Cast Titanium for Obturator Framework Construction in Maxillofacial Prosthodontics

ABSTRACT

A 37 year old male presented with the complaint of a loose and bulky acrylic obturator prosthesis. He had previously tried to using a different acrylic obturator prostheses as well as both cobalt chromium and titanium framework obturators. The most successful previous prosthesis was a titanium based obturator which had performed well prior to a fractured clasp. Accordingly, following an exploration of the available surgical and prosthodontic treatment options, a further tooth borne partial maxillary obturator was provided successfully. The case highlights the relative merits and limitations of the use of cast titanium as a denture base material in partial denture and obturator construction.

Keywords

Removable Maxillofacial Prosthodontics
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INTRODUCTION

Maxillary defects are often the result surgical resection of a tumour, leaving an anatomic defect which leads to a communication between the oral cavity, nasal cavity and maxillary sinus. The Brown and Shaw classification 2010 system of maxillectomies is one developed by surgeons through their own experience to help classify the defects on firstly height and then width, which ultimately serves guide them as to whether the defect should be surgically or prosthodonticaly reconstructed. Class II means the defect is a maxillectomy that causes an oral nasal fistula but does not extended to involve the orbit and the "b" means that the defect is less than or equal to half unilaterally. With Class II b defects there is no clear evidence or consensus as what is better an obturator or surgically reconstruction or even zygomatic implants to support a denture. Some acquired maxillary defects can be successfully restored to provide acceptable function and aesthetics with a removable obturator prosthesis.[1] Where these communications are present it is very difficult for the patient to form a oro-nasal and/or oro-antral seal which compromises normal function including mastication, deglutition, and speech. A removable prosthesis can be constructed to obturate the defect, restore the missing structures and act as a barrier between the various cavities restoring form and function. The principles for constructing an obturator reflect those applicable to any other removable prosthesis. In patients with maxillary defects, the degree of extension of the prosthesis into the defect is determined by the defect's size, location and shape as well as the quality of the soft tissues lining the cavity. These factors combined with the requirement for the defect to provide support, retention and stability for the obturator determine the shape of the obturating bung.

A variety of materials are available for obturator framework or base construction. Cast cobalt chromium alloy and acrylic resin are commonly used materials, however cast titanium (Ti) is less commonly prescribed.

The article describes a case where a Ti framed obturator has performed well and considers the alternatives to prosthetic obturation in class IIB maxillectomy defects. In this case it was chosen to obturate the defect due to patients pathology being an Adenoid cystic carcinoma which has a very high chance of recurrence therefore an obturator offers the chance to continuously surveying the defect for recurrence.[2] Another contributing factor as to why obturator was used was due the maxillary defect offering lots of favourable anatomy to retain the prosthesis as well as the remaining dentition in the maxilla being in a good enough condition to be clasped for retention.

CASE REPORT

A 37 year old male attended complaining of his obturator being loose and of nasal fluid leakage. An Adenoid Cystic Carcinoma of the left maxilla was diagnosed in 2003. He underwent a Class II b partial maxillectomy.[1] Neither further surgery nor adjunctive radio/chemotherapy was required. At presentation his cast titanium-acrylic obturator was 8 years old and all clasps had fractured. He had previous experience of an all-acrylic resin obturator, which he found to be too cumbersome and intolerable. He had also used a colbat a cobalt–chromium (Co/Cr) based obturator which he was unable to tolerate owing to the adverse taste.

On examination there was an acquired defect of left maxilla with oro-nasal communication *(Figures 1&2)*. No limitation of mandibular opening and marginal gingivitis was observed. A tooth and mucosa borne, cast Ti-acrylic resin obturator was present. The clasps had fractured and poor retention and support were noted *(Figures 3,4&5)*. The previous mucosa borne acrylic resin obturator was examined and found to have satisfactory stability and retention *(Figure 6)*.

Figure 1: View of the superior extent of the defect

Figure 2: Intra-oral view of the left maxillary defect

Figure 3: Left buccal view of existing Titanium obturator

Figure 4: Intra-oral view of the existing Titanium obturator

Figure 5: Right buccal view

Figure 6: View of the polished surface of the current Ti and previous acrylic obturators

The treatment options involving either surgical or prosthodontics rehabilitation were discussed with the patient *(Table 1)*. Following discussion the patient expressed a preference for a new cast titanium obturator having also considered the possibility of refurbishing his existing prosthesis via the placement of a new bung and the addition of replacement clasps where the old ones had fractured.

