

DENTAL TECHNIQUE

## A salivary sensor for the management of xerostomia in edentulous patients

Vasudevan Karthikeyan, MDS,<sup>a</sup> Naveen Gopi Chander, MDS, DNB, MFDS, RCPS,<sup>b</sup> and Kuttae Viswanathan Anitha, MDS<sup>c</sup>



The rehabilitation of acquired maxillofacial defects requires an interdisciplinary approach as the patients present with many difficulties.<sup>1</sup> Depending on the nature of the disease and the size and extent of the defect, the patient may have been subjected to surgical resection, radiotherapy, chemotherapy, or a combination of these.<sup>2</sup> The effectiveness of each therapeutic measure overrides its limitations. Xerostomia or dryness of mouth from the lack of normal secretions is one of the major limitations of radiation therapy.<sup>3</sup> Saliva is an important oral fluid for mastication, swallowing, taste perception, lubrication, and buffering action and improves patient comfort when present in adequate quantity and quality.<sup>4,5</sup>

The retention and stability of an obturator prosthesis even with adequate salivary presence is compromised because of the loss of the resected diseased tissues inside the oral cavity. Thus, the presence of saliva contributes to the effectiveness of the maxillofacial prosthesis.<sup>6</sup> The intensity of the dry oral condition and its durability depends on the dosage of radiation provided. Nearly 50% to 70% reduction in salivary flow has been reported after 10 to 16 Gy radiation.<sup>4</sup> The volume, consistency, and pH of saliva becomes damaged,<sup>5</sup> and the synchronous administration of chemotherapy amplifies the salivary gland dysfunction.<sup>7</sup> Such patients should receive immediate palliative care.

### ABSTRACT

This article describes a method for managing xerostomia in edentulous patients with a newly developed salivary sensor. A micropressure sensor unit with a capsule to hold artificial salivary substitute was built into the dental prosthesis. This sensor prosthesis can help patients overcome mouth dryness, improves patient comfort, and aids in retention of the prosthesis. (J Prosthet Dent 2019;121:384-6)

Various management strategies have been suggested for xerostomia, including gustatory and pharmacological means of increasing salivary flow and the use of mouthwash, chewing gum, lozenges, oral buffering products, artificial salivary substitutes, lubrication sprays, rinses, and acupuncture.<sup>5</sup> For patients who cannot tolerate sialogogues because of side effects or hypersensitivity, palliative support with alternative methods has to be considered.<sup>8,9</sup> In spite of the availability of numerous topical oral sialogogues, there is no strong evidence for the superiority of one over others.

This present report puts forward a new dental technique wherein an obturator prosthesis was made with an inbuilt sensor for the management of xerostomia. Sensors are those devices that detect physical, chemical, and biological signals and provide a way for those signals to be analyzed and recorded. They give information about signals which could not be otherwise directly detected by the senses and can sense physical properties such as temperature, pressure, vibration, sound level, or light intensity.<sup>10</sup> Among the many available sensors, pressure sensors can measure gases or liquids and express the force required to stimulate the flow of a fluid.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

<sup>a</sup>Postgraduate student, Department of Prosthodontics, Sri Ramaswamy Memorial Dental College, Chennai, India.

<sup>b</sup>Professor, Department of Prosthodontics, Sri Ramaswamy Memorial Dental College, Chennai, India.

<sup>c</sup>Reader, Department of Prosthodontics, Sri Ramaswamy Memorial Dental College, Chennai, India.

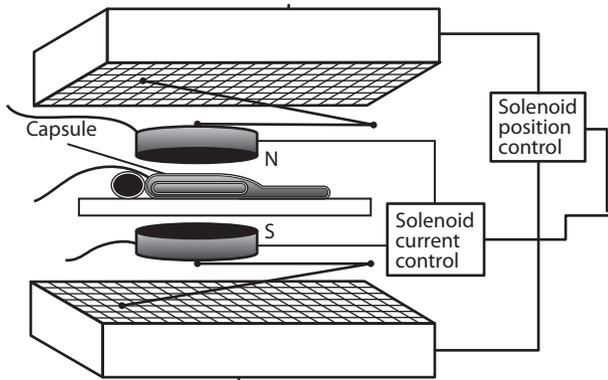


Figure 1. Components of sensor unit.



Figure 2. Tube for addition of artificial salivary substitute.

