Case Report

Two-piece obturator using "lock-and-key" mechanism

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Abstract

This paper describes a method used for the fabrication of a two-piece denture obturator for a patient who had surgical removal of the premaxilla due to squamous cell carcinoma. The patient had been wearing a two-piece obturator but encountered difficulty in inserting the prosthesis. In this case report, a lock-and-key mechanism was used to easily assemble the two-piece prosthesis intraorally. A keyhole was designed on the obturator to act as the lock while the denture was used as the key that fitted into the keyhole. This mechanism facilitated insertion and provided retention for the prosthesis. Heat-cured resilient acrylic material (Molloplast B®), which was used to fabricate the obturator, was a nonirritant, nontoxic, tissue-compatible material. It also did not contain plasticizers, therefore eliminating the problems associated with leaching out of plasticizers. The use of this flexible and resilient material allowed the obturator to engage in the undercuts without causing trauma and irritation to the soft tissues in the region of the defect. To conclude, the "lock-and-key" mechanism used in the fabrication of the two-piece denture obturator provided the patient with a lightweight, comfortable, and user-friendly form of prostheses.

Key Words: Acrylic resins, lock-and-key mechanism, maxillary prosthesis, mouth rehabilitation, obturator

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INTRODUCTION

The glossary of prosthodontic terms defines an obturator as a maxillofacial prosthesis used to close a congenital or acquired tissue opening, primarily of the hard palate, and/or contiguous alveolar/soft-tissue structures.[1] Many of us are aware that prosthodontic intervention is pivotal in the rehabilitation of patients who have undergone maxillectomy, which is often the treatment modality in head- and neck-related cancer, resulting in oroantral communication. Often, an obturator will be prescribed to manage the oroantral communication, in which it acts as a partition between the oral and nasal cavities. This allows restoration of a patient's normal oral functions such as speech, swallowing, and mastication, thereby improving one's quality of life.[2,3] At the same time, an obturator can also improve one's appearance as it replaces missing teeth, surrounding hard, and soft tissues as well as help retain the remaining dentition for psychological purposes.[4]

Various methods have been described in the literature on the different designs, techniques, and materials which can be used for an obturator.[3,5-8] A maxillary defect can be closed with three different types of obturators, namely, a solid bulb obturator, hollow bulb obturator, or a two-piece obturator which is commonly prescribed for patients with

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reduced mouth opening, especially after radiotherapy treatment.[4] An obturator needs to fulfill certain criteria to function well, both as an obturator and a prosthesis to replace missing teeth. These criteria include lightness in weight, high tolerance by patients, tissue compatibility, ease of insertion and removal, durability, and easy cleaning. Apart from that, an obturator needs sufficient retention which is derived by engaging the undercuts within the defect region, aside from gaining retention, and stability from the remaining dentition. One of the materials which is commonly used in recent years to fabricate obturators is the permanent heat-cured resilient acrylic.[9] This material is tissue compatible, able to engage in the soft-tissue undercuts, and provides easy maintenance.

In a two-piece obturator-denture design, one problem often encountered by the patient during insertion of the prostheses is the ability to accurately insert the second piece, which is the removable partial denture. This is often due to the restricted mouth opening, difficulty in orientating the exact position of the denture and in some cases due to the lack of manual dexterity of the patients. A simple way to manage this difficulty is to have a lock-and-key mechanism incorporated into the obturator system to help the orientation and ease the insertion process for patients.

The lock-and-key mechanism was first described by Emil Fischer in 1894.[10] It was a theory used to explain the mechanism of enzymatic reactions. He proposed that the enzyme acts as the lock and substrate as the key. The enzyme and substrate bind temporarily to form an enzyme–substrate complex. The binding site on the enzyme is known as the "active site" and is structurally complementary to the substrate. Thus, the enzyme and substrate are now said to fit together as a lock and a key.[11]

The concept is similarly applied in this clinical case report, where the obturator acts as the lock and the removable partial denture as the key. The obturator design was modified by incorporating a "keyhole," to act as an active site for the removable partial denture to snugly fit in. This paper documents the fabrication of a two-piece obturator denture using the lock-and-key mechanism.

