

# The Reverse Zygomatic Implant: A New Implant For Maxillofacial Reconstruction

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*This case report describes the rehabilitation of a patient who had been treated with a hemimaxillectomy, reconstruction with a latissimus dorsi vascularized free flap, and radiotherapy for carcinoma of the sinus some years previously. Limited jaw opening, difficult access through the flap to the bony site, and the very small amount of bone available in which to anchor the implant inspired the development and use of a new "reverse zygomatic" implant. For this treatment, site preparation and implant insertion were accomplished using an extraoral approach. The implant was used along with two other conventional zygomatic implants to provide support for a milled titanium bar and overdenture to rehabilitate the maxilla. Two years later, the patient continues to enjoy a healthy reconstruction. The reverse zygomatic implant appears to show promise as a useful addition to the implant armamentarium for the treatment of the patient undergoing maxillectomy.*

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Zygomatic implants may be used to facilitate the predictable<sup>1,2</sup> treatment of the atrophic maxilla, reducing the need for graft surgery<sup>3–5</sup> and shortening<sup>6</sup> the treatment time. For the optimal placement of a zygomatic implant with either an extramaxillary approach or classic ad modum Brånemark approach, it is generally necessary to raise an extensive flap to orient the surgical site, avoid trauma to the tissues along the path of the implant, and avoid penetration of the sinus membrane.

## CASE REPORT

This report presents the use of a new implant that was designed to overcome many of the problems faced when treating a patient with advanced reconstructive challenges in the maxilla, particularly after

reconstruction of the hemimaxillectomy defect. In this case, the patient had suffered a carcinoma of the maxillary sinus 5 years before treatment. She had undergone a hemimaxillectomy with a simultaneous latissimus dorsi flap reconstruction of the right maxilla, with postoperative radiotherapy. After surgery, she received a removable partial denture, which also obliterated persistent small fistulae. For several years the patient managed well. However, with failure of the remaining teeth she found that she could increasingly no longer function with her prosthesis, and was told that she would be unsuitable for dental implant treatment.

At the time of referral, the left hemimaxilla was highly atrophic and the right hemimaxilla entirely absent (Fig 1a) along with most of the zygomatic prominence. Having had high-dose radiotherapy to the right latissimus dorsi flap reconstruction of the maxilla, there was little scope for the use of conventional implants on either side of the jaw. Although the radiation dose delivered to the area immediately surrounding the right maxilla was in the order of 60 Gy, the dose delivered to the lateral orbital rim tapered off to a level that made implant placement a reasonable proposition.<sup>7</sup> The dose to the left side was also lower, particularly in the zygomatic region.

Lower anterior teeth were present and jaw opening somewhat restricted. Extraorally, the patient complained of a lack of bulk to the side of her face.

Planning took place using NobelClinician computer software (Fig 1b), (Nobel Biocare), and a three-dimensional (3D) printed model (Cavendish Imaging). Planning seemed to allow for the positioning of three

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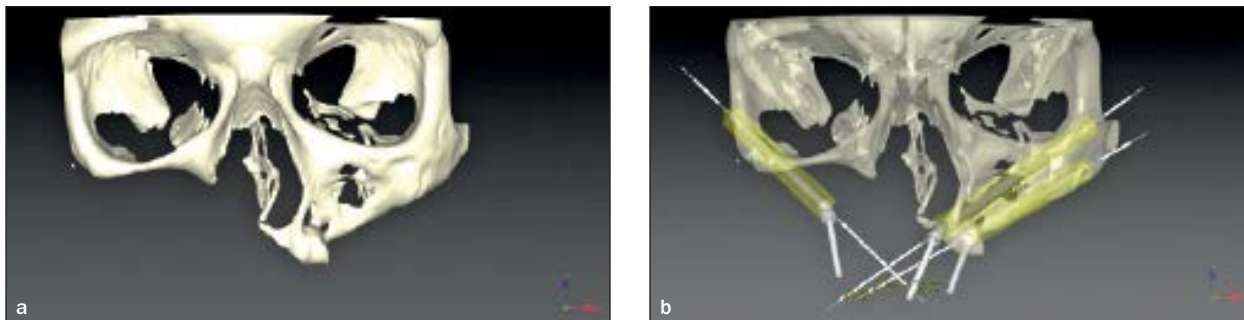
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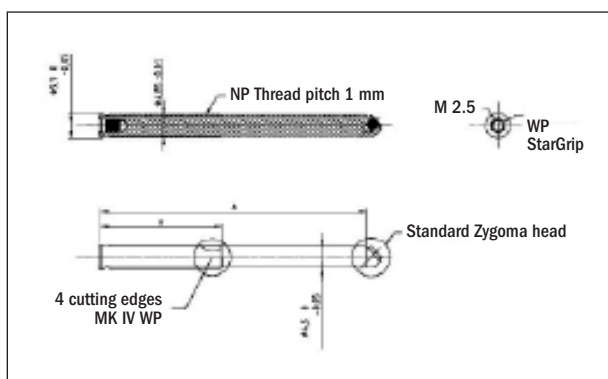
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**Fig 1** (a) Three-dimensional model of the midfacial region. (b) Software plan for zygomatic implant placement with the NobelClinician software.