**TECHNIQUE**

1. Make a preliminary impression of the maxillectomy defect by covering the entire defect area with irreversible hydrocolloid impression material (Zelgan Plus; Dentsply Sirona).
2. Use dental stone (Ultra stone; Kalabhai Karson Pvt Ltd) to make the preliminary cast for fabricating a custom tray.
3. Block extreme undercuts with baseplate wax (Modelling Wax No. 2; Hindustan) and construct a custom tray with single thickness full spacer design.
4. Fabricate a custom tray with autopolymerizing polymethyl methacrylate resin (Cold Cure; Dental Products of India-RR) by using the sprinkle on technique of 2- to 4-mm thickness.
5. Make a definitive impression with monophasic polyvinyl siloxane impression material (Aquasil Monophase; Dentsply Sirona).
6. Bead and box the definitive impression with wax (Rolex Beading and Boxing Wax; Deccan Dental) to obtain the definitive cast for obturator fabrication.
7. Use autopolymerizing polymethyl methacrylate resin to make an interim denture base (DPI Cold Cure; Dental Products of India-RR) and wax the occlusal rims to record the jaw relation.
8. Arrange the teeth (Acry Rock; Ruthinium Dental Products) for verification of the trial prosthesis.
9. Complete the denture waxing. Seal the waxed prosthesis onto the cast.
10. Invest the cast with dental plaster (Plaster of Paris; The Ramaraju Surgical Cotton Mills Ltd) and eliminate the wax by boiling.
11. After dewaxing, use a 3-mm thickness of modeling wax to block out the undercuts in the cast.
12. Adapt a 3-mm thickness of modeling wax onto the palatal defect area to create a shim. Create a ledge around the periphery of the defect with wax to leave an opening to the defect portion.

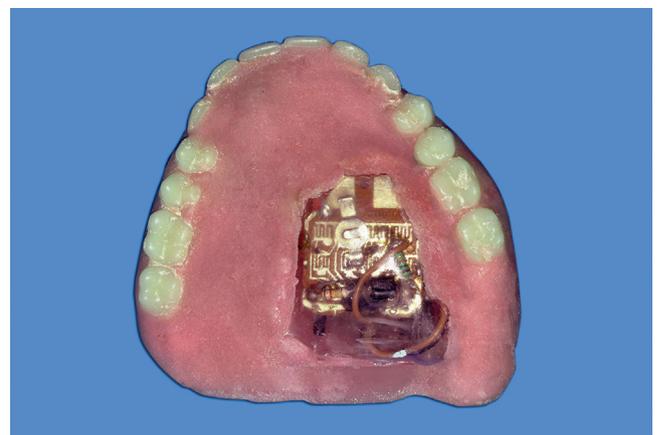


Figure 3. Sensor placed within prosthesis.

13. Evaluate the passive seating of the part of the flask that contains the teeth on its counterpart without any resistance.
14. Take another flask cope and seat it over the flask drag containing the definitive cast, fill it with dental plaster, and dewax.
15. After wax elimination, pack the flask with heat-polymerizing polymethyl methacrylate denture base resin (DPI Heat Cure; Dental Products of India) to obtain a hollow shim and palatal portion of the denture with teeth.
16. Separate the processed flasks. A projection of dental plaster in the obturator region will be seen. Now bevel the acrylic resin borders around the defect area and adapt a sheet of light-polymerizing acrylic resin sheet (Profibase; VOCO GmbH) to cover this portion.
17. Before light polymerizing the adapted resin sheet, gently scrape and remove the projection of dental plaster in the defect area just enough to accommodate the sensor component.
18. The sensor unit (555 integrated circuit chip; Murata Electronics India Pvt Ltd) consists of 3

layers. The base layer contains a battery sealed within the denture and is followed by the middle layer, which is made up of medical-grade silicone (Fig. 1).

19. The silicone is in the form of a sponge-like structure so that it can absorb the saliva substitute.
20. Inject 20 mL of artificial saliva substitute (Wet Mouth; ICPA Health Products Ltd) through the tube connected to the silicone pouch (Fig. 2).
21. The outermost layer of the sensor unit consists of a salivary pressure transducer which converts the mechanical stimuli of the tongue into electromagnetic stimuli when the tongue is pressed against the sensor.
22. With the sensor unit in place, use autopolymerizing acrylic resin (DPI Cold Cure; Dental Products of India-RR) to close the opening between the denture base and light cure resin sheet.
23. Place the processed base containing the sensor unit onto the initial flask with the teeth.
24. Evaluate both units of the flask for passive fit. If there is any resistance, trim the resin portion until the components of the flask seat completely.
25. Pack using heat-polymerizing polymethyl methacrylate denture base resin (DPI Heat Cure; Dental Products of India) to secure the denture teeth onto the processed base holding the sensor unit.
26. After processing, retrieve the prosthesis to observe the sensor unit incorporated in the prosthesis (Fig. 3).

