NEGATIVE PRESSURE WOUND THERAPY AS ADJUNCTIVE TREATMENT FOR REDUCTION OF PERIODONTAL POCKET DEPTH

Extrapolation of an Orthopaedic Treatment to the Oral Cavity:
Possible Research Project Idea

Mark Wolgin, MD, Orthopaedic Surgeon, Albany, GA
drwolgin.com/npwt

Introduction

While the goals of periodontal therapy are to halt the progression of periodontal disease, restore some of the losses of periodontal structural tissues that occurred as a result of disease progression, and hopefully preserve the natural dentition, one of the biggest challenges has been to reliably either eliminate or reduce the depth of the periodontal pockets. Periodontal disease, present in both developed and undeveloped countries, affects between 20-50% of the global population making this condition a public health concern (B). The prevalence of this condition in the United States remains significant, with estimates of almost 50% of adults over 30 years of age having some degree of periodontitis (D).

Whereas there is a vast array of conditions that can affect the periodontium, aside from gingival disease and periodontitis (A), with multiple risk factors identified (E), the essential pathophysiology of the periodontal pocket formation is a chronic inflammatory state that exists at the depth of the pocket. The bacterial flora can adhere to the surfaces with similar cellular mechanisms as described elsewhere in the body (F). The chronic presence of bacterial flora at the depth of the pocket sets up a "double indemnity" (C) situation where the response to bacteria in this area creates a chronic inflammatory phase during which enhanced tissue destruction occurs. The clinical condition behaves essentially as a chronic low grade infection within the depths of the pockets.

Even when patients do their best and are most aggressive with their home care, pockets greater than 4mm cannot be cleaned with home methods. The morbidity that occurs as a result of periodontal disease is not due specifically to food particles remaining in the depth of the pockets, but is a consequence rather of plaque formation and the resultant chronic inflammation within the depths of the pockets. Therefore, any treatment modality that could be used to decrease pocket depth would result in less surface area for bacterial proliferation and therefore a diminished chronic inflammatory response. Accordingly, decreased periodontal pocket depth could lower the risk of disease progression, bone loss and potential loss of dentition.

From the moment of completion of a deep cleaning of the plaque and tartar from the periodontal pocket, a race begins between the competing forces of soft tissue healing within the pocket vs. re-establishment of bacterial adhesion to the surfaces within the pocket, either on the epithelium lining the pocket or on the base of the dentition. With the idea in mind of using negative pressure wound therapy (NPWT) an adjunctive technique that has been used elsewhere in the body to bring about healing in challenging wound situations with more devitalized tissue and worse vascularity (K), this paper posits that the use of negative pressure could potentially help bring about soft tissue healing at

the base of the pocket after aggressive dental deep cleaning, one aspect of which is supremely important: To start the cascade of healing events which can be modulated by the application of negative pressure, a wound must be created by removal of the epithelial lining of the pocket. Without removal of the epithelial layer, application of NPWT would be no more effective at decreasing pocket depth than trying to heal two fingers into one by subjecting them to a suction force (negative pressure).

Based on a recent literature review, the application of NPWT as an adjunctive treatment for treatment of periodontal pockets has not been described. However, to extrapolate the NPWT treatment paradigm from orthopaedic applications to the intraoral environment, the negative pressure would have to be applied to a wound where the cellular events that occur with the healing process can be modified. Simply removing the plaque and tartar from the base of the tooth structure would not create a micro environment that could be modulated by application of NPWT.

Background

The genesis of this idea is the author's experience both as a patient with periodontal disease and as an orthopedic surgeon. As a dental patient with no identified risk factors for periodontal disease, but continuing with aggressive home care. and even having had previous flap surgery, the author still struggles with pocket formation between 5-7mm even with professional cleanings every three months. As an orthopedic surgeon, he has noted the effectiveness of negative pressure wound therapy to bring about healing in challenging wounds of the spine and extremities, in cases where otherwise soft tissue management options would be limited. These challenges include trying to provide soft tissue coverage after debridement done for infection with exposed bone, cartilage, and in some cases even hardware (illustrative case shown in Exhibit 1). Many of the ideas behind the proposed treatment paradigm are outlined on this webpage: **drwolgin.com/npwt**, with the proposal based on the following considerations:

--For the author's personal periodontal flap surgery, no antibiotics were used, the surgical area was not sterilized (likely cannot be), indicating that success of that surgery was not based on changes in the microbial flora. (Also, changes of the NPWT dressings in orthopaedic applications are not done with any pretense of sterility.)