Construction of a new tooth and mucosa borne obturator proesthesis with a cast Ti framework and a one piece soft bung was commenced *(Figures 7&8)*. The soft bung was made from Mucropren ® which a permanent soft liner made from vinyl polysiloxane

Table 1. The relative merits of treatment options for Class II B maxillary defects

	Advantages	Disadvantages
Soft tissue flap (pedicled or free flap)	Restores defect immediately	Can complicate prosthesis provision. Unable to undergo immediate adjunctive radiotherapy Increased morbidity Difficult to inspect resection site for signs of reoccurrence
Composite osteocutaneous free flap	No maintenance Obliterates defect and can restore facial profile Easier for patients in short term especially if radiotherapy needed[1] Provides a solution into which implants can be placed[6]	Increases length of hospital stay Immediate dental prosthesis complex to provide[1] Increased morbidity Unable to undergo immediate adjunctive radiotherapy if needed Difficult to inspect resection site for signs of tumour recurrence[7]
Zygomatic implants and implant retained/ supported prostheses	Improved support and retention of obturator prosthesis[7] No complex graft needed Implants can be placed at time of resection Possibility of providing a fixed prosthodontic solution.	Delay until definitive obturator provided Increased costs and theatre time compared to conventional prosthetic obturation
Obturation with a conventional removable prosthesis	Possibility to provide an immediate prosthetic dentition and the possibility for surveillance Immediate adjunctive radiotherapy can be provided No complex graft required	High maintenance requirements Delay until definitive obturator provided Retention is determined by the defect anatomy and the position and status of the remaining dentition

Figure 7: The new cast titanium framework obturator, with the one piece soft (Mucopren®) bung.

Figure 8: The new cast titanium framework obturator in situ.

DISCUSSION

The patient's wishes were accommodated in the obturator framework design: the 23 was not clasped and a soft bung was provided. Since good framework retention was gained from the teeth, using a hollow acrylic bung could have reduced the maintenance burden inherent in using a soft bung (*Table 2*). Due to the soft silicone based bungs hardening over time, their poor cleansability and greater susceptibility to biofilm formation, it all adds to the more frequent need to refurbish compared hard acrylic bungs.[3,4,5] Another great advantage of hard acrylic bungs would have been of benefit in this case is the ease at which it can be modified, be it in the lab or chair side, whereas that luxury is not possible with soft silicone based bungs. As in this case Modification of the bung was required to reduce nasal irritation and nasal secretions. It was modified by re-making the bung and ensuring it was not in intimate contact with the inferior nasal turbinate. Following this modification the patient no longer reported the nasal irritation.

The clasp on the 14 could be easily removed to improve the aesthetics, although the patient was unconcerned by its presence. The clasps in this design were modified compared to one of the patients original Cast Ti obturator ensure they did not fracture, this was carried out by increasing the width of the clasp arm. Casting titanium can be a challenging process as it can only happen in an inert environment often in argon.[3] This because Titanium is highly reactive at high temperature, taking up oxygen, nitrogen and even hydrogen if in the atmosphere, the result of this take up leads to porosities in the cast.[4] Titanium has an elastic modules of 120GPa which is roughly half that of stainless steel 209Gpa, but if there is a slight hint of reactive elements in the environment (20ppm) it can cause the reduction in fatigue strength.[3] Cast Ti increased risk of po-

Table 2. Summary of the advantages and disadvantages of soft and hard bungs for obturators

	Advantages	Disadvantages
Hard acrylic bung	Easy to modify and reline. Longevity Easier to maintain good hygiene of the prosthesis Can be hollow or solid	Inability to engage multiple undercuts for retention Single path of insertion cannot be used when engaging multiple undercuts
Soft bung e.g. silicone	Deformation of bung allows multiple paths of insertion and retention using opposing undercuts. May be easier to insert Can be hollow or solid	Hardens over time [5] Increased biofilm formation[8] Poorly cleansable [5] Low surface wettability which can lead to irritation of nasal mucosa[9] High maintenance/ replacement requirements

Table 3. The relative merits of cast titanium compared to conventional materials

	Advantages	Disadvantages
Cast Titanium	Biocompatible, Neutral taste, non allergenic [10] Lower density than conventional cobalt chromium alloy[11] Lower elastic modulus, therefore can be used in deeper undercuts and with shorter clasp arms Major connectors can be cast thinner than sections of cobalt chromium No reports of the framework failing catastrophically [12]	High Porosity, which leads to increased risk of clasp fractur[12] Increased production cost Difficult to cast[13] Fatigue strength of clasps decreases with time[13] Specialist lab required
Acrylic	Relatively easy to fabricate and modify Wrought clasps can be added Low production cost	Lower fracture strength compared to cast titanium. Higher density which results in a heavier prosthesis Low durability
Cobalt Chromium	Fatigue strength of clasps increases with use[14] Widely available Lower production cost than cast titanium Laboratory production more widely available	Less biocompatibility Can have metallic taste Casts in thicker sections

rosity could be to explain for the original clasp fracturing off, taking that into account we designed them so they were gingivally approaching and were of greater width than compared to the original. The other option was to have new cast clasps laser welded to the framework but the patient declined due to the period of time he would have to go without the obturator, due to the prosthesis having to be sent overseas for the repair.

The retention, stability and occlusion scheme of the new prosthesis were improved over the original prosthesis. The cast titanium framework overcame the limitations of the bulk of the acrylic prosthesis and the reported altered taste with the Cobalt Chromium prosthesis *(Table 3*).

This report outlines reconstructive options available when patients present with class II b maxillary defects.[1] In this case, a cast titanium framework provided a sound prosthodontic obturator solution where conventional materials had failed. The patient was satisfied with treatment, perhaps helped by being involved in the prosthesis design including a discussion of materials to be used and clasp positions.

MANUFACTURERS DETAILS

Mucopren® is a permanent soft reline material based vinyl polysiloxane. Made by Kettenbach GmbH & Co. KG

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