Case Report

Treatment of an Ill-Fitting Complete Dental Prosthesis with Digital Sensor Device: A Case Report

Abstract

Complete edentulism is one of the most common problems encountered by geriatric individuals. With advanced aging, despite attempts made to retain natural dentition, loss of entire teeth is yet observed. For precise denture fabrication, a digital sensor device was used during the making procedure. The use of sensor device aided in better appreciation and more retentiveness of denture.

Keywords: *Complete edentulism, dental prosthesis, geriatrics, mini sensors*

Submitted: 27-Jan-2022 **Revised:** 12-Mar-2022 **Accepted:** 13-Jul-2022 **Published:** 12-Jul-2023

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Introduction

The overall quality of life in geriatric population is impacted by the presence of near normal physical, psychological, and social health. The absence of natural dentition affects the well-being of patient, due to difficulty in chewing, speech, and unesthetic appearance. Immediate rehabilitation with dental prosthesis becomes compulsive to restore lost functions. Accurately fabricated prosthesis, make the denture-wearing experience more satisfactory. A retentive complete denture increases physiological and psychological comfort of the patient. It enables the patient to masticate food with ease and shows an improvement in phonetics.[1] The initial step to establish denture retention starts from the stage of appropriate diagnosis and clinical examination of intra-oral structures.[2] A dental impression made with right extensions of denture-bearing areas enhance retention. When intimate adaptation of denture surface to underlying tissues is present, homogeneous transmission of masticatory forces and preservation of residual alveolar bone occurs.[3]

In a fully tissue-supported complete denture, residual anatomic landmarks aid in retention of the prosthesis. Maxillary denture retention is critical due to the effect of gravitational forces that dislodge the denture. The zone at the junction of hard and soft palate named "posterior palatal seal" (PPS) is compressible and provides seal in the posterior part of maxillary denture. It enhances the retention and stability of a well-adapted denture through forces of adhesion, cohesion, and interfacial surface tension by providing complete seal.[4] It also prevents food accumulation between posterior border of denture and soft palate, reduces the tendency to gag as the posterior limit is confined, makes the sunken distal border of the denture less noticeable to the tongue, supplies a thickened area that provides added strength to the denture and compensates for polymerization shrinkage.[4,5] This area can take up pressure within physiological limits to help in retention."[6] Skinner *et al*. evidenced the significance of PPS and as an important anatomical landmark to be recorded for denture retention in the post-dam region.[7]

Denture retention being an effective outcome measure, various techniques and materials for recording PPS have been documented, such as the conventional technique, fluid wax technique, arbitrary technique, and extended palate technique.[8] Hardy and Kapoor classified techniques for recording PPS into functional, semi-functional, and empirical techniques.[5] The conventional method of recording PPS proposed by Winkler involves the use of T-burnisher

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Access this article online

Website: www.jmssjournal.net

DOI: 10.4103/jmss.jmss_10_22

Quick Response Code:

How to cite this article: Gupta S, Srinivasan R, Tharakan SR, Viswanathan AK, Chander GN. Treatment of an ill-fitting complete dental prosthesis with digital sensor device: A case report. J Med Sign Sens 2023;13:233-8.

and visual inspection of postdam area by phonetic method.[4] Miller used a ball burnisher to palpate the width and displaceability of PPS tissues.[9] Ettinger and Scandrett indicated an arbitrary procedure, in which scraping of the master cast was done before denture processing.[10] Nikoukari recommended use of a Kingsley scraper to score the master cast in PPS region.[11] Narvekar and Appelbaum used ultrasound transducer to study real-time image of soft tissue in posterior palatal region.[12] Each method has its own advantages and limitations, making the clinical usage more subjective. Choice of PPS recording is based on subjective operator's preference. In the absence of an objective estimation method, outcome of the treatment becomes more variable and less predictable. In this case report, a digital sensor device was used to record and quantify tissue displace-ability for suitable use in complete denture construction. When the tissues are read and captured more precisely, denture fabrication becomes more definitive.