--Following the flap surgery noted above, healing was evident within 3-4 days post op (dressings and sutures fell out), indicating that the gingival tissues were a more forgiving healing environment, implying that soft tissue repair or reattachment could be achievable.

--NPWT has brought about healing in more challenging wound environments with higher levels of soft tissue contamination and more compromised vascularity (better vascularity correlates with better healing potential).

--Given the natural moisture of the gingival mucosa and that the spaces between the teeth that could allow for equalization of applied negative pressure, a relatively comfortable appliance can apply the negative pressure with less challenges than in the extremities.

-- The advantages of NPWT, which include decreasing local tissue swelling, contracting wound edges, and causing focal tissue microstrain (helps to bring in healing cells and increased local vascularity), would all be beneficial effects in potentially decreasing the depth of his pockets.

Based on the above, the author reasoned that NPWT could be applied following a deep cleaning that importantly included curettage of the oral epithelium on the inner surface of the periodontal pockets **to create an acute wound environment**. All elements of the suggested treatment plan incorporate techniques already currently in use.

Materials and Methods

The first step would be to make a dental impression from which an oral appliance can be made for local application of negative pressure to the gingival sulcus, (Exhibit 2). Commonly available vacuform techniques can be used as are often incorporated for the formation of bleaching trays, using the thinnest material available for maximum flexibility of the appliance (Henry Schein, Thermo Forming Material, Blue-Mouthguard, 0.20"-0.150", Melville, NY). The negative pressure can be directed to the gingival sulcus by a modification of the process of forming the appliance: some putty can be placed at the gingival sulcus on the dental impression prior to the vacuform process to create a channel to direct the negative pressure to this area.

By applying putty to the area indicated in black, before the vacuform process, a channel in the appliance could be created to direct the negative pressure to the gingival sulcus.	

Since it would not be practicable to function for full days with a suction tube coming out the front of the mouth, the plan was that the patient would wear the appliance for essentially for 24 hrs after the treatment, mainly at home, followed by application of the appliance and negative pressure for at least 12 hrs the next 6-13 days, depending on how long is required for gingival healing to reach a stable plateau. Negative pressure can be applied to the area within the appliance, generated by a currently available suction drain (Jackson Pratt suction drain, Cardinal Health, Dublin, OH, Exhibit 3), which was can generate pressures of at least negative 70 mmHg (I). The appliance would be kept in place on the upper or lower arch much like a suction cup would stick to a flat surface once the suction is applied.

One study design for a potential treatment plan could include internal controls in each patient, especially if the periodontal pocket formation is relatively diffuse (deep pockets

distributed fairly evenly in all four quadrants). A suggested study paradigm could be as follows: Negative pressure would be applied to one arch (for example/illustration here the upper arch), and the debridement/treatment could be applied to either the right or left side (upper and lower quadrants on one side). In this example, if right side were treated, the various quadrants could be compared in each patient, functioning as an internal controls:

--RUQ: (+) debridement, soft tissue curettage and (+) NPWT
--LUQ: (-) no debridement and (+) NPWT
--RLQ: (+) debridement, soft tissue curettage, (-) NPWT
--LLQ: (-) no debridement, no (-) NPWT

The post procedure oral intake recommendations would be up to each practitioner, but some general guidelines could be:
--First few days, only soft or blended foods
--Dental hygiene to include warm water salt rinses.
--Avoid flossing 4-7 days.
--Repeat exams at one week, one month, and two months.

Technique Suggestions (from a non dentist...)

Before the procedure, careful measurements should be made of all pocket depths. Under local anesthesia, the patient would have both curettage of the epithelial lining of the pockets to the point where the tissue was bleeding, along with scaling to remove the plaque and tartar to the apex/depth of the pockets.

After the procedure, the patient would apply NPWT continuously until bleeding stops, which would likely take about 24 hrs (author experience, see below). Though blended foods could be consumed through a straw even with appliance in place, the appliance could be removed for short periods (15-20 min) for an occasional salt water rinse. Based on the author's experience, the appliance was not painful to wear, he was able to sleep with it in place, and with a small amount of a dental adhesive on the region corresponding to the hard palate, the appliance was able to stay in place without requirement for continuous lingual muscular contraction.

