Case report: post-maxillary (mouth) cancer: oro-facial and dental rehabilitation using zygomatic implants to support a bar-retained obturator

This case report details the orofacial dental rehabilitation of a 46-year-old man, who had lost significant maxillary bone following a T4N2 oral squamous cell carcinoma. The cancer was treated with surgery and adjuvant chemoradiotherapy. Rehabilitation was based on the placement of four oncology zygomatic implants, which were splinted by a ring-shaped milled titanium bar. This formed the support for a removable obturator, which was retained by precision attachments. The treatment resulted in a large reported improvement in the patient's quality of life, chewing capacity, speech and appearance. The treatment also allows for long-term mouth cancer surveillance in a young man of this age, as the resection site can be easily visualised on removal of the obturator.

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Introduction

It is estimated that 700 new cases of oral and pharyngeal cancers occur in Ireland each year.[1] The incidence of oral cancer is also increasing, particularly among women.[2] In contrast, the treatment options and survival rates for oral cancer have not changed significantly over time (9.5-78.5% five-year survival).[3] Surgery following multidisciplinary team discussion remains the main treatment modality for mouth cancer, including maxillary cancer, supplemented by radiotherapy when needed and, less frequently, chemotherapy. The sequelae of treatment include loss of teeth, loss of alveolar and facial bone, reduced mobility or loss of support of the soft tissues, and loss of sensation to parts of the mouth, head and neck.[4]

Dental rehabilitation has traditionally been provided following the initial recovery period from the cancer surgery and radiotherapy. Where large surgical maxillary defects exist, this has conventionally taken the form of a removable prosthesis that functions as an obturator to cover the defect and a denture to replace the missing teeth.[5] Retention and stability of this type of prosthesis becomes more challenging as the defect size increases and dental implants can be used to provide improved support.[6]

We report on a post-cancer case where zygomatic implants were used to support a bar-retained obturator. Following cancer surgery, a large maxillary defect limited the functionality achievable with a conventional obturator. Further, the lack of remaining alveolar bone in prosthodontically useful sites prevented the use of conventional dental implants.

Case report

Background

A 46-year-old man attended following successful treatment for a 35mm well-differentiated squamous cell carcinoma arising from the anterior right maxillary gingivae three years previously. The cancer had been surgically removed and a neck dissection carried out. The tumour was graded as T4N2 using the TNM cancer staging system.[7] As a result of close margins, adjuvant chemoradiotherapy was provided. This comprised 66 Gray as fractionated steriotactic radiotherapy with cisplatin chemotherapy. The patient had worn a surgical splint for one year following his cancer surgery and then had a conventional obturator fabricated. He found that it was very mobile in his mouth and was difficult to eat with. Liquids could escape beneath the obturator and would frequently come out his nose. As a result, his diet was quite restricted and eating socially could be embarrassing for him. His speech was indistinct and hypernasal. The lip and cheek support provided by the obturator were inadequate. There was no relevant medical history and he was a life-long non-smoker. He was married with a supportive family.

Extra-oral examination showed reduced facial hair growth that was consistent

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FIGURE 1: Due to loss of alveolar bone, the patient's nose was undersupported and his facial profile flattened.

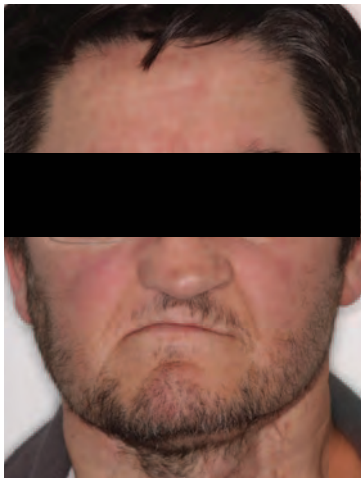


FIGURE 2: Normal drape of the upper lip was disrupted due to loss of support and tightening of tissues, with asymmetric scarring leading to asymmetric elevation.

