chronic, inflammatory disease, chronic periodontitis.\(^12\)\(^,\)\(^13\)

Two particular antioxidants, phloretin and ferulic acid, polyphenols found in plants, used in combination have been found to be beneficial in mitigating the effects of tobacco on human fibroblasts and aiding in recovery of DNA synthesis and cell viability after metal-induced toxicity \textit{in vitro}.\(^14\)\(^-\)\(^16\)

The purpose of this study is to test the efficacy of a combination topical antioxidant formulation containing phloretin and ferulic acid (AO ProVantage Gel, Periosciences\(^6\), Dallas, TX) in treating patients with signs and symptoms of oral lichen planus and to examine the effects on levels of the salivary oxidative stress markers, MDA and 8-OH-dG.

MATERIALS AND METHODS

A total of 40 patients with OLP were recruited from the Stomatology Clinic, Baylor College of Dentistry (Dallas, TX). Inclusion criteria included: (1) documented diagnosis of OLP or lichenoid mucositis via biopsy, (2) signs and/or symptoms of active OLP, and (3) refractory to conventional therapy or incomplete response to conventional therapy after 6 or more weeks of therapy. “Unresponsiveness” is defined as no alleviation in signs and/or symptoms, and “incomplete” response is defined as an improvement in signs and symptoms but not to an acceptable level to the patient.

Exclusion criteria were: (1) allergy to any ingredients in AO ProVantage Gel (2) past or current use of any topical antioxidant therapy applied intraorally, (3) history of oral malignancy or active oral infections, (4) having a diagnosis of hepatitis C or HIV, (5) bone marrow and/or kidney transplant recipients, (6) current smoker as defined by the WHO (reports smoking at least 100 cigarettes in their lifetime and, at the time of survey,
smokes either every day or some days) or have used or are using smokeless tobacco, (7) poorly controlled diabetes mellitus with a hemoglobin A1c score greater than 7%, (8) and having a known disease resulting in immunodeficiency.

Patients were placed into two groups: PLC (placebo, n = 20) or AO (test, n = 20). All gel tubes were labeled with either an A or B accompanied by a value from 1 to 20, and a decryption grid was kept by the company until all patients completed the study.

At the baseline evaluation, un-stimulated whole saliva was collected by having the patients drool saliva into a graded sampling tube until about 5 ml was collected. The collected saliva was immediately centrifuged at 1,250g for 10 minutes at 4°C and the supernatant was stored in 1 ml aliquots at -80°C. Intraoral lesions were evaluated and scored based on the scoring system described by Piboonniyom et al.\textsuperscript{17}. The final whole mouth composite score was the sum of the three types of lesions with the erythematous score multiplied by a factor of 1.5 and the ulcerative lesions factored by a factor of 2 (Fig. 1). Patients indicated what current therapy they were using, lesions were photographed, and patients were asked to indicate their current symptoms using a 100 mm VAS scale with marks at every 5 mm (0 = no pain whatsoever, 100 = worst pain ever).

Randomization was achieved by writing all corresponding codes onto small squares of paper and placing them into an envelope. Patients selected were given the tube with the corresponding code they selected. The patients were instructed to treat each area with symptoms or lesions with a pea-size amount of product 3 times a day in a gentle dabbing motion and refrain from eating or drinking for 30 minutes after each use.

<table>
<thead>
<tr>
<th>Site</th>
<th>Reticular Area</th>
<th>Erythematous Area</th>
<th>Ulcerative Area</th>
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<tbody>
<tr>
<td>U/L Labial Mucosa</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>R Buccal Mucosa</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>L Buccal Mucosa</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Dorsal Tongue</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ventral Tongue</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Floor of Mouth</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hard Palate Mucosa</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Soft Palate/Tonsils</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Max. Gingiva</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Mn. Gingiva</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td><strong>Total</strong></td>
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Patients were instructed to continue their current therapy for lichen planus during the duration of their participation, even if it included no treatment at all, to ensure equal baseline and final oral conditions. Repeat photographs, VAS assessment, and OLP scoring were obtained again at 2 and 4 weeks, and saliva collection was repeated again at 4 weeks. Salivary 8-OH-dG levels were assayed using a commercially available competitive enzyme immunoassay, DNA/RNA Oxidative Damage EIA Kit (Cayman Chemical, Ann Arbor, MI), according to the manufacturer’s instructions. Salivary MDA levels were assayed using a commercially available kit, NWLSS Malondialdehyde Assay (Northwest Life Science Specialties, Vancouver, WA). It should be noted that the manufacturer was unable to assure us that MDA was an effective measuring tool when tested in saliva. However, in the interest of furthering knowledge about this test material, it was decided to include MDA in the study.