Case Report

A 75-year-old male patient reported to the department of prosthodontics with a chief complaint of ill-fitting denture. History taking revealed the patient had lost his entire dentition over the years due to mobility and carious infection. He had become completely edentulous a year before [Figure 1]. He had been wearing a removable complete dental prosthesis on both maxillary and mandibular arch for the past 3 months. He was dissatisfied with his loose maxillary denture and reported denture dislodgment even during rest.

Intraoral examination revealed completely edentulous upper and lower arch devoid of any pathology or inflammation. A low well-rounded "U-shaped" ridge was observed in both the arches. A thorough intraoral and extraoral examination was done. A detailed inspection of the previous denture revealed an inadequate extension of maxillary denture anteroposteriorly. When it was seated

Figure 1: Intraoral preoperative view

intraorally and PPS area was examined, air bubbles escaped from the under surface of the upper denture. This evidently showed improper recording of PPS zone to retain the maxillary prosthesis. Extensions of lower denture were proper, and patient-reported with no complaints in relation to mandibular prosthesis.

Various treatment options of modification of existing denture, refabrication with conventional tissue supported, implant-supported overdenture, and fully fixed implant-supported denture was given to the patient. After deliberation, patient showed no interest in modification of previous denture and henceforth fabrication of new conventional tissue-supported removable prosthesis was decided. An option of implant-supported prosthesis was eliminated, as the patient was unwilling for surgical intervention during treatment. All procedures of clinical appointments and duration of completion of treatment were explained to the patient. An informed consent was obtained regarding the use of digital sensor device during denture making process. The protocol of the treatment was approved by the ethical review board of the institution at which the study was conducted.

A preliminary impression of both the arches was made with irreversible hydrocolloid (Zelgan, Dentsply, Germany) using perforated edentulous trays. Segmental border molding was done with a low-fusing compound (Dental Product of India (DPI), Pinnacle tracing sticks, India) followed by secondary impression with zinc-oxide eugenol impression paste (DPI impression paste, India). The greatest attention was paid by the operator for recording of PPS zone. Examination showed a class I palatal throat form with 3–5 mm of PPS area available for registration. For its clinical recording, the patient was asked to sit in an upright position, with head flexed at nearly 30° forward to place the soft palate in depressed position. He was instructed to rinse oral cavity with astringent mouth wash (Colgate Plax, India) and sterile cotton swab was used to make the PPS region moist-free. Careful inspection of post palatal and pterygomaxillary seal area was done by asking the patient to perform phonation and nose blowing method to appreciate the anterior and posterior vibrating lines. Now, the digital sensor device was used to record and register the tissue displaceability in PPS zone.

In clinical practice, a conventional T-burnisher is used for PPS recording. In the present case report, a conventional T-burnisher (TB2; GDC Dental) was modified to accommodate the sensor unit. Ball end of burnisher was altered to house the sensor structure. A casting was done with nickel–chromium alloy (Wiron 99, Bego, Germany) by traditional lost wax process. The superior surface of casting was made flat of 8 mm length and 5 mm width to accommodate sensor. An access hole was made on inferior surface to mechanically fit the casting onto the ball end of T-burnisher. This design was initially incorporated in the wax pattern before casting. A "Flex force" sensor device (Flexi force A301, Tekscan) of a 12.5 mm diameter and 0.02" inch thick round sensing part was used [Figure 2]. It was made of two flexible polyester substrate layers separated by a spacer with a vent in between. Active part was of silver metal foil arranged in a loop fashion back and forth configuration followed by a pressure-sensitive ink layer. It showed pressure values ranging from 0 to 100 N when applied over 0.125 sq in surface area. It had two small diameter conductor wires at the open end for connection to the micro-controller unit (Arduino Nano; ATmega 328) [Figure 3].