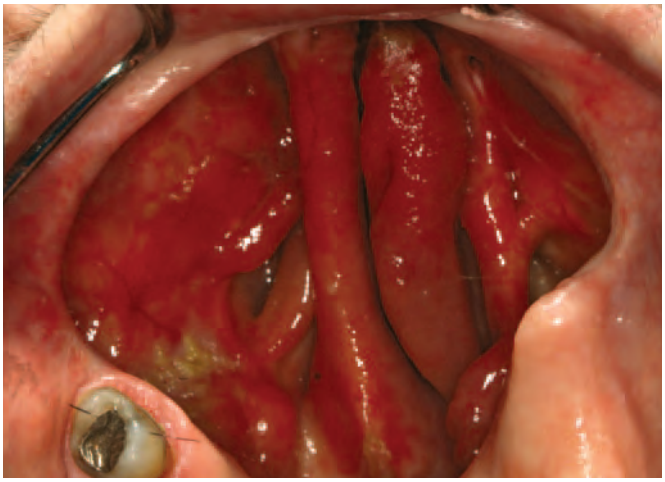


FIGURE 3: Complete absence of anterior maxilla and hard palate.

FIGURE 4: The obturator moved up and down, falling into the defect in function.

FIGURE 5: The patient's appearance was poor with limited tooth display.

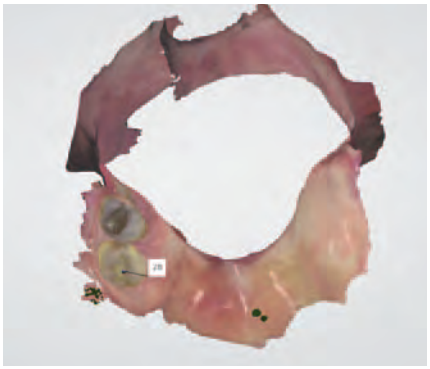


FIGURE 6: An intraoral optical scan was taken to generate a primary model.

with the previous radiotherapy. Due to the loss of alveolar bone, the nose was undersupported and the facial profile flattened (**Figure 1**). The normal drape of the upper lip was disrupted due to loss of support and tightening of the tissues, with asymmetric scarring leading to asymmetric elevation (**Figure 2**). There was bilateral paraesthesia of the upper lip. Intraorally, there was a complete absence of the anterior maxilla and hard palate (**Figure 3**). The left tuberosity, and right second and third molars were retained, with a strap of hard palate connecting the two. The oral cavity was continuous with the nasal and pharyngeal cavities. There was an intact lower dentition with moderate oral hygiene and some carious lesions, as is typical following radiation treatment. With the absence of a typical denture-bearing area, the obturator lacked stability and retention. It moved up and down, falling into the defect in function (**Figure 4**). The resulting appearance was poor with limited tooth display (**Figure 5**).

Treatment planning

The treatment options for dental rehabilitation included a new conventional obturator, an implant-supported obturator or a late microvascular reconstruction. As it was felt that a new conventional prosthesis would suffer the same problems as the existing prosthesis, implant options were investigated. A CT scan of the remaining maxilla, nasal bones and zygomatic bones was taken. This was examined to look for potential sites for implant placement. The remaining alveolar bone in the tuberosity region lacked sufficient bone volume for conventional implants and was poorly positioned for prosthodontic utility. Ideally, implants would need to offer support in the mid-anterior palatal region where the bulk of the obturator would be positioned. In this case, the zygomatic bones did have sufficient bone volume to support two implants on each side.

Prosthetic planning was developed to establish the prosthetic envelope, where an implant bar could be housed to offer support and retention for an obturator of the required size, while satisfying appearance, soft tissue support and occlusal requirements. The position of the bar would be determined by the palatal vault inferiorly, the nasal and pharyngeal tissues superiorly, and the flanges of the obturator laterally. An important step in restoring zygomatic implants is to rigidly splint the implants within 24 hours following placement. For this reason, a ring-shaped bar design would be used rather than the horseshoe shape design typically used in overdentures supported by conventional dental implants. The severe loss of hard and soft tissues provided an abundance of restorative space; however, the implant head positions were restricted to an arc defined by their emergence from the remaining zygomatic

FIGURE 7: Space for the retentive bar was defined and wax added to the milled model to form an arbitrary floor of the defect.