**Fig 2** Engineer's drawing of the "reverse zygomatic" fixture.

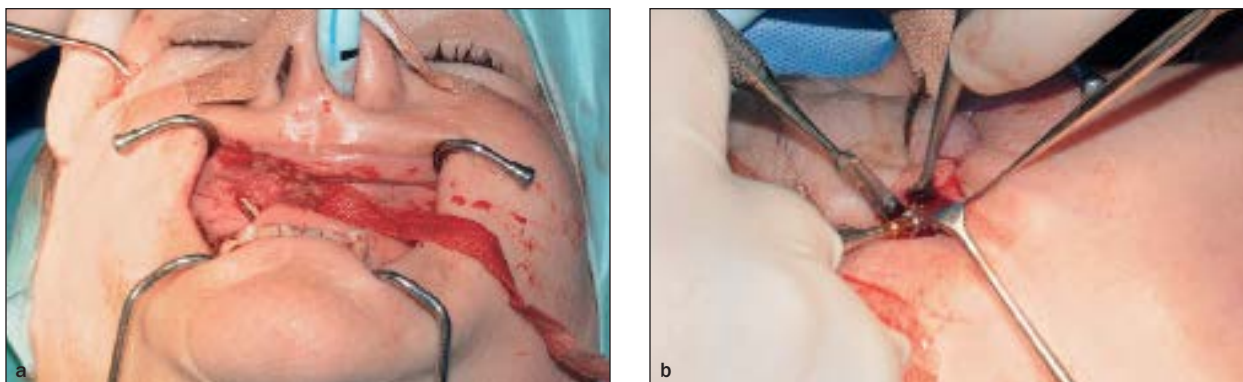


**Fig 3** Trial surgery in a 3D printed model of the midfacial region.

zygomatic implants that could then be used to support a milled bar/overdenture type prosthesis. On the left side, two of the zygomatic implants would be anchored into the zygoma, and closely approximated to the lateral wall of the maxilla in a conventional arrangement—essentially as one side of a “quad zygo-ma” type of configuration.<sup>8</sup> On the right side, however, as the zygoma had also been mostly removed, the implant would need to be anchored into the residual lateral orbital wall, and would be traversing a large bulk of soft tissue. Although a conventional surgical approach could be used on the left side, on the right side, the fixture must first traverse an approximately 2-cm thickness of vascularized free flap, and this side had been subjected to a high dose of radiotherapy, with limited access and the unfamiliar anatomy adding further complexity.

The limitations of the surgical site and the difficult access with reduced opening inspired a new design for a bespoke implant with features that would permit reverse insertion and a more direct approach to the surgery. The fixture was designed by the author, drawn in engineering software (Fig 2), and milled from

commercially pure type IV titanium to a specification from measurements derived from the planning software and from a trial surgery in the 3D printed model (Fig 3). The fixture comprised a long unthreaded shaft of a length calculated to pass through the bulk of the free flap/soft tissues, and a threaded part, designed to engage the remaining structure of the lateral orbital rim. The strength of the fixture was at least equivalent to the strength of a standard zygomatic implant, because the minimum diameter of the unthreaded shaft of the implant was greater than that of the overall diameter of the threaded shaft of a standard zygomatic implant. In this case, the threaded portion of the implant had the thread pitch and depth of an NP Brånemark zygomatic fixture, compensating for the increased width of the fixture shaft to some extent, and also allowing for a great deal of control over placement. The small thread and the introduction of a self-tapping element at the junction of the unthreaded shaft and the threaded shaft reduced the possibility of fracture or induced stress in the narrow dense bone column that was available at the orbital rim. Implant placement was facilitated by means of an internal “star grip” feature (as may



**Fig 4** (a) Using the zygomatic system depth gauge to confirm position and implant length. (b) Extraoral implant insertion with “star grip” insertion tool.