Before the attachment of sensor on flat upper surface of customized T-burnisher, a 220-size grit sandpaper was used to polish the surface followed by use of acetone solvent to ensure the surface was dust free. Sensor was handled with a tweezer and placed onto a clean glass slab, with the conductive portion facing upward. Direct contact with hands was avoided to prevent damage and/or contamination to sensor. The sensor was first glued on clean glass base with transparent tape and then a cotton swab dipped in solvent was used to clean the same. A piece of clear tape was taken and uniformly applied on the sensor film. A marker was used to outline the attachment site of sensor. A drop of cyanoacrylate was applied on casted flat upper surface and the sensor was affixed. No exertion of excessive force was done while removing sensor from tape as it could deform and produce inaccurate results. Once the cyanoacrylate was set, the tape was carefully removed leaving away sensor firmly fixed to T-burnisher. A magnifying glass was used to inspect intact bonding of sensor and absence of bubbles.

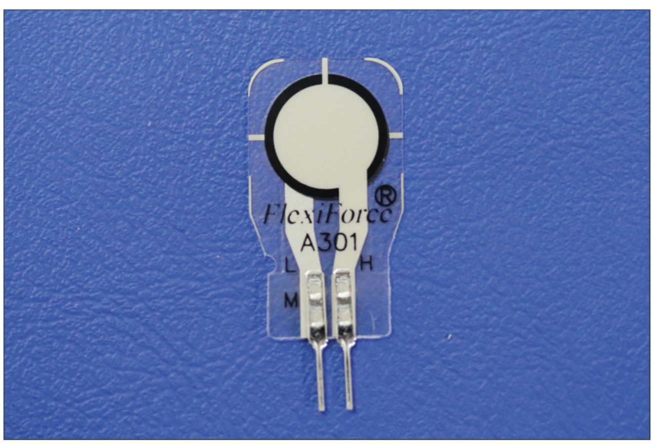

Figure 2: Flexi-force sensor

Now, the modified T-burnisher had one flat straight end for the location of hamular notch and other customized end for pressure sensing of PPS area [Figure 4]. The shaft of the device consisted of a micro-controller unit embedded within a 3D-printed polymer (Wanhao Natural White ABS1.75 mm filament) casing. Output from the micro-controller was read on a mobile phone through a universal serial bus (USB) connection cable [Figure 5]. Only the two working ends were to be used intraorally and were shielded with a sterile disposable insulating polyethylene sheet exposing the sensor part alone. One end of the resistive sensor was connected to 5V power and other to a pull-down 10K resistor to ground. A microcontroller programmer board was adopted for acceptance of input data and for reading output value. To facilitate this, a part of the fixed pull-down resistor leg was connected to the analog input of a microcontroller. Its coding language aided to read the input pressure signals as resistance values on computer. In-depth coding allowed conversion of ohms into newton reading. A serial monitor mobile application was downloaded to display the values from the computer on mobile phone through USB cable as shown by illustration [Figure 6].

Before intraoral use, all connections were evaluated for the right working status. Flat end of device was used to locate hamular notches on both sides [Figure 7]. The sensor end was used in the post palatal seal region to determine tissue displaceability. Depending on the extent of compressibility in PPS, the numerical value was displayed in mobile phone in the form of newtons (N). A varied value was observed as the sensor was placed at different regions within the boundaries of PPS. Two experienced prosthodontists evaluated with the digital sensor device to eliminate variability. Based on the displayed value, corresponding tissue displacement was facilitated while