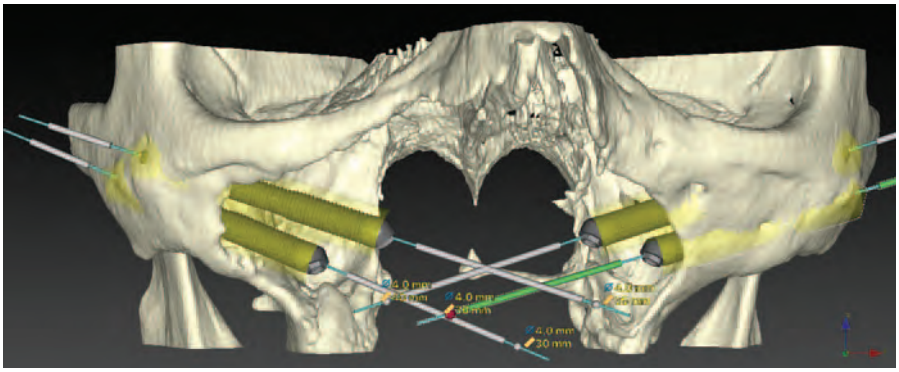


FIGURE 8: Virtual implant planning was carried out using the CT scan data to estimate the implant positions and lengths.

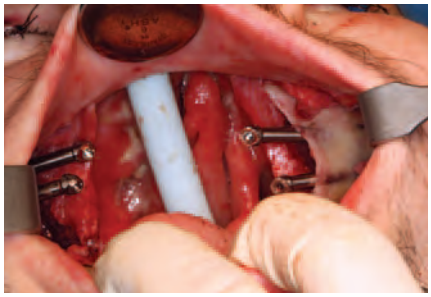


FIGURE 9: Surgical treatment was carried out under general anaesthetic.

bones. A surgical guide was required, which would optimise the positioning of the head of the zygomatic implants and remain stable during surgery.

The surgical guide was fabricated as follows:

- an intraoral optical scan was taken to generate a primary model (**Figure 6**) – the anterior border and base of the defect could not be imaged accurately;
- wax rims were formed on a temporary base with hard reline material added to the anterior border;
- teeth were set in wax for try in;
- space for the retentive bar was defined and wax added to the milled model to form an arbitrary floor of the defect (**Figure 7**); and,
- this cast was used to fabricate a vacuum-formed guide, with retention from the molars and tuberosities.

Surgical planning occurred in tandem with the restorative planning. This included the fabrication of a steriolithographic model of the remaining facial bones. In combination with the surgical guide, this could be used to visualise the relationship between the zygomatic bones and the planned prosthesis and tooth positions prior to surgery. Virtual implant planning was carried out using the CT scan data to estimate the implant positions and lengths (**Figure 8**).

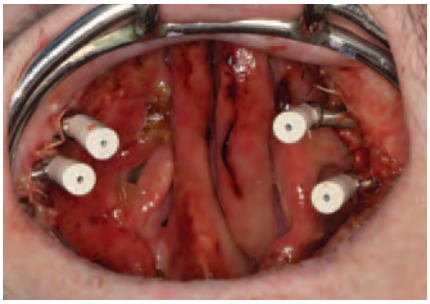
Surgical treatment

The surgical treatment was carried out under general anaesthetic (**Figure 9**). Due to prior radiotherapy, conservative mucoperiosteal flaps were raised via an intraoral approach to expose the zygomatic bones bilaterally. The infra-orbital nerves were identified and protected. The prosthetic guide was used to visualise the planned tooth positions and prosthetic envelope. Four oncology zygomatic implants (Southern Implants; Irene, South Africa) were placed. Leukocyte-rich, platelet-rich fibrin (Intra-Lock; Florida, USA) was placed over the sites to encourage vascularisation and with the aim of improving wound healing. Primary closure of the wound was achieved with resorbable sutures. Postoperative healing was uneventful initially. There was anaesthesia of the upper lip, where previously the patient had partial sensation. Some wound breakdown then occurred, with exposed bone between the two left implants. This slowly healed with time and local, gentle irrigation using 0.2% chlorhexidine mouthwash.