Results

(This is obviously the section that is to be determined, along with the various combinations of dose vs response, or for how many days should NPWT be applied if there is a demonstrated benefit.)

Anecdotal report: Though the author did try the experimental design on himself with the paradigm described above, with the cooperation of his periodontist, the following was noted:
--The debridement was done on a Friday afternoon about 3pm. Except for a total time without the appliance of about 90 minutes over the next two days, he wore the appliance with applied negative pressure for about 48 hrs, and then discontinued it.

--The bloody egress of fluid was noted for about 24 hrs, and the appliance was removed for short periods and the lumen of the tubing was cleaned several times, so that blood within the tubing would not clot and block the administration of negative pressure.
--At the one week follow up, there was no noted improvement in pocket depth on either right upper or lower, but there was still significant inflammation of treated gingival tissues
--The conclusion was that probably the NPWT could or should have been applied for longer time as inflammation was still occurring and could be affected.
--New theoretical plan would have been to apply continuous negative pressure for 24 hrs at least or longer if still bleeding, and then 12 hrs/day for 6-13 days more. Aside from his own mouth, the author does not have the option to study this potential treatment paradigm in other patients.

Discussion

In the often cited article from 1948 "Pocket Elimination or Reattachment," Orban defines reattachment as occurring in the area of the gingival or periodontal pocket as an establishment of an organic (cellular) connection between the cementum and gingival tissues (G). However, there is a difference between reattachment, the process akin to scar formation to fill in the periodontal pocket, vs. regeneration, which has been noted by Melcher to involve reformation of the basic morphologic elements of the periodontium, including reformation of periodontal ligament and bone (H).

In the extremities and spine, where the healing environments are much more challenging, NPWT has shown effectiveness to the point of literally saving limbs (J). With NPWT, a pressure gradient is created, which in orthopedic use involves application of a sponge to distribute the negative pressure over the wound surface, and an adherent dressing to maintain the seal, providing benefits including:
--Reduction of tissue edema, whereby less interstitial fluid leads to less accumulation of cellular breakdown products and less inhibition of healing. Also, the remaining interstitial fluid can be thought of as a culture medium for local bacteria.
--Contraction of would edges,
--Healing cells are brought into the wound, and
--Encouraged by the pressure gradient, angiogenesis, neovascularity occurs (K). This effect on vascular ingrowth might be the most important beneficial aspect. As anyone who shaves their face knows, an inadvertent cut will be healed in 2-3 days due to the excellent circulation there, but in patients with poor circulation in an extremity, a small cut or skin ulcer can begin a cascade of events that could even lead in some instances to amputation.

While NPWT in the trunk and extremities has to be in place continuously for weeks to be effective, the idea in this case was that, given the more rapid healing capabilities of the tissues of the mouth, a more limited application of this therapy would be needed, which is fortunate, since patients would likely tolerate having a tube attached to their spine or extremity longer than they would for their mouth. Additionally, due to the natural moisture of the mucosal membranes along with the channel built into the appliance to

focus negative pressure on the gingival sulcus, along with the flexibility of the appliance material, the sponge was not needed.

Any pocket-like space has finite dimensions including an apex/tip/deepest part. The margins of a periodontal pocket include a tooth root on one side, and epithelial cells on the other surfaces. Epithelial cells, which are present in multiple locations in the body (skin, lungs, GI tract), have as their specific primary characteristic that they do not heal together. The cells lining these pocket surfaces have limited mitotic potential, and therefore, to generate any healing activity (that would hopefully be modulated by NPWT), this epithelial layer would have to be removed, creating a focal wound.

This proposal is offered based on observations that more challenging wound have been salvaged with NPWT in the orthopedic setting. The author has observed multiple instances where, after debridement, tissues with less healing capability than gingival tissues, and some with no vascularity at all (cartilage, exposed hardware), have had healing occur after debridement through the effects of NPWT to provide soft tissue coverage of significant structural integrity.