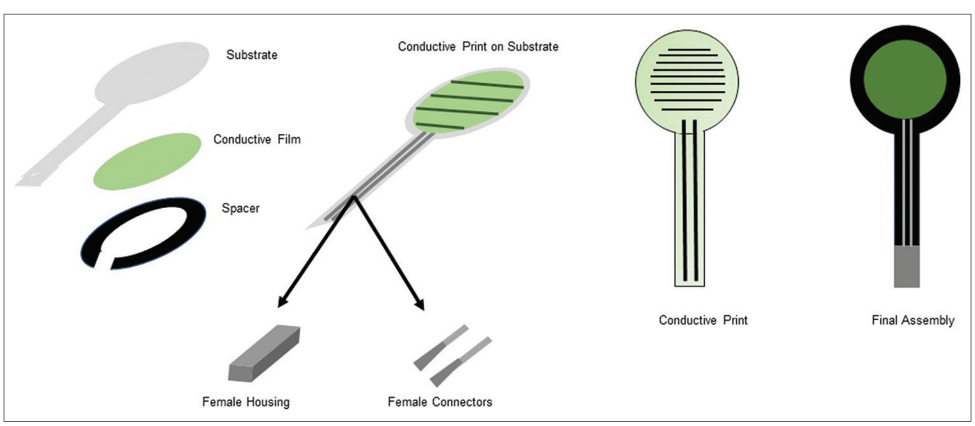

Figure 3: Components of "flexi-force" sensor unit

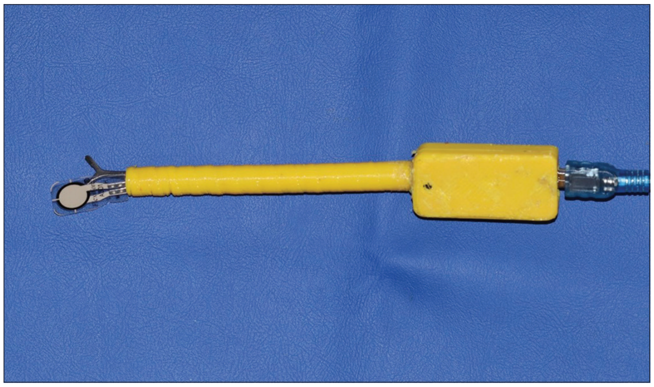

Figure 4: Modified T-burnisher with the sensor

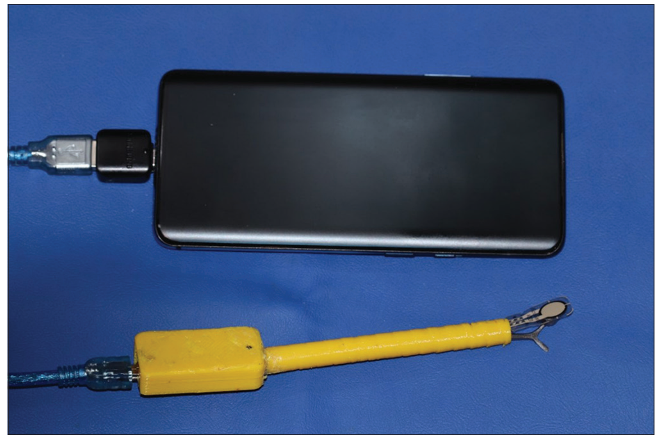

Figure 5: Device assembly connected to mobile phone through USB cable. USB: Universal serial bus