Prosthetic treatment

An immediate obturator and immediate temporary bar was constructed after the surgery as follows:

- an acrylic obturator with the previously established tooth positions was fitted while a definitive milled bar was being constructed;
- an optical impression was made recording the positions of freshly placed



FIGURES 10 and 11: An optical impression was made recording the positions of freshly placed zygomatic implants – soft tissues are recorded with reduced accuracy and gaps are not well accepted by the technology.

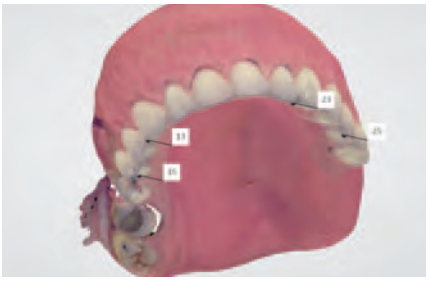


FIGURE 12: Optical scan of the obturator in situ, which was referenced to the scan of the implant positions – scans contained retained natural molar teeth, providing reference points for comparison.

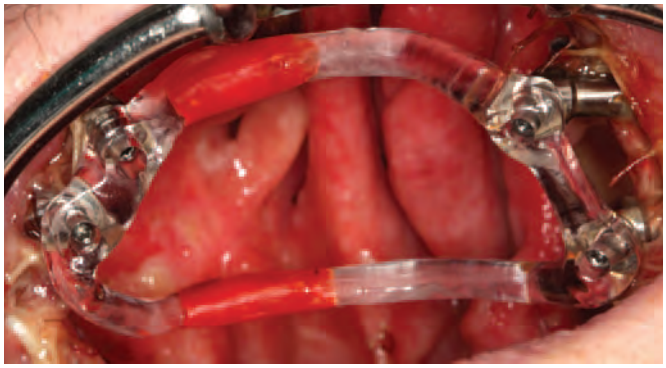


FIGURE 13: A milled primary bar was designed using CAD – a cross arch error in the optical scan was readily corrected by sectioning the bar and relinking it with Duralay resin under rubber dam isolation intra-orally.

zygomatic implants (**Figures 10** and **11**) – soft tissues are recorded with reduced accuracy and gaps are not well accepted by the technology;

- an optical scan of the obturator in situ was referenced to the scan of the implant positions – both scans contained the retained natural molar teeth and this provided reference points to compare both scans (**Figure 12**).
- a milled primary bar was designed using CAD, milled in acrylic and offered to the implants – a cross arch error in the optical scan was readily corrected by sectioning the bar and relinking them with Duralay resin under rubber dam isolation intra-orally (**Figure 13**);
- this bar served to rigidly splint the implants and offer support to the obturator while the definitive milled titanium bar was being fabricated;
- this resin bar also served as a verification jig and was used to correct the cross arch discrepancy on the master model; and,
- the immediate obturator was modified on the undersurface to allow full seating with respect to the occlusion established (**Figures 14** and **15**).

The definitive obturator, retained on a milled titanium bar with Novaloc (Valoc AC, Switzerland) attachments was constructed as follows:

- a milled titanium bar was fabricated with four Novaloc attachments along with a corresponding milled framework to be embedded within the obturator (**Figure 16**);
- this bar and framework offered an extremely stable foundation to verify tooth positions and detail the occlusion for finalising the definitive obturator – the retained natural molars maintained the patient's preoperative occlusovertical dimension;

FIGURES 14 (left) and 15 (below): The immediate obturator was modified on the undersurface to allow full seating with respect to the occlusion.