One patient in the AO group dropped out after 1 week of usage due to frustration from a

| Table 2: Between Group Differences for Each Variable/ *- P < 0.05 |
|-----------------|-----------------|-----------------|
| VAS             | PLC (n = 17)    | AO (n =16)      | P values |
| Baseline        | 31.41 ± 30.82   | 33.25 ± 28.82   | 0.678    |
| 2 Weeks         | 21.53 ± 23.75   | 14.25 ± 14.05   | 0.612    |
| 4 Weeks         | 24.41 ± 24.44   | 16.75 ± 22.14   | 0.336    |
| MDA (µM)        | PLC (n = 17)    | AO (n =16)      | P values |
| Baseline        | 3.39 ± 1.07     | 3.24 ± 1.07     | 0.471    |
| 4 Weeks         | 3.52 ± 1.28     | 4.63 ± 1.82     | 0.019    |
| OLP Lesion Score| PLC (n = 17)    | AO (n =16)      | P values |
| Baseline        | 6.75 ± 3.48     | 7.79 ± 5.18     | 0.759    |
| 2 Weeks         | 5.75 ± 2.86     | 6.26 ± 4.10     | 0.885    |
| 4 Weeks         | 5.19 ± 2.52     | 6.53 ± 4.63     | 0.588    |
| 8-OH-dG (pg/ml) | PLC (n = 17)    | AO (n =16)      | P values |
| Baseline        | 179.01 ± 99.47  | 216.88 ± 132.01 | 0.428    |
| 4 Weeks         | 193.58 ± 158.23 | 178 ± 116.56    | 0.801    |
lack to symptomatic improvement. One patient in the PLC group dropped out after 3 weeks of usage due to similar frustrations. For intent-to-treat analysis, the data missing for the remaining time points was assumed to remain the same as the last recorded value for VAS, OLP, MDA, and 8-OH-dG. In addition to the incomplete data on the drop-outs, 2 additional patients had incomplete data for salivary MDA at 4 weeks due to laboratory error and a resultant loss of remaining sample from those patients. The MDA level from baseline was assumed to have remained the same in these cases.

All variables were treated as interval data and since the sample was not normally-distributed, non-parametric tests were used. A Friedman test was used to test for universal differences among the repeated measures within each group. Post hoc Wilcoxon signed-rank tests were used to analyze within group differences from baseline to 2 weeks, 2 weeks to 4 weeks, and baseline to 4 weeks. Bonferroni corrections were used to adjust the $\alpha$ value for multiple comparisons ($\alpha = 0.05/3 = 0.0167$). A Mann-Whitney $U$ test was used to examine differences between the two groups at each time point. The significance value was set at $\alpha = 0.05$.

**RESULTS**

Of the 40 patients screened, 7 were disqualified. A total of 33 patients were included in the study. There were 17 patients in the PLC group (13 females and 4 males, average age of 61 ± 12.03 years) and 16 patients in the AO group (12 females and 4 males, average age of 65.69 ± 9.84 years). During the course of
the study there were 3 drop-outs, 1 from the PLC group, and 2 from the AO group. Complete data was obtained up to the 2 week follow-up for the patients in the AO group, while only baseline data was available for the PLC group drop-out. For intent-to-treat analysis, the data missing for the remaining time points was assumed to remain the same as the last recorded value for VAS, OLP, MDA, and 8-OH-dG. In addition to the incomplete data on the drop-outs, 2 additional patients had incomplete data for salivary MDA at 4 weeks due to laboratory error and a resultant loss of remaining sample from those patients. The MDA level from baseline was assumed to have remained the same in these cases.

The VAS for the AO group decreased from 33.25 ± 28.82 to 14.25 ± 14.05 at 2 weeks and remained stable at 16.75 ± 22.14 at 4 weeks. The VAS for the AO group was statistically lower at 4 weeks than at baseline (Table 1). However, there were no statistically significant differences between the PLC and AO groups at any of the time points (P >0.05). (Fig. 2)

The OLP lesion score for the AO group dropped from 7.79 ± 5.18 at baseline to 6.26 ± 4.10 at 2 weeks and remained stable at 6.53 ± 4.63 at 4 weeks. The reduction in OLP lesion score from baseline to 4 weeks was statistically significant for the AO group (P <0.05) (Table 2). There were no statistically significant differences between the groups at any time point (P >0.05) (Fig. 2).