Additionally, the effects of NPWT are likely independent of, and in many instances supersede, issues of microbiology of the wound. While orthopaedic injuries are debrided in the operating room with the first NPWT dressing applied in conditions as close to completely sterile as possible (though some patients present with grossly contaminated wounds), the first dressing change which occurs 2-3 days after the index surgery is not sterile. Yet, the healing will be observed, promoted by the effects of negative pressure.

In the oral space, using as a reference both discussions with dental professionals and the author's own periodontal flap surgery, given that the debridement in the mouth had no attempt made at achieving sterility, a wound environment is created that is itself contaminated by bacterial flora. Immediately following the procedure, what occurs is a race between tissue healing to make the pocket less deep versus bacterial recolonization of the treated surfaces that would impede tissue attachment and continue the chronic inflammatory process. Unless the very tip/apex of the pocket has a repair response characterized by cell division, repair, and most importantly neovascularity, this apex will remain a contaminated area. The strategy of using NPWT is to influence the cascade of cellular events involved with wound healing to advantage the tissues over the bacteria, to encourage the healing process to close up the pocket by creating a gradient bringing in new vascularity, especially at the tip/apex region, along with reduction of edema and contraction of the wound. However, for NPWT to have an effect, a wound would have to be created as noted by removal of the epithelial surface lining the pocket. An adequate healing response would not be stirred up simply by scaling and root planing.

If NPWT can be shown to favorably modulate post debridement pocket healing to become less deep, the results could be profound. Periodontal disease is very common, and also a main reason for tooth loss. Decreased pocket depth would mean less room for bacterial colonization. Less colonization would mean less inflammation and less risk of loss of supporting bone. Also well known is the association between periodontal disease and systemic health (L), with the logical conclusion being that less chronic colonization

of the pockets would result in lower chances of systemic bacteremia occurring. While open to interpretation, from discussions with periodontists and dental professionals, the impression is that a decrease in pocket depth of 1mm would be a significant improvement.

While this proposal looks at non surgical application of NPWT, this technique could also have benefits in surgical situations with expedited healing, potentially optimizing healing of tissue donor or bone graft recipient sites, or augmenting healing of surgical wounds, with the previously described focal benefits of NPWT.

As noted in the Results section above, still to be determined would be an optimal schedule for application of NPWT (dose/response relationship), assuming some benefit would occur. While documented benefits of NPWT use are abundant, with excellent results for otherwise unsalvageable clinical situations (Exhibit 1), the author does not have capability of applying this treatment to the oral space, and thus the purpose of this paper is to hopefully interest a dental or periodontal professional to consider studying this treatment paradigm in the clinical setting. As noted, all of the components parts of this treatment are already standard treatments (fabrication of bleaching trays, application of negative pressure), but the hope of this presentation is that someone will study this issue to look for a potential clinical application.

Referances:

B. Nazir, MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. Int J Health Sci (Qassim) 2017 Apr-Jun; 11(2): 72–80. PMCID: PMC5426403

A. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol 1999;4:1-6.

C. Ebersole, JL, Dawson, DR III, Morford, LR, Peyyala, R, Miller, CS, Gonzaléz, OA. Periodontal disease immunology: 'double indemnity' in protecting the host. Periodontol 2000. 2013 Jun; 62(1): 163–202. doi: 10.1111/prd.12005. PMCID: PMC4131201. NIHMSID: NIHMS611674

D. Eke, PI, et al. Update on prevalence of periodontitis in adults in the United States: NHANES 2009 to 2012. Journal of Periodontology. May 2015, Vol. 86, No. 5, Pages 611-622. https://doi.org/10.1902/jop.2015.140520.

E. Genco, RJ, Borgnakke, WS. Risk factors for periodontal disease. Periodontology 2000, 62: 59–94 (2013). doi: 10.1111/j.1600-0757.2012.00457.x

F. Gristina, AG, Costerton, WJ. Bacterial adherence to biomaterials and tissue: The significance of its role in clinical sepsis. JBJS, 67-A (2), February, 264-273, 1985.

G. Orban, B. Pocket elimination Or reattachment? NY State Dent J. 1948 May;14(5):227-32. PMID: 18861984

H. Melcher AH, McCulloch CA, Cheong T, Nemeth E, Shiga A. Cells from bone synthesize cementum-like and bone-like tissue in vitro and may migrate into periodontal ligament in vivo. J Periodontal Res. 1987 May;22(3):246-7. PMID: 2955109

I. Grobmyer SR, Graham D, Brennan MF, Coit D. High-pressure gradients generated by closed-suction surgical drainage systems. Surg Infect (Larchmt). 2002 Fall;3(3):245-9.