CASE REPORT

A 60-year-old male reported at the Postgraduate Clinic, Department of Restorative Dentistry, King's College, London, for the fabrication of a new obturator to replace his prosthesis which was approximately 20 years old. The patient had a maxillectomy done after being diagnosed with oral squamous cell carcinoma of the maxilla, resulting in resection of the premaxilla. Extraorally, there was evidence of scar tissue in the perioral region, which reduced the capacity to retract the upper lips. The patient also had a canted smile line which appeared to show more of the upper right incisors both at rest and when smiling [Figure 1].

On the other hand, intraoral examination revealed a classic Class VI defect, which was a large defect in the premaxillary region, with an oroantral communication. He was missing all of the upper anterior teeth and the upper first right premolar tooth [Figure 2a and b]. His existing prosthesis was also a two-piece obturator and removable partial denture, but the retention of both prostheses was poor. There was a lack of tissue contact and seal between the obturator and soft tissues at the region of the defect and an incomplete extension into the soft-tissue undercuts. This resulted in poor retention of the obturator. The obturator had been fabricated using cold-cured acrylic, and it had not been replaced for many years which resulted in the material becoming hard causing inflammation to the soft tissues in the region of the defect. The periodontal condition of the patient was quite poor with generalized probing depths between 4 and 5 mm in both the upper and lower remaining dentition. The patient's neglect of oral and denture hygiene was clinically visible with plaque and calculus deposition both intraorally and on the prostheses [Figure 3a and b]. The free gingival margins and interdental papilla were inflamed due to chronic periodontal tissue disease.

Initially, the patient was given oral hygiene counseling to improve plaque control aside from nonsurgical periodontal therapy to manage the deep pockets. The patient's existing denture and obturator were relined with a soft liner (GC Reline™ Soft, GC Europe, Leuven, Belgium) to allow healing of the soft tissues in the region of the defect before making the final working impression. Apart from that, the retention of the existing prostheses was temporarily improved as the soft liner managed to engage into the

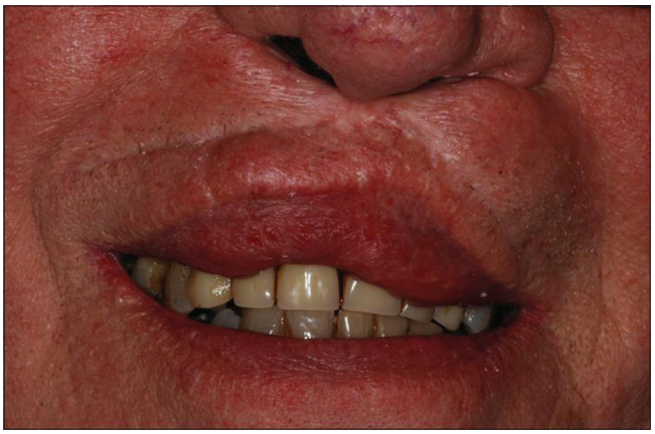

Figure 1: Extraoral frontal view with the existing prosthesis *in situ* showing the canted lip

soft-tissue undercuts in the region of the defect. The area of the obturator and denture which needed to be relined was relieved with a tungsten carbide bur and thoroughly cleaned and dried. GC Reline™ Primer R was applied to the cleaned surfaces and allowed to gently dry. Subsequently, GC Reline ™ Soft was applied to the fitting surfaces of the denture and obturator. These prostheses were then fitted into the patient's mouth one at a time, with the obturator being inserted first followed by the denture. They were allowed to set *in situ* before the excess was trimmed for the patient's comfort.

To overcome the difficulty of inserting a one-piece hollow bulb obturator, the guarded motivation, the condition of soft tissue in the region of the defect, and given the patient's age, the authors decided to provide the patient with a two-piece obturator denture, utilizing the lock-and-key mechanism.

Procedure

First, a primary impression was taken using irreversible hydrocolloid material (Aroma Fine Plus Normal Set, Alginate Impression Material, GC Corporation, Tokyo, Japan) with a piece of gauze placed across the defect to prevent the impression material from gaining access into the nasal cavity.