At 4 weeks, the AO group had a 17.93% reduction in mean salivary 8-OH-dG level to 178
± 116.56 from 216.88 ± 132.01 at baseline. This reduction was not statistically significant ($P >0.05$) (Table 3), and there were no statistically significant differences between the PLC and AO group at any time point ($P >0.05$) (Fig. 2).

At 4 weeks, the mean salivary MDA level for the AO group was increased to 4.63 ± 1.82 from 3.24 ± 1.07 at baseline. This increase in the MDA was statistically significant ($P <0.05$) (Table 4), and the AO group had a significantly higher level of MDA at 4 weeks compared to the PLC group ($P <0.05$) (Fig. 2).

**DISCUSSION**

This was the first study to investigate the efficacy of a topical antioxidant combination gel in treating patients with OLP and also the first interventional study analyzing salivary biomarkers of oxidative stress before and after treatment. Alleviation of symptoms and clinical signs of the disease are important variables in determining the efficacy of any potential treatment for patients with chronic, often painful diseases such as OLP. In our study, although there was a statistically significant reduction in VAS from baseline to 2 weeks for the PLC group and from baseline to 2 and 4 weeks for the AO group, there were no statistically significant differences between the two groups at any time point. Wide variability was noted in the responses. The error inherent in the VAS is well documented, and it was no surprise that the only subjective measure in this study was perhaps the weakest. Statistically significant reductions in OLP lesion score was observed from baseline to 2 weeks in the PLC group and from baseline to 4 weeks in the AO group. No statistically significant differences were found between the two groups at any time point.

This is the second study to evaluate levels of salivary MDA in OLP patients and the first to do so before and after treatment. MDA is the main byproduct of lipid peroxidation by free radical interaction with cellular membranes. It was a peculiar observation that MDA levels actually increased to a statistically significant level after 4 weeks of usage of the active formulation. Additional investigation found the
MDA increase was not associated with any of the other clinical parameters such as lesion type and lesion location, and these changes appeared to be opposite of direction of the VAS and OLP lesion scores from baseline to 4 weeks. A reasonable explanation for this observation is elusive at this time but a small sample size makes it difficult to predict whether or not this would be true in a larger sample.

To our knowledge, this is the first study to examine the level of salivary 8-OH-dG as a marker of oxidative stress in oral lichen planus patients. 8-OH-dG is a by-product of DNA damage by free radicals and has been found to be much higher in patients with chronic periodontitis. The data showed that there was no statistically significant differences between the groups in the salivary levels of 8-OH-dG from
baseline to 4 weeks. This finding appeared to be related to the lack of statistically significant differences in VAS and OLP lesion scoring. Based on these observations, despite an almost 18% decrease in levels of 8-OH-dG in the AO group, compared to an 8.14% increase in the PLC group, 8-OH-dG did not appear in this study to be associated strongly with clinical improvement in the features of OLP. Coupled with the lack of significant change in MDA levels, it appears that the use of this regimen of the antioxidant gel may not result in a statistically significant change in the patients' levels of either of these oxidative stress markers.

Several reasons may account for the lack of difference in all parameters studied excluding the increased salivary MDA at 4 weeks in the AO group. First, the sample size was small. Second, numerous patients had a VAS less than 20 (12 total), and inclusion of the data sets which had a baseline VAS of less than 20 may have skewed the results of the VAS assessment. The majority of the patients had reticular lesions either alone or in combination with erythematous and ulcerative forms. The literature has shown a majority of patients with reticular lesions are asymptomatic. Since nearly all (94%) of patients in this study presented with reticular lesions, it would be expected that the VAS may tend to be skewed towards the low end. In this study, patients who presented with ulcerative lesions tended to have higher VAS, much like other reports in the literature. However, many of the patients with higher OLP scores did not necessarily have the highest VAS scores at baseline. A possible reason is that many of the patients in the study had been in long term management (> 12 months) of their OLP and had reached a level of acceptance. Furthermore, the placebo may have had some inherent antioxidant properties. Secondary ingredients include peppermint oil, sage oil, clove flower oil, and xylitol. The literature has shown that all of the secondary ingredients do have some level of antioxidant function. However, since all of these secondary ingredients are found in both the placebo and the test, it would be assumed that any differences would be attributed to phloretin and ferulic acid only.

