Jaw in a Day: Immediate Dental Rehabilitation during Fibula Reconstruction of the Mandible

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Abstract

Reconstructing mandibular defects presents challenges to dental rehabilitation related to altered bone and soft tissue anatomy. Dental implants are the most reliable method to restore the lost dentition. Immediate dental implants have been placed for many years but with unacceptably low rates of dental/prosthetic success. Current virtual technology allows placement of both fibulas and guided implants in restoratively driven positions that also allow immediate dental rehabilitation. Inexpensive three-dimensional printing platforms can create provisional dental prostheses placed at the time of surgery. This article reviews our digital and surgical workflow to create an immediate dental prosthesis to predictably restore the dentition during major jaw reconstruction with fibula free flaps.

Keywords
► Jaw in a Day
► fibula free flap
► dental implants
► mandible reconstruction
► virtual surgical planning

Although microvascular fibula flaps have been used for decades to restore mandibular continuity, dental rehabilitation remains challenging. Due to the altered oral anatomy of both bone and soft tissue, conventional removable prostheses are rarely successful. Immediate implant placement in microvascular bone flaps was first described by Urken et al in 1989.1 These implants were buried under the soft tissue and allowed to integrate for 4 months prior to being uncovered and restored with a dental prosthesis. Over a decade later, Rohner et al described a technique for prefabricated fibula flaps where implants were placed in the intact fibula and left to osseointegrate for 6 weeks.2,3 This required staged operations that delayed definitive treatment and reconstruction of the oral cavity. Digital planning was not yet available and Rohner’s group later described their laboratory-based workflow with physical impressions and models.4 Similar staged techniques were later described in separate papers by Odin et al and Schepers et al using digital planning but still required more than one operation.5,6

The first single operation to place immediate implants and an immediate dental prosthesis was performed in 2007 by Hutchison and Dawood using a scapula free flap.7 This was later termed “Jaw in a Day” by Levine in 2013 when his group described their experience in three patients with benign tumors of the mandible and one patient with benign maxillary pathology.8

Since Levine’s publication, other groups have reported their outcomes and experience with the Jaw in a Day technique. Qaisi et al described three patients with ameloblastoma of the mandible. Each underwent segmental mandibulectomy with simultaneous fibula free flap and placement of immediate dental implants and prosthesis.
experiences and variations on the technique. Most authors have recommended this surgery only for benign lesions due to the increased time required for fabrication of a dental prosthesis. Preoperative planning is critical to create a predictable result. Data gathering begins with a computed tomography (CT) scan of the jaws and the fibulas with 1 mm cuts. Patient-specific fibula data are essential for planning of accurate implant positions. An intraoral optical scan allows creation of a digital file (Fig. 1A, B) to serve as a reference for implant positioning and a template for the creation of the temporary dental prosthesis. The most common digital format is stereolithography. For patients with an intact preoperative dentition, the teeth can be cloned with an optical scanner and 3D-printed to create the temporary prosthesis (Fig. 2A, B). The digital file of the intraoral scan should be uploaded to the VSP planner to align with their CT data for the virtual planning session.

VSP consists of four elements: mandible resection location, fibula orientation, dental implant positioning, and plate/screw design. Mandible osteotomies should be not only based on oncologically sound margins but also on ideal fibula positioning. Extending resection margins is sometimes necessary to prevent short fibula segments that may have a less robust blood supply. For a hemimandible defect extending to the midline, the authors often extend the resection to include all four lower incisors and create a two-segment fibula construct.

Fibula orientation is planned to allow implants to emerge from the anterior surface. The lateral surface of the fibula will become the buccal plate of the mandible and is where the reconstruction plate will be placed. If a skin paddle is needed, it should be positioned to rotate over the buccal aspect of the neomandible. This creates slight tension that allows formation of a buccal vestibule. For an optimal dental outcome, the fibula should be positioned with appropriate restorative space in mind. Restorative space is the distance from the platform of the implant to the occlusal surface of the planned teeth. This distance should be 15 to 17 mm to allow for sufficient strength of the prosthesis, to develop a hygienic and cleansable emergence profile, and to provide space for adequate bulk for a strong cantilever when needed. Since mouth opening is more limited posteriorly, the fibula should be at the inferior border in the molar region, then raised superiorly as the incisors are approached. The double-barrel technique is rarely necessary to improve facial contour unless the patient is exceptionally thin. In addition, it is common when using the double-barrel technique to

Fig. 1 (A) An optical scan of the teeth (shown in orange) creates a digital stereolithography file that is aligned with the computed tomography scan. This eliminates radiographic artifact from metallic dental restorations. (B) The same patient with the optical scan (shown in orange) with the planned fibula, implants, and abutments positioned so that the original teeth can be restored.

Fig. 2 (A) Using the intraoral scan, the preoperative teeth are cloned and digitally contoured into a fixed hybrid prosthesis over the planned implants. (B) This prosthesis is created with 6 mm diameter holes to allow room for injecting resin to pick up the implant temporary copings in the dental prosthesis. Additionally, the “floating prosthesis” suspends the teeth in the proper occlusal position over the guided implants.
obliterate needed dental restorative space leading to the need of bone reduction prior to dental implant placement.

Dental implants are virtually positioned in the fibula using the preoperative dentition as a reference when possible. For posterior teeth, the implant trajectory should be through the occlusal surface. For anterior teeth, the implants should emerge through the lingual aspect of the teeth. If the dentition is absent preoperatively, the opposing teeth can be used as a reference. Mandibular implants should be angled toward the palatal cusp of the maxillary teeth posteriorly, or the junction of the cingulum with the palatal gingiva anteriorly. The implants should be planned for subcrestal depth in the fibula, as marginal bone loss of 1 to 3 mm is common within the first year. The position and angulation of the dental implants will be incorporated into the fibula cutting guide.