A wax-up (Metrodent No. 2 Modelling Wax, England) of the obturator was done on the resulting cast, and a keyhole was incorporated into the obturator, for the "lock" to allow for the fit of the removable prosthesis, which acted as the "key" [Figure 4a]. The completed waxwork was then flasked before finally processing with a heat-cured resilient acrylic, Molloplast B® (Molloplast B, Regneri GmbH and Co. KG, Karlsruhe, West Germany) [Figure 4b].

The patient was recalled for a try-in of the resilient obturator intraorally, to ensure that it was able to fit and engage the soft-tissue undercuts without traumatizing the tissues [Figure 5]. Once the patient felt, it was comfortable, and the fit was established, the obturator was used in the laboratory to aid the subsequent fabrication of the conventional heat-cured removable prosthesis.

A final working impression of the remaining dentition and the surrounding soft tissues including the depth and width of the buccal sulci was recorded using a special tray (Metrodent, Light Curing Tray Material, Germany) and irreversible hydrocolloid material (Aroma Fine Plus Normal Set, Alginate Impression Material, GC Corporation, Tokyo, Japan). The obturator was fitted on the resulting master cast, and this was followed by the fabrication of the definitive baseplate. During the wax-up (Metrodent No. 2 Modelling Wax, England) for the baseplate, an extension

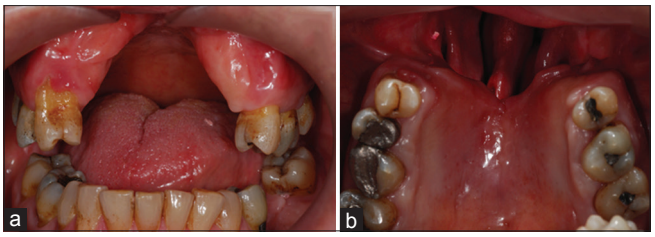

Figure 2: Intraoral (a) frontal and (b) occlusal views of the defect region

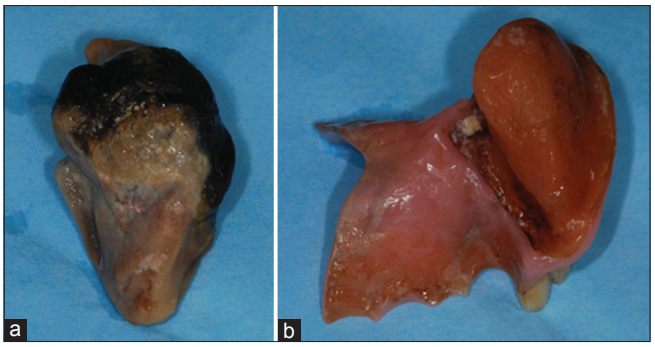

Figure 3: (a and b) Patient's existing denture with plaque and calculus accumulation

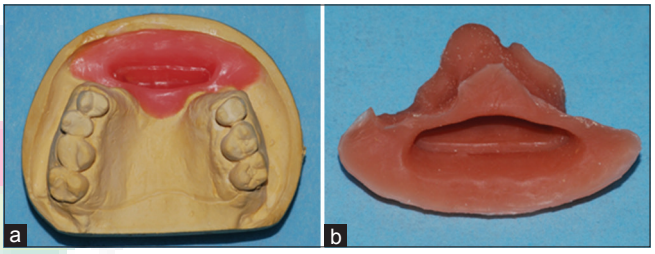

Figure 4: The (a) wax-up and (b) finished permanent heat-cured resilient acrylic obturator with the keyhole incorporated

of the wax was incorporated into the keyhole simulating the lock-and-key mechanism.

The next clinical step was to record the retruded jaw relationship of the patient [Figure 6a]. It was then followed with a wax try-in to evaluate the esthetics and phonetics of the patient [Figure 6b]. Once the patient was completely satisfied with the appearance and could comfortably articulate, we proceeded with the final processing to produce the conventional heat-cured acrylic (Meliodent® Heat Cure, Heraeus Kulzer GmbH, Hanau, Germany) removable partial denture.