Another possible reason for the lack of difference between the AO and PLC groups may be attributed to the area of involvement. Most patients had gingival lesions either on the maxilla (69.7%) or mandible (72.7%). This is higher than reported in the classic literature reports. We found reticular and ulcerative scores to be easily measured if found on the gingiva, but erythematous scores were difficult for several reasons. Involvement of papillae made measuring with a calibrated polygon on transparency paper difficult to do. Most gingival lesions in this study failed to achieve significant improvement, and this may be attributed to an inability of the scoring system to identify qualitative changes in erythema in the gingiva. Unpublished data from the Stomatology Center indicates that erythematous gingival OLP is more difficult to successfully treat than in other oral sites. This is important since most of the gingival lesions present in this study were erythematous lesions.

Despite the absence of differences in VAS, OLP score, and salivary 8-OH-dG and MDA levels from baseline to completion of the study between the placebo and test group, there are some findings which support further investiga-
tion of the use of combination antioxidants in the treatment of OLP. Although the study duration was only 4 weeks, the fact that none of the patients reported flare-ups associated with OLP signs and symptoms during use of either the test or placebo suggest that the combination antioxidant gel as a maintenance treatment may be warranted. This would be helpful to patients in whom the bad taste of topical steroids tends to limit compliance. It is worth noting that 2 patients (1 in each group) developed candidiasis-like signs and symptoms such as pseudomembranous lesions and burning sensations. Candidiasis was confirmed with a salivary candida culture. Both patients had reported a previous history of frequent bouts of candidiasis and both had used clobetasol during the duration of the study. It would be of interest to investigate the frequency of oral candidiasis in susceptible patients using a combination antioxidant rather than topical steroids. Furthermore, although not statistically significant, the trend towards more reduction in the VAS, OLP, and 8-OH-dG in the AO group suggests that a study with a longer duration and more intensive application regimen may result in significant clinical and statistical findings.

CONCLUSIONS
Within the limits of this study, the patients receiving the active AO gel had significant improvement in VAS throughout the 4 weeks and an improved OLP lesion score from baseline to 4 weeks. Patients receiving the AO gel had lower levels of salivary 8-OH-dG before than after treatment. Interestingly, MDA levels increased significantly at 4 weeks in the AO group, and this observation cannot currently be explained. This finding suggests the possibility that salivary MDA may not be a useful test for salivary oxidative stress levels and further study is indicated. Overall, the differences between the groups were not statistically significant at any point in time except for salivary MDA levels at 4 weeks. Despite the fact that there were limitations to this study such as a small sample size and large variability in the data, there may be a place clinically for the use of this topical combination antioxidant gel in the maintenance of patients with oral lichen planus who have not received further benefit from conventional topical therapy. Future research should further investigate the efficacy of longer use and perhaps a heavier dosage of antioxidants.

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It has long been accepted, although with some limitations, that the discipline of veterinary dentistry has tended to follow the trends and advancements in the human dental field. This is the case for the area of dental implantology. As for any procedure performed on a patient, the patient (in human dentistry) or the pet owner (in veterinary dentistry) need to be able to make an informed decision based on the available evidence, given to them by their clinician. The concept of informed consent is paramount in the relationship between clinician and patient/pet owner. This case report describes the replacement of four mandibular incisor teeth with two cantilevered implant bridges in a dog. Treatment included selective extractions with bone grafting and dental implants to replace the 4 mandibular incisors.

**KEY WORDS:** Dental implants, veterinary dentistry, canine, case report
INTRODUCTION

It has long been accepted, although with some limitations, that the discipline of veterinary dentistry has tended to follow the trends and advancements in the human dental field. This is the case for the area of dental implantology. As for any procedure performed on a patient, the patient (in human dentistry) or the pet owner (in veterinary dentistry) need to be able to make an informed decision based on the available evidence, given to them by their clinician. The concept of informed consent is paramount in the relationship between clinician and patient/pet owner.

This is certainly true for the more involved treatments in veterinary dentistry which can include the disciplines of endodontics and dental implantology. Years ago in veterinary dentistry, when it was suggested by some clinicians that root canal therapy for pets’ teeth was a predictable procedure, this was based on no or very little anecdotal evidence. However, over the years and with a number of published case reports (grade 3-4 EBM), it has been accepted by the veterinary dental fraternity that endodontic therapy is indeed predictable and a valuable service that can be offered to pet owners. Only time will judge whether oral implantology also becomes
Figure 4: Extraction sites filled with osseous graft material and resorbably collagen membrane placed ready for site closure, restoring the ridge for future implant placement.

Figure 5: Flap closure with sutures demonstrating primary closure of the affected area.

Figure 6: Radiograph demonstrating healing and integration of the osseous graft taken at 8 months post surgically.