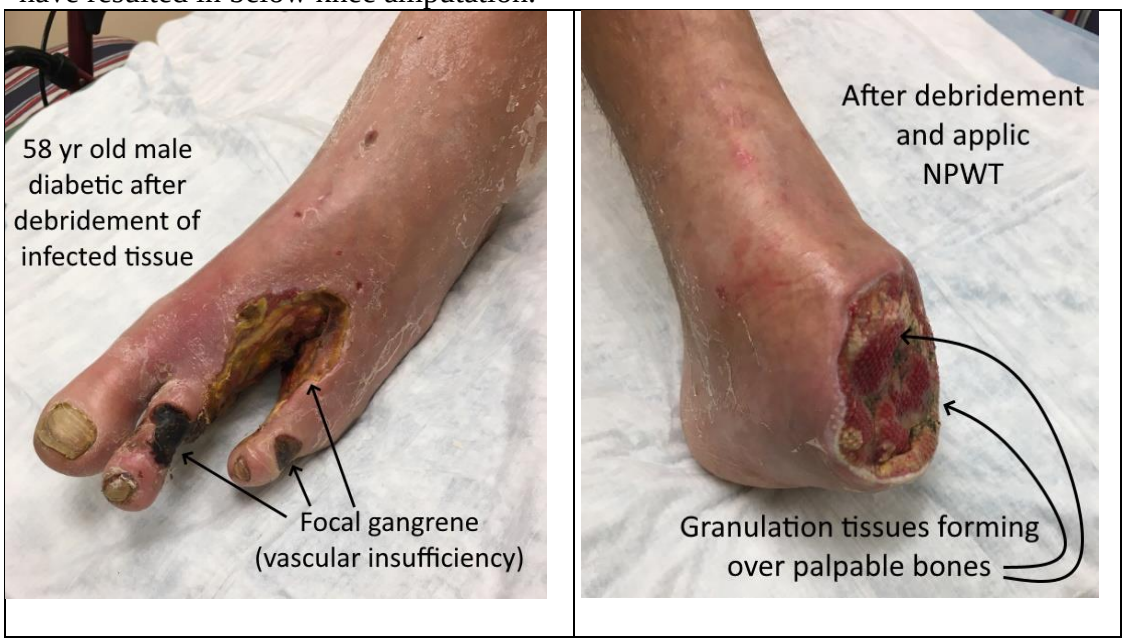
J. Armstrong, DG, Lavery, LA. Negative pressure wound therapy after partial diabetic foot amputation: a multicentre, randomised controlled trial. Lancet 2005; 366: 1704-10.

K. Orgill DP, Bayer LR. Negative pressure wound therapy: past, present and future. Int Wound J. 2013 Dec;10 Suppl 1:15-9. doi: 10.1111/iwj.12170.

L. Hegde, R, Awan, KH: Effects of Periodontal Disease on Systemic Health. Dis Mon 2019, June;65(6): 185-192

Exhibit 1:

These images indicate a clinical example showing how NPWT in an orthopaedic situation, with significant necrotic tissue present and poor circulation, was able to help induce healing granulation tissues to cover exposed bony surfaces, wound contraction, and formation of epithelial tissues, to salvage the limb. Without NPWT, this case would have resulted in below knee amputation.



The treatments would involve applying a sponge over the exposed wound, covering it with a dressing (think of the plastic wrap from your kitchen, but sticky on one side), then make a small hole on that dressing and negative pressure is applied through that hole, through the sponge, to affect the wound surfaces.

With continued application of NPWT, the patient was able to heal the wound and save his leg, though he requires a special shoe.

	Exhibit 2: This photo displays the appliance used for the upper arch, made with the vacuform process used to create a bleaching tray, but extended to contact the gingival surfaces.
	Exhibit 3: While most applications in the orthopaedic space of NPWT use a machine which calibrates the level of suction, negative pressure was able to be applied and maintained with a commonly available surgical suction drain.

Respectfully submitted.

Mark Wolgin, MD
drwolgin.com/npwt
Albany, GA
mwolgin@gmail.com
Cell: 310-704-6275