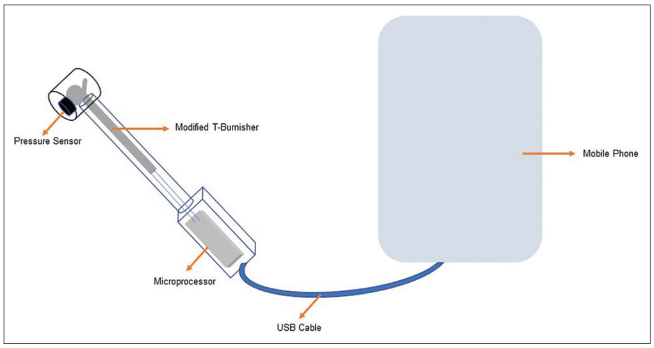

Figure 6: Illustration of device assembly

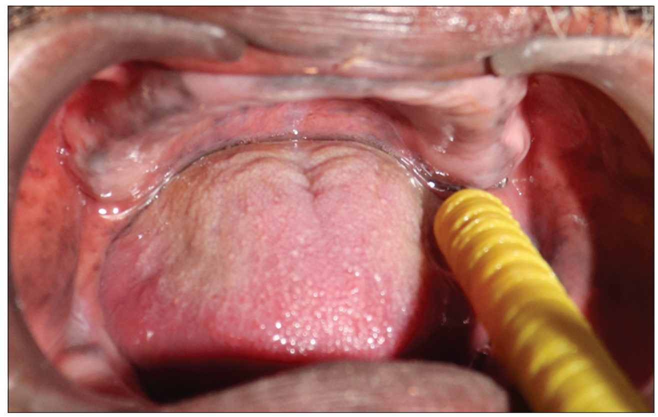

Figure 7: Device used intraorally

complete denture impression making. On completion of secondary impressions, master casts were prepared, and maxillomandibular relationship was recorded on the third clinical appointment. After artificial teeth arrangement, trial denture was verified for extension, fit, occlusion, phonetics, and esthetics inside the patient's mouth. Upon satisfaction between both operator and patient, denture processing was done in a conventional manner with heat polymerizable polymethyl methacrylate resin material. On the day of denture placement, prosthesis extension, retention, stability, and support were verified [Figure 8]. A pressure indicator paste was applied on tissue surface of denture to eliminate impinging spots. Post insertion instructions were given, and the patient was recalled after 24-h to check for any acute problems. The patient was educated on the denture and oral hygiene maintenance and was instructed to report for review every 3 months from then.

Discussion

Artificial dental prosthesis wearing is most challenging in geriatric individuals. Measures such as denture retention, stability, support, and life-like appearance of prosthesis determine the success of treatment.[13] Ignorance of any minute details during prosthesis fabrication can have a deleterious effect post placement. With the development of material science and technology, best of denture services are possible today.[14] In the current report, a mini sensor was used along with conventional T-burnisher for registration of PPS area. The "flexiforce" sensing device used here, worked on the principle of sensor and resistor technology. The active conductive portion of sensor was made with lithography technology. Sensor was connected to an electronic circuitry to work. To evaluate tissue, displaceability in PPS area, external force is applied by the operator with the help of sensor. The conductive film then deformed against the substrate. At this point, air from spacer was pushed from the air vent and film came in contact with conductive print on the substrate. The applied force and resistance change of sensor are inversely proportional.[15] A lower resistance value was obtained when more conductive ink contacted the film. When more pressure was applied to displace the tissues, more layers touch the conductive film and lessened the resistance value. Ferguson and Cardi[16] in 1993, developed a prototype for wheelchair mapping with this sensor. Later, it was also used for the identification of pressure between skin and support surface. It was evidenced that the output of sensor increased when the measurement area was more than 32 mm. Acceptable repeatability, linearity, and hysteresis were observed with this sensor.[17]

Figure 8: Final dental prosthesis

The coding language of the micro-controller helped to capture input signals as resistance values and then converted resistance to newton readings on the computer. To enable use of the complete device on chair side, a software application was downloaded on a mobile phone to visualize the objective readings. Tekscan literature evidenced the efficacy of sensor to be presented with a <3% drift in logarithmic time, both linearity and repeatability were within 5%, hysteresis was found to be <4.5% when 50% of the full force range was applied. There was no information on curvature effects.[17]

The device assists dental specialist to obtain numeric values of the pressure that can be applied on the PPS area. It can be used as an objective tool for the estimation of tissue displace-ability not only in PPS region but wider application facilitates its use anywhere in an edentulous mouth. The extent of hyper-plastic or flabby tissue displacement can be read with the device. Subjective evaluation is eliminated.

In the current case report, the use of this handheld digital sensor device on a T-burnisher enabled to overcome the chief complaint of ill-fitting maxillary denture due to improper registration of PPS while impression making. The use of the device supported better understanding of PPS morphology, thereby avoiding any operator related issues during denture construction.

Conclusions

Ill-fitting prosthesis caused by improper registration of PPS area for maxillary denture was treated with aid of new device. A digital sensor device was customized for objective analysis of tissue displacement in PPS region during impression-making procedure. Conventional T-burnisher was modified to accommodate a force-resistor sensor. It was enabled to show output pressure values (N) on a mobile phone. It was used as a definitive guide during the construction of complete denture rather than subjective analysis by the operator. An accurately captured impression was reflected by a well-fitting prosthesis. Increased denture retention, helped to enhance the psychological comfort of patient.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

None.

Conflicts of interest

There are no conflicts of interest.

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