Figure 7: Measurements on the digital radiograph to determine available width and length for implant placement.
an accepted and predictable procedure that can be offered to pet owners. Human oral implantology research often uses another species such as a canine model. The results from which are then extrapolated back to treatment modalities in man.

The success rate for endosseous implant osseointegration\(^1\) or functional ankylosis is very high in man. Success rates are also very high in animals used for implantology research. Canine studies have shown good bone-to-implant contact of around 73% in osseointegrated endosseous implants based on histological sections.\(^2\) Also, studies have shown through radiographic and histological findings that crestal bone levels
are stable after loading endosseous implants for up to 12 months in a dog model. Single Implant crown survivals have been estimated to be 94.5% after 5 years. Crown design, screw retained versus cement retained, did not influence the survival rate. Other treatment planning decisions include whether to place the implant at the time of

Figure 12: Site closure with sutures demonstrating primary closure.

Figure 13: Radiograph following implant placement and additional crestal grafting demonstrating the site.

Figure 14: Implant were uncovered at 4 months post placement.

Figure 15: Healing abutments placed in the integrated implants following implant exposure.
tooth extraction or at a time post tooth extraction.

Today, there is little debate over whether an implant can be placed at the time of extraction (Immediate implant placement) when compared to the more conservative approach of placing the implant some weeks or months after extrac-

Figure 16: Radiographs to verify seating of the healing abutments.

Figure 17: Soft tissue was repositioned to the healing abutments and sutured.

Figure 18: Patient in occlusion.

Figure 19: Prosthetic wax up of the substructure for bilateral cantilever screw retained implant crowns.
tion (delayed implant placement). Short-term survival rates and clinical outcomes of immediate and delayed implants were similar and were comparable to those of implants placed in healed alveolar ridges. These authors do note however, that at present, there are no long-term studies that support or contradict the use of immediate implants in extraction sockets.

At present there are studies that have shown similar implant healing and survival rates after loading following an immediate versus a delayed implant protocol. Most studies suggest
that immediate implant placement is successful so long as implants are placed by experienced operators, not placed where acute infection may exist at the extraction site or where there is active periodontitis affecting the tooth to be extracted and replaced by an implant/crown. Other concerns that are raised with immediate implant placement include filling of the potential gap (if >1mm) between the implant body and the alveolar wall. In these cases, the use of bone replacement materials with or without a barrier membrane may be required. Also soft tissue closure over the immediate implant may also be a problem, due to there often being a lack of keratinized mucosa for flap adaptation and to achieve primary closure. Inadequate primary stability may also be a concern when placing an immediate implant. Long term stability of the soft tissues after immediate implant placement may also be less predictable than delayed placement. It has been shown that even with chronic apical infection affecting teeth to be extracted; an immediate implant can still be placed so long as the extraction socket is thoroughly curetted to remove any chronic inflammatory/ granulomatous tissues.7

In veterinary dentistry, one of the more common reasons for tooth extraction would be due to a complicated crown or root fracture or both. These teeth may not be suitable candidates for direct or indirect restorations or even endodontic treatment. One of the arguments for immediate implant placement after tooth extraction in veterinary dentistry would be the reduction in the number of anesthetic episodes for implant and implant crown placement, thus saving the owner some costs as well as one less anesthetic episode for the pet. Also the extraction socket can be used as
a guide (to some extent), for placing the implant in a good restorative position. However the caveats mentioned above need to be taken into account when treatment planning for implant placement.

Although most animals can function and masticate reasonably well with missing teeth, there can be complications seen after tooth extraction, especially with lip entrapment after the extraction of the maxillary canine tooth in both cats and dogs. There appears to be no published studies looking at implant and restorative crown survival rates in client owned pets.

This case report describes the replacement of four mandibular incisor teeth with two canti-

levered implant bridges in a dog. Decision making in veterinary dentistry is no different to that performed in dentistry in man. Treatment options, a discussion of surgical and post-surgical complications needs to be done prior to obtaining informed consent from the pet’s owner. Owners also need to be made aware of the forces that dogs can apply to implant crowns during normal mastication as well as forces applied to implant crowns from abrasive and hard objects such as bone chewing. These forces can lead to prosthetic failure. Therefore as a part of management of any implant case, bone chewing and other potentially damaging habits are not recommended.