The final removable partial denture was designed to be an acrylic denture, engaging into the interdental undercuts with maximum extension of the baseplate for additional retention, resistance, and stability.

During the final fit, the denture was polished, and instructions were given to the patient on how to insert and remove the prostheses. A significant improvement in

the patient's appearance could be noticed after insertion of the obturator and denture. There was a slight midline shift toward the right to accommodate the missing teeth in the edentulous space [Figure 7a and b].

When compared with the previous denture, the occlusion of the new prosthesis was maintained as a Class I incisor relationship but with an increased overbite, and the patient was more satisfied with the given denture. Furthermore, through regular oral hygiene counseling, the patient's plaque control had improved tremendously, and the periodontal condition was at the maintenance phase after nonsurgical periodontal therapy. The patient was also advised on how to maintain and clean the prostheses so that it can remain well fitted, functional, and esthetically pleasing. The patient was recalled 1 and 4 weeks postinsertion to examine the health of the soft tissue in the region of the defect as well as the fit of both the obturator and denture. During the first recall visit, minor adjustments were made to the extension of the baseplate of the denture in areas which showed soft-tissue trauma at the buccal sulci. Otherwise, the authors were satisfied with the progress of patient's oral health and handling of prostheses. The patient was advised to come for regular maintenance appointments at 6 monthly intervals.

DISCUSSION

Patients who undergo maxillectomy not only suffer from the anatomical limitations of having their maxilla resected but very often also suffer psychological setbacks. It can compromise a patient's mastication, phonation, deglutition, esthetics, and self-esteem. An obturator provides a barrier between the oral and nasal cavities and allows for the return of daily functions such as speech, swallowing, and the improvement of appearance. It is important for a patient to be able to perform the daily routines to be able to then resocialize, thus improving ones' quality of life significantly.[12]

Lack of support, retention, and stability are common prosthodontic treatment problems for patients who have had a maxillectomy. As mentioned earlier, the fabrication of the obturator and removable denture was based on the lock-and-key mechanism, where a "keyhole" was incorporated in the design of the obturator. The obturator acted as the active site for the insertion of the removable partial denture and therefore ensured a tight fit of the denture. The lock-and-key mechanism allowed the patient to easily insert the obturator before slipping in the removable partial denture to fit snugly into the "keyhole" as shown in the schematic diagram in Figure 8. This also contributed to a proper seal between the obturator and soft tissue at the region of the defect which was poor with the patient's previous denture. This marked improvement in the seal between obturator and soft tissue, allowed for improvement in patient's speech and deglutition.

In the management of this patient, the authors decided that no retentive components would be incorporated in the