**Fig 5** (a) Mirror view of palate with abutments in place on implants. (b) Milled titanium bar secured to MultiUnit abutments. (c) Overdenture seated onto bar.

be found on MKIII and MK IV Brånemark fixtures), built into the “head” of the “reversed” implant. Otherwise, the implant prosthetic platform and its relationship to the implant shaft was similar to that of a Brånemark zygomatic implant.

An extraoral incision was made through an existing scar line, almost directly over the lateral orbital rim, making site preparation reasonably straightforward, with retraction of the lateral orbital structures. Site preparation was completed in stages, using a depth gauge (Fig 4a) to visualize the position of the implant platform and the correct depth. The implant was placed (Fig 4b) along with the conventional zygomatic implants, which were immediately provided with MultiUnit (NobelBiocare) abutments to support a screw-retained titanium bar (Fig 5a). On completion of the implant surgery, a Coleman fat graft,<sup>9</sup> using fat harvested from the abdomen, was used to somewhat improve the contour of the side of the face.

Because the patient had great difficulty managing with the prosthesis, and because the implants achieved high torque values, a decision was made to proceed rapidly with provision of the milled bar/overdenture

prosthesis. This was fitted (Figs 5b and 5c) after a short series of appointments, and the patient was pleased with the outcome (Fig 6), experiencing a greatly increased level of confidence. The implants and prosthesis were in normal function at the 2-year review.

## DISCUSSION

Increasingly, implant dentistry relies on advanced digital technology<sup>10</sup>: 3D imaging, 3D printing, and 3D milling technologies to tailor treatment specifically to the patient’s needs. In this challenging case, 3D imaging, 3D printing, and 3D milling of a custom implant and also a complex overdenture bar all played a part in the treatment.

In cases in which an extraoral approach is available in the course of complex maxillofacial procedures, direct surgical access to the site of a zygomatic implant allows direct visualization and improved retraction and protection of nearby vulnerable structures. The unthreaded shaft was thought to be a necessary feature to avoid the irritation that may be caused by the



**Fig 6** Patient with prosthesis in place.

threads<sup>11</sup> of a zygomatic implant as it traverses the soft tissues. This approach to surgery also enables a great degree of direct control over site location and preparation for a fixture that is usually 30 to 52.5 mm in length.

A bifunctional implant intended for reconstruction of the nose has been described.<sup>12</sup> In this procedure, an intraoral platform was used to support an oral prosthesis, and an intranasal platform was used to provide anchorage for a nasal prosthesis. The reverse zygoma fixture is also bifunctional, in that one end of the fixture incorporates a prosthetic platform, whereas the other end incorporates a feature that engages with the insertion tool. Uniquely, the tip of the implant is also the prosthetic platform.

The use of a guided surgical approach may one day make it possible to accurately position a zygomatic implant into a small island of bone from an intraoral approach; however, in a cadaver study<sup>13</sup> examining the accuracy of guided surgery used for zygomatic implant placement, an angular deviation of up to 6.4 degrees was found. For an implant that is 45 mm in length, this degree of deviation would translate into a positioning inaccuracy of  $\pm 5$  mm from either side of the intended position, making guided surgery a dangerous procedure in the present context. Furthermore, as seen in this and many other maxillofacial cases, jaw opening may be limited by previous surgery and by radiotherapy, making access for zygomatic surgery difficult, and for guided surgery with the need for longer-than-usual drills and templates, even more difficult. The use of surgical navigation has also been described,<sup>14</sup> but there is little information on the accuracy of this technique. Thus direct access via an extraoral approach and the use of the reverse zygomatic implant seems advantageous.

## CONCLUSION

Only a few patients perhaps might benefit from this approach; but those patients are often in a great deal of need, and this simple approach to treatment may be of great value for such oncological or other maxillofacial situations in which implant reconstruction might have a role.

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