The follow up with this case has been extensive with regular six monthly reviews, and reinforcement of oral hygiene practices to prevent peri-implant mucositis and peri-implantitis. Implant/crown stability was assessed through periodontal probing depths, bleeding on probing, and signs of pocket exudate, any signs of crown mobility and with the help of periapical radiographs, crestal bone stability around the implant.
CASE REPORT
A healthy 10 year old, Wheaton Terrier presented for a scheduled dental cleaning and oral evaluation. During the initial exam it was noted that a mild gingivitis with light calculus was present and missing two lower mandibular central incisors (#’s 302 : 402) Charting, probing and dental radiographic examination was completed and a diagnosis of grade 3/4 periodontal disease was made at the intact # 301 and # 401 incisor site (Figure 1). The treatment options were discussed at length with the client, which included selective extractions, perio surgery, or extractions with bone grafting and dental implants to replace the 4 mandibular incisors in 6-8 months following site preparation. The owner elected to extract the affected teeth with socket preservation and place two endosseous implants at a later date.

SURGICAL PHASE 1: EXTRACTIONS AND BONE GRAFTING
Prior to the surgical appointment blood was drawn and a CBC and Diagnostic Profile was tested to check the patients general health. At the appointment, (Atropine, Ace Prom, Veterinary Products, Westlake TX) was administered via injection as a pre-anesthetic agent for mild sedation and to control salivation during the surgery. An IV line was placed and Lactated ringers solution started (Baxter Healthcare, Deerfield, IL) A general anesthetic phase/pain protocol was followed which included use of a general anesthetic induction with Midazolam and Ketamine via IV and maintenance with Sevoflurane a Inhalent Anesthetic Agent (Abbott Animal Health, Abbott Park Illinois U.S.A.). A pain protocol was utilized with local anesthetic administration of a Marcaine block (Patterson Dental, Saint Paul, MN) and Butorphanol (Hospira World Wide, Lake Forest, IL) was supplemented via IV.

A complete oral exam was performed on the patient to confirm the initial findings. The procedure was initiated with prophylaxis utilizing ultrasonic scaling to remove any hard deposits supra and subgingivally. A full thickness mucoperiosteal flap was reflected to gain access to the surgical site. Extraction was accomplished of the periodontally affected teeth using elevators and extraction forceps The extraction sockets were debrided utilizing surgical curettes (Figure 2). The sites were then augmented with Periomix, a DFDBA (demineralized freeze-fried bone allograft) and a mini bone bock (Veterinary Transplant Services, Kent, WA) (Figure 3) were utilized for guided bone regeneration (GBR) to fill the defects created by the periodontal bone loss and extraction process. Citagenix Neomem (OCO Biomedical, Albuquerque NM) a resorbable collagen membrane was placed over the ridge and tucked under the flap margins (Figure 4). Flaps were repositioned without tension and the site was closed using a simple interrupted / cruciate pattern. Absorbable 4/0 Monocryl; Ethicon, Johnson & Johnson (New Brunswick NJ 08933, One Johnson and Johnson Plaza) (Figure 5).

SURGICAL PHASE 2: IMPLANT PLACEMENT
At eight months after surgery, a radiograph was taken to evaluate the grafted site for possible implant placement. (Figure 6) The patient was again IV sedated following the same protocol as was utilized in phase 1. An envelope flap was created and a full thickness flap was elevated to expose the underlying bony ridge. Measure-
ments were taken from the post healing radiograph with regard to available width and length to assist in choosing the proper size implants for the sites (Figure 7). A sequential drilling protocol as recommended by the implant companies manufacturer (Simpler Implants Inc., Vancouver, BC) was initiated to create osteotomies to accommodate two implants in the site available. Two endosseous HA coated implants based on prior measurements (Simpler 3.25 X 10 mm) were placed into the osteotomies prepared at 20 rpm and 40 Ncm (Figure 8). Stability was confirmed with a torque wrench with a final insertion torque measured at 50 Ncm for each implant (Figure 9) and a screw cover was hand tightened on the implants. Gaps at the crest were filled with a mixture of Periomix and L-PRF (autologous fibrin collected from the patient’s blood during the surgery) (Figure 10) placed to maximize the crestal shape following healing and minimize future bone loss (Figure 11). The site was treated in a two-stage surgical protocol and implants with cover screws were submerged and the flap closed to achieve primary closure. (Figure 12) A radiograph was taken to demonstrate implant placement and additional crestal grafting (Figure 13).