- the framework of the bar was positioned within the defect to avoid interfering with the palatal denture form and to support the maximum bulk of the obturator – at least 3mm of space above the bar was allowed for hygiene access; and,
- a border seal was generated using a functional impression of the periphery – this accounted for the changes in shape following healing (**Figures 17** and **18**).

The patient was delighted with his appearance, speech and ability to chew (**Figure 19**). Function exceeds that of a conventionally restored edentulous patient and liquids no longer escape above the obturator. Maintaining the natural molar teeth in the upper arch mitigates against excessive force generation as proprioceptive feedback is maintained. The retention and stability achieved with this type of prosthesis is so great that it closely replicates the function that can be generated from a fixed prosthesis, but still allows removal to facilitate monitoring of the soft tissues as well as cleaning of the prosthesis, bar and implants. Oncology zygomatic implants have a machined cervical collar with no threads to minimise plaque accumulation.

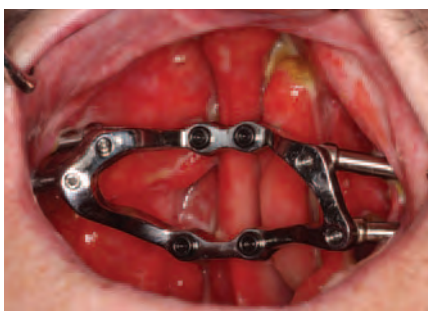


FIGURE 16: A milled titanium bar was fabricated with four Novaloc attachments along with a corresponding milled framework to be embedded within the obturator.

FIGURES 17 and 18: A border seal was generated using a functional impression of the periphery – this accounted for the changes in shape following healing.

FIGURE 19: Final patient appearance.

At follow up 18 months following implant placement, the patient reported a continued high level of satisfaction with his result. He has no restriction of his diet, is happy with his appearance and can speak well. He removes the obturator for hygiene and mucosal monitoring, and is well motivated with his home cleaning. The anaesthesia of the upper lip has resolved, returning to the baseline of partial sensation that the patient had following his cancer surgery.

Discussion

Tooth loss can occur following oral cancer treatment where teeth are included as part of the cancer resection and when teeth of poor prognosis are removed prior to radiotherapy. The loss of teeth and bone leads to significant lack of soft tissue support, affecting the patient's ability to eat and speak. A reduction in the oral aperture and scarring can make routine oral hygiene challenging following cancer treatment. Radiotherapy contributes to this, causing reduced mouth opening and a reduction in salivary function.[8] Loss of teeth contributes to reduced chewing function and speech difficulties, as well as reduced overall and oral health-related quality of life.[9,10]

When there is reduced mouth opening, salivary hypofunction and poor oral hygiene, conventional fixed prostheses can be technically challenging to fabricate and difficult for the patient to maintain and even tolerate. Removable prostheses have the advantage of maintaining access for hygiene as well as for mucosal monitoring; however, retention and stability can be difficult to achieve following large resections. Ali *et al.* (2018) investigated the impact of a conventional obturator on quality of life following maxillectomies.[5] Their study, while limited by a small sample size, showed improved quality of life when obturators were provided. One of the significant factors that related to reduced quality of life, however, was poor retention of the obturator. Radiotherapy was also associated with a further reduced quality of life.

In this case report, a conventional obturator had been attempted; however, the size of the defect meant that there was little to no retention or stability. Establishing tooth positions was complicated by the lack of a stable foundation for record bases to allow the three-dimensional positioning of replacement teeth. Conventional obturators rely on support gained from the remaining hard palate along with any remaining natural teeth. Where a well-defined scar band remains around the defect, some retention can be gained by gently engaging the undercut of the defect and subsequently any implant positions can be extremely challenging using conventional impression techniques. An optical scanner was employed to overcome some of these challenges and avoid the risk of impression material escaping into the airways. An initial scan allowed a reasonably accurate primary cast to be generated; however, this cast was still a poor representation of the anterior extent of the defect since the boundaries were positioned on mobile tissues. A combination of digital and analogue technologies was necessary to capture all of the information.