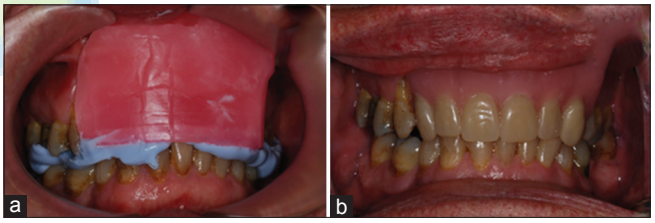

Figure 6: The (a) retruded jaw registration and (b) wax try-in stages

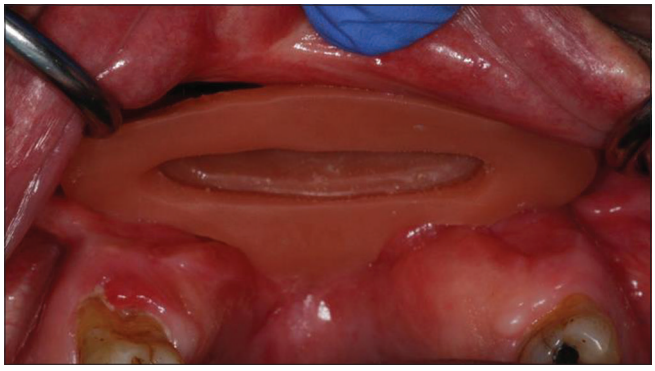

Figure 5: The obturator fitting well into the defect region

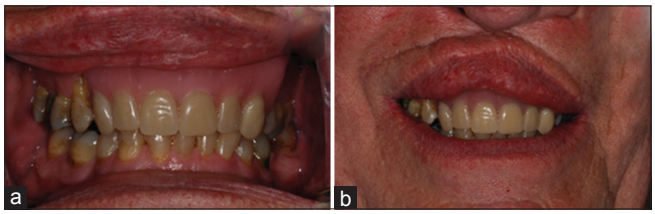

Figure 7: (a and b) Final fit of the two-piece obturator

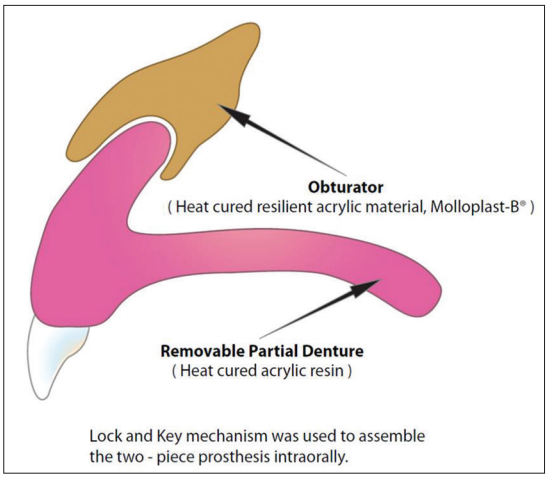

Figure 8: Schematic diagram showing the assembly of the two-piece denture obturator

removable partial denture as the major retention was to be gained from the "keyhole" in the obturator, which in return, would acquire retention from the soft-tissue undercuts in the defect region. Moreover, it would be easier to insert this type of prosthesis for a patient with compromised mouth opening and reduced manual dexterity. A similar approach was used in a case report documenting the rehabilitation of a patient who had undergone partial maxillectomy.[6] However, the "keyhole" incorporated in the obturator was smaller, and the primary retention for the removable partial denture was gained with the incorporation of stainless steel wire which utilized the existing undercuts in the remaining dentition on the contralateral side of the upper arch. For this case, we designed the obturator to ensure that it was able to utilize the remaining soft and hard tissues to stabilize, support, retain, and provide maximum effectiveness.

The heat-cured resilient acrylic used for the fabrication of the obturator was the Molloplast B® (Molloplast B, Regneri GmbH and Co. KG, Karlsruhe, West Germany). It was nontoxic, noncarcinogenic, and a material well tolerated by patients. It was also a convenient choice as the final finishing and polishing of this material was done in the laboratory using conventional techniques employed in the polishing of heat-cured removable partial dentures. The use of Molloplast B® also allowed for formation of a tight seal between the obturator and soft tissues which helped create pressure to prevent leakage of liquid around the prosthesis.[13] This was because, once in contact with moisture in the oral cavity, Molloplast B® became flexible and allowed for the obturator to engage in the tissue undercuts and seal the cavity.[6]

Cold-cured resilient acrylic is an alternative material used in the fabrication of an obturator. However, one of the problems associated with this material was the leaching out of plasticizers which would have resulted in the obturator becoming hard after a period of wear intraorally. Heat-cured resilient acrylic, however, has plasticized ethyl methacrylate polymers that bind the plasticizers to the methacrylate, hence eliminating the problem of plasticizers leaching out and keeping the material resilient for a significantly longer duration.

Although Molloplast B® had been marketed to have antiplaque potential, the patient was counseled on the importance of maintaining a good oral and denture hygiene to prevent colonization of bacteria and fungi on the prostheses.[5] However, the eventual colonization of bacteria and fungi is inevitable and in view of that a strict follow-up schedule was stressed upon the patient to detect any such problem which may be addressed at a much earlier stage. This approach may also prolong the life of the denture and obturator.

CONCLUSION

Satisfactory functional and esthetic results can be achieved in patients restored with a two-piece obturator denture using the "lock-and-key" mechanism.

Declaration of patient consent

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

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Conflicts of interest

There are no conflicts of interest.

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