RESTORATIVE PHASE
At 4 months post implant placement the site was checked for tissue health and radiographs were taken to evaluate the implants to verify integration. A mini envelope flaps were created to expose the implant cover screws (Figure 14). Implants were determined to be stable and free of mobility. Cover screws were removed and implant level heads were placed and impressions were fabricated with VPS hand mix putty, fast set with custom formed trays (Benco Dental Supply Co., Tucson, AZ). Transmucosal healing abutments (Simpler Implants) were placed (Figure 15) and a radiograph was taken to confirm seating of the healing abutments (Figure 16). An appositional flap was secured with sutures to ensure a proper emergence profile to support the future prosthetic components (Figure 17).

The VPS impressions were sent to the dental lab (Doks Lab, Tucson AZ) and a soft-tissue stone model was created with implant analogs embedded within the model. The upper and lower models were mounted in occlusion. The planned prosthetics was waxed up for the metal substructure for planned bilateral PFM cantilever crowns with a distal pontic at each site (Figure 19). The substructures were cast and porcelain was applied to complete the PFM prosthetics (Figure 20-22). One month post impressions the patient returned for delivery of the prosthetic components. The patient was anesthetized following the same protocol utilized at the prior appointments. The healing collars were removed, to expose the healthy soft tissue collar and emergence profile (Figure 23). The prosthetics was tried in and fixation screws hand tightened then checked with a torque wrench. A radiograph was taken to verify seating of the prosthetics (Figure 24). The prosthesis was completed (Figure 25).

THREE-YEAR FOLLOW-UP
The patient presented for a comprehensive oral exam and dental cleaning at 3 year post dental implant restoration. Radiographs were taken and periodontal probing performed to check pocket depth and general health of the implants (Figure 26). The surrounding tissue demonstrated with a healthy bio-
type and an absence of bleeding on probing with no evidence of peri-implantitis (Figure 27).

CONCLUSIONS
The authors are unaware of any published case reports of long standing implants/crowns in a privately owned companion animal. Animals have long been used as recipients of endosseous implants in research. This case study demonstrates that implant/crown survivability and maintenance of the crestal bone levels around implants is indeed possible in dogs for return of masticatory function. Case selection, technical skills of the operator, limiting excessive forces to implant/crowns as well as the importance of homecare maintenance by the animal’s owner are all paramount as in humans to the success or failure of the implant/crown.

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The rehabilitation of edentulous patients with two implant supported overdentures is the standard of care. Conventionally, bone level implants with corresponding attachments or single piece implants have been described in the literature. Tissue level implants with Locator attachments are a simple, cost effective yet a very successful option got the edentulous mandible. This case report summarises the surgical steps required for the placement of tissue-level implants and clinical steps to fabricate an overdenture with Locator attachments.

**KEY WORDS:** Dental implants, overdenture, locator attachment

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INTRODUCTION

Edentulism, commonly seen in geriatric patients is an important public health issue. Poor oral health leading to loss of teeth due to caries and periodontal diseases has a negative impact on the quality of life of older adults.1 The edentulous mandible undergoes resorption at a greater rate than the maxilla affecting the stability and retention of a denture.2 An implant-retained mandibular overdenture has shown to significantly improve chewing ability as compared to a conventional complete denture.3 According to the McGill and York consensus statements, a two-implant retained overdenture is the standard of care for edentulous patients.3 It helps improving the nutritional status and patient satisfaction as compared to conventional dentures.4,5 This case-report elaborately explains the use of tissue level implants and Locator attachments for rehabilitation of an edentulous patient with a mandibular overdenture.
CASE REPORT

A 58 year old edentulous patient reported to the Department of Prosthodontics (Figure 1) with a chief complaint of difficulty in eating and impaired speech due to a loose mandibular denture. A detailed history revealed that his teeth were extracted due to a compromised periodontal state 8 months ago. Following extraction of all his teeth, the patient wore a set of complete dentures for a period of 1 month. However, these dentures were ill-fitting and he desired a stable mandibular denture.

A radiographic evaluation (Figure 2) was carried out by placing radiopaque markers on the existing dentures corresponding to specific teeth. A Cone Beam Computed Tomography (CBCT) (iCat, Insight CBCT, Imaging Sciences International, Harfield, PD) was taken. The scan was studied using software (iCatVision) to measure available height and width of bone, density of bone and the proximity of the inferior alveolar canal.