Dental implants have the advantage of providing a fixed point of anchorage where teeth have been lost following cancer surgery. The use of dental implants to retain removable prostheses has been associated with high patient-related outcomes and quality of life.[11]

Despite the large defect present in this case report, the prosthetic envelope was limited by the palatal vault and planned tooth positions. The need for thorough prosthetic planning in order to generate accurate tooth positions and estimate the shape of the final prosthesis pre-operatively cannot be overstated. Transfer of this information at the time of the surgery is challenging. In this case, the use of preoperative models, CT scans and close multidisciplinary planning allowed the implant positions to be estimated prior to the implant surgery. This was then successfully transferred to the time of implant placement and resulted in optimal implant positioning.

Zygomatic implants have been used to support both fixed and removable prostheses in the upper jaw, with high success rates when there is limited available alveolar bone such as can arise following tooth loss, severe trauma or following cancer surgery.[12,13] In large defects, where the site of implant fixation is distant from the teeth, they offer the capacity to move the restorative platform from the position of the available bone towards the teeth. The design of the implants incorporates a 45º or 55º angulated head, which allows the screw access to be inclined occlusally. The zygomatic bone has the advantage of being distant from the site of an oral cancer and is, therefore, rarely involved in the resection. The available bone volume in the zygomatic bone also remains suitable for implant placement over time, in contrast to alveolar bone, which tends to resorb significantly over time and following tooth loss.[14]

Boyce-Varley *et al* (2007) set out a protocol for the management of maxillary defects following oncology resections.[12] They found that the use of zygomatic implants allowed the provision of fixed as well as removable restorations, and reduced the need for vascularised free flaps. More recently, in 2017, Butterworth and Rogers described the use of a soft tissue vascularised flap that is supported by zygomatic implants.[15] This, as well as the approach advocated by Boyce-Varley *et al.*, suggests a protocol of placing implants at the time of cancer resection.[12] Immediate placement and restoration of implants has been advocated as a way of minimising distress, speeding up recovery, and providing an opportunity to place the implant prior to radiotherapy.[16] While this is likely to be the ideal timing for implant placement, it is reliant on the availability of the appropriate expertise and resources.

In our case, the option of placing implants was not available at the time of the cancer resection. This led to a delayed reconstruction and placement of implants following radiotherapy. Placement of implants following radiotherapy carries a risk of osteoradionecrosis. While an increased failure rate would also be expected, a recent study by Butterworth does not support this.[17]

Preliminary one-year post-loading data from a randomised controlled trial suggests that immediately loaded zygomatic implants were associated with significantly fewer prosthetic and implant failures, as well as reduced time

needed to functional loading when compared to augmentation procedures with conventionally loaded dental implants. The early findings from this study support zygomatic implant rehabilitation as a superior treatment modality for severely atrophic maxillae despite more complications being reported for zygomatic implants. Long-term data is required to evaluate if these positive results can be demonstrated after long-term follow-up.[18]

Conclusion

This case report demonstrates the provision of four zygomatic implants to support a large bar-retained obturator. The treatment has improved this patient's quality of life and self-esteem by restoring his appearance, speech and chewing function.

Acknowledgements

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CPD questions

To claim CPD points, go to the MEMBERS' SECTION of www.dentist.ie and answer the following questions:

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CPD

1. Which of the following statements is true of a removable prosthesis for patients with oral cancer?

- ○ A: There is a reduced rate of cancer recurrence
- ○ B: There is improved access for cancer monitoring compared to a fixed prosthesis
- ○ C: There is reduced stability when an implant-supported prosthesis is used

2. How many new cases of oral and pharyngeal cancer occur per year in Ireland according to the Irish Cancer Society?

- ○ A: 200
- ○ B: 700
- ○ C: 1,000

3. Which of the following statements is not true of zygomatic implants?

- ○ A: They are indicated where insufficient maxillary alveolar bone is present to support conventional dental implants
- ○ B: They can be used to support removable prostheses only
- ○ C: An angulation correction can be incorporated in the implant head