## DISCUSSION

The technique described in this report is a way to fabricate a dental prosthesis with inbuilt microsensors for ejection of artificial saliva. The prosthesis contains a micropressure sensor unit and a transduction unit to convert the input signal into output source.<sup>11</sup> The input signal is mouth dryness, and the output action is ejection of the incorporated saliva substitute. The micropressure sensor works on the principle of mechanical bending of a thin silicon diaphragm by tongue pressure. The strain associated with the deformation of the diaphragm is measured by tiny doped silicon piezoresistors placed in strategic positions in the diaphragm. Doped silicon has high resolution and sensitivity, producing the output signal when deformed.<sup>12,13</sup>

Although sensors play an essential role in artificial prostheses for capturing senses, their application is still in its infancy. The limitations that restrict the use of sensors in prostheses include biocompatibility, difficulty in fabricating the unit, weight of the unit, sensor efficacy, standardization in output saliva ejection, and durability.<sup>14</sup>

However, with the development of sensor technology, their application in dental prosthetics will increase.

## SUMMARY

A removable dental prosthesis was fabricated with inbuilt sensors to help in the management of xerostomia. A micropressure sensor was incorporated into the prosthesis to detect a dry mouth. On detecting a dry mouth, tongue pressure ejects artificial saliva from a capsule inside the sensor. The addition of a small sensing unit helps with detection of the dry mouth. Saliva substitute is released according to the requirement of the patient and unnecessary dispensing and frequent replacement of artificial saliva is avoided. In the future, the use of microsensing units will become more straightforward in prosthodontics.

## REFERENCES

1. Keyf F. Obturator prostheses for hemimaxillectomy patients. *J Oral Rehabil* 2001;28:821-9.
2. Koyama S, Sasaki K, Inai T, Watanabe M. Effects of defect configuration, size, and remaining teeth on masticatory function in post-maxillectomy patients. *J Oral Rehabil* 2005;32:635-41.
3. Depprich R, Naujoks C, Lind D, Ommerborn M, Meyer U, Kübler NR, et al. Evaluation of the quality of life of patients with maxillofacial defects after prosthodontic therapy with obturator prostheses. *Int J Oral Maxillofac Surg* 2011;40:71-9.
4. Turner MD. Hyposalivation and xerostomia: etiology, complications, and medical management. *Dent Clin North Am* 2016;60:435-43.
5. Mercadante V, Al Hamad A, Lodi G, Porter S, Fedele S. Interventions for the management of radiotherapy-induced xerostomia and hyposalivation: a systematic review and meta-analysis. *Oral Oncol* 2017;66:64-74.
6. Murakami M, Nishi Y, Kamashita Y, Nagaoka E. Relationship between medical treatment and oral dryness diagnosed by oral moisture-checking device in patients with maxillofacial prostheses. *J Prosthodont Res* 2009;53:67-71.
7. Jawad H, Hodson NA, Nixon PJ. A review of dental treatment of head and neck cancer patients, before, during and after radiotherapy: part 1. *Br Dent J* 2015;218:65-8.
8. Epstein JB, Beier Jensen S. Management of hyposalivation and xerostomia: criteria for treatment strategies. *Compend Contin Educ Dent* 2015;36:600-3.
9. Tschoppe P, Wolgin M, Pischon N, Kielbassa AM. Etiologic factors of hyposalivation and consequences for oral health. *Quintessence Int* 2010;41:321-33.
10. Schott TC, Ludwig B, Glasl BA, Lisson JA. A microsensor for monitoring removable-appliance wear. *J Clin Orthod* 2011;45:518-20.
11. Hori K, Ono T, Tamine K, Kondo J, Hamaoka S, Maeda Y, et al. Newly developed sensor sheet for measuring tongue pressure during swallowing. *J Prosthodont Res* 2009;53:28-32.
12. Cheri MS, Shahraki H, Sadeghi J, Moghaddam MS, Latifi H. Measurement and control of pressure driven flows in microfluidic devices using an optofluidic flow sensor. *Biomicrofluidics* 2014;8:054123.
13. Yang Z, Dong T, Halvorsen E. Identification of microfluidic two-phase flow patterns in lab-on-chip devices. *Biomed Mater Eng* 2014;24:77-83.
14. Pouriahi M, Gurman P, Daich J, Cynamon P, Richler A, Elman N, et al. The use of micro-electro mechanical systems in vascular monitoring: implications for clinical use. *Expert Rev Med Devices* 2016;13:831-7.

### Corresponding author:

Dr Kuttae Viswanathan Anitha  
Department of Prosthodontics  
Sri Ramaswamy Memorial Dental College  
Ramapuram  
Chennai 600089  
INDIA  
Email: kvaniseenu25@gmail.com; drankiv@yahoo.co.uk

Copyright © 2018 by the Editorial Council for *The Journal of Prosthetic Dentistry*.  
<https://doi.org/10.1016/j.prosdent.2018.07.003>