The possible treatment options were presented to the patient considering the available height and width of the bone, the patient’s expectations and his financial constraints. The final treatment plan chosen was that of a conventional complete denture for the maxillary arch and an implant supported overdenture for the mandibular arch.
Surgical Phase
The existing denture was duplicated in clear acrylic resin (DPI Heat Cure, DPI, Mumbai) and used as a surgical guide. The surgical procedure of implant placement was carried out under local anesthesia using 2% Lidocaine with 1:80,000 adrenaline (Ligox 2% Warren, Navi Mumbai, India). A midcrestal incision was given, the flaps reflected and the stent was used to mark the position of the future implants. The pilot drill was followed by the use of paralleling pins and radiographs to access the relative parallelism of the osteotomies with respect to each other. Two tissue level implants (3.8 x11 Myriad Connect, Equinox Medical Technology, Netherlands) were placed in the canine regions (Figure 3). An insertion torque of 45-50Ncm was obtained for the implants. The surgical site was sutured leaving the occlusal portions of the implants exposed. Post operative instructions were given. Medications included antibiotic (Amox, Amoxicillin 1000 mg, Ranbaxy) administered 1 hour before surgery and a non-steroidal anti-inflammatory drug (Emanzed D, Emcure Pharmaceuticals Ltd.) to be taken as needed. The patient was advised to rinse with Betadine mouthwash twice a day and maintain hygiene. A post operative OPG was taken (Figure 4). The sutures were removed after assessing the healing 1 week after. The existent denture was relieved in the region of the implants and relined using a soft liner (GC soft line, GC Corp).
Prosthetic Phase

The prosthetic phase was started after a healing phase of 2 months. Conventional procedures for the maxillary denture were followed.

For the mandibular final impression the pick-up caps were placed accurately over the exposed portion of the implant (Figure 5). A custom tray was fabricated in tray material (DPI, RR cold cure, DPI, Mumbai) with a spacer thickness of 2mm. Border moulding was carried out by the sectional technique using low fusing impression compound (DPI Pinnacle Tracing Sticks, DPI, Mumbai). The final impression was made using polyether elastomeric impression material (Impregum, 3M ESPE). The pick up caps were picked up in the final impression (Figure 6). The laboratory analogues were carefully repositioned into the pick-up caps, the gingival mask (GI Mask, Coltene Whaledent) placed around the analogues...
and a cast was poured using Type 3 gypsum (KalRock, Kalabai, Mumbai, India) (Figure 7).

The jaw relation was recorded using the Niswongers method and the interocclusal check-bite technique. A face-bow record was made and a semi adjustable articulator was used to mount the record. The try-in was assessed intraorally for visibility, esthetics, phonetics, adequate freeway space and a tight intercuspation (Figure 8). The waxed up trial dentures were flaked. The maxillary denture was fabricated using routine laboratory protocol. For the mandibular denture after dewaxing, the Locator attachment was attached onto the analogues with the silicon ring between them. The denture was packed and processed using heat cured acrylic resin (Figures 9-11). The Locator attachments were placed in the mouth and torqued using a torque wrench to 25 Ncm, before denture insertion (Figures 12, 13).

The first recall appointment was after 24 hours to check for any irritation to the mucosa. The patient was recalled after three days and instructed to continue a soft diet and gradually start with the regular diet after seven days. The blue locator matrices were placed within the attachment. These can be subsequently changed to a one with more retention (pink and clear) or on wearing of the matrix.

**DISCUSSION**

In the above case report, tissue level implants have been used with a single step procedure. This can allow a faster loading protocol as studied by Bornstein et al. The non-submerged implants are an alternative to submerged implants as it merits good healing of the soft and hard tissue along with bone integration with good clinical efficacy as reported by Zhao P et al.7

Hermann JS et al.8 studied that bone remodelling takes place rapidly during the early healing phase, soon after the placement of an implant with the non-submerged approach. The gingival margin is located more coronally and the biologic width dimensions are similar to that of the natural teeth around one-piece non-submerged implants.9

The studies done in the past have compared the survival rate and the bone loss around these tissue level and bone-level implants, without showing any significant difference between the two.10-13

The use of Locator attachments helped us achieve better retention and stability when compared to the other attachment systems available.14-16 This attachment system has been reported to provide optimal load distribution on both the residual ridge as well as the implant.17

The soft tissue health around the Locator attachment system has reported to be satisfactory.18 The other advantages of this system are the ease with which patients can remove and place the dentures, easy replacement of silicone rings, their use in cases with a reduced interocclusal distance and comparative costs.19

**CONCLUSION**

This case report summarises the use of tissue-level implants for a faster loading protocol of the overdenture with the Locator attachment system. The retentive and stability properties are improved as compared to conventional dentures and various other attachment systems. The combination of tissue level (non-submerged) implants and Locator attachment system with
their associated advantages can thus be successfully used for edentulous patients.

Disclosure
The authors report no conflicts of interest with anything mentioned in this article.

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