Design of the plate and screws should be performed after implant design since screw location is much less critical than implant positioning. The plate should be designed as low as possible on the fibula and away from the implant platforms. This lowers the risk of an exposed and infected plate if later vestibuloplasty is needed. A minimum of two screws per fibula segment are needed for fixation. The authors often plan for more screw holes that are not drilled unless needed to alter fibula positioning during final inset.

Design of the dental prosthesis is easiest to perform if the patient has a preoperative dentition. Teeth to be removed during the mandibulectomy can be cloned and 3D printed for immediate replacement. The authors use Blue Sky Plan (Blue Sky Bio, Libertyville, IL) and Meshmixer (Autodesk Inc, San Rafael, CA) to design the dental on the digital files from the VSP session. A key design element includes placement of holes in the prosthesis at the location of each implant. Most temporary copings are around 3.5 mm in diameter so the authors create a 6 mm diameter hole in the prosthesis for each implant to allow room for resin to flow while luting the dental prosthesis to the implant copings. A “floating prosthesis,” described elsewhere, allows attachment of the dental prosthesis to the implants while still attached to the leg without the need for occlusal splints or intermaxillary fixation. Dental laboratories can also fabricate this prosthesis, but this greatly increases cost and requires additional weeks that may delay treatment. The authors design the prosthesis in roughly 30 minutes and 3D print the prosthesis with NextDent MFH resin (3D Systems, Rock Hill, SC). Pink gingival characterization is added with Anaxgum (Anaxdent, Ardmore, OK; Fig. 4).

Surgical Technique

The mandibulectomy is performed with surgical guides as with any VSP-assisted case. The fibula is harvested with standard techniques and remains pedicled to the leg during implant placement, fibula osteotomies, and attachment of teeth. The fibula cutting guide is fixated to the fibula with monocortical screws. Dental implants are placed using the manufacturer’s guided system through the fibula cutting guide in the planned positions. It is important to note that the fibula osteotomies should be performed last to avoid placing implants in mobile fibula segments that increase the difficulty and decrease accuracy. Implant depth is verified to be subcrestal by visual inspection on the medial (lingual) aspect of the fibula prior to removing the guide.

After using the fibula cutting guide to place implants and perform fibula osteotomies, the fibula cutting guide is
removed. Wedge ostectomies between fibula segments are removed. Multiunit abutments are placed on the implants and torqued to manufacturer specifications. The authors use Nobel Parallel CC implants (Nobel Biocare, Zurich, Switzerland) of 3.75 mm diameter in most cases. The preoperative VSP should angle the implants to emerge through the occlusal surface so that straight (not angled) multiunit abutments can be used. Straight abutments remove implant timing/rotation from the process to simplify the restorative process. Multiunit abutments have additional advantages such as raising the restorative platform higher through thick tissue, allowing for simplified restoration of nonparallel implants, provide platform switching, allow easier impressions and seating of the prosthesis, accommodate for deeper subcrestal placement of implants, and place the inherent prosthetic misfit at the abutment level instead of the implant level. Temporary copings are placed on the multiunit abutments that will be picked up in the provisional prosthesis.

While still perfusing on the vascular pedicle, the fibula segments are fixated to the defect model provided by the VSP vendor. Screw holes in the fibula segments are often difficult to locate through the muscle. Drill bits can be useful to orient the fibula segments to the plate prior to screw fixation (Fig. 6). Drill bits are removed one at a time and replaced with screws for definitive fixation of the fibula segments to the plate. It is wise to place the dental prosthesis over the temporary copings while placing these screws to ensure implant trajectories remain positioned through the planned holes in the dental prosthesis. Despite great accuracy in the virtual plan, sources of error will always exist and malpositioned fibula segments can rotate implants out of alignment during screw fixation to the plate. The authors prefer to use locking screws to avoid the inherent “barrel roll” rotation of fibula segments when tightening nonlocking screws to the plate.

After fixation of the fibula segments to the plate and defect model, the floating prosthesis is positioned on the defect model for pickup and attachment to the implant copings (Fig. 7). This can be accomplished on the leg with partially dentate cases, but full arch cases have superior occlusion when attached in the mouth after fibula inset. For attachment of the dental prosthesis to the implant copings, the authors use Luxatemp (DMG America, Ridgefield Park, NJ) for its ideal handling properties, high viscosity, and ability to bond to the 3D-printed prosthesis.

After attaching the prosthesis to the temporary copings, the prosthesis is removed for final shaping and addition of more Luxatemp to fill in holes (Fig. 8). The fibula remains attached to the plate but is removed from the defect model. The fibula vessels are ligated, and the fibula is transferred to the mouth for bone inset with screw fixation followed by microvascular anastomosis. The prosthesis is seated onto the implants and the occlusion is adjusted to avoid any contact of opposing teeth. Final soft tissue closure is performed under the dental prosthesis. A highwater design of the prosthesis allows easy closure and access for hygiene. After discharge, a postoperative panorex verifies implant positioning (Fig. 9).

**Discussion**

Although Jaw in a Day experience with malignant disease is limited, early reports show successful use in patients needing adjuvant radiation therapy after surgical intervention. Detrimental effects of radiation on bone likely do not appear until several weeks after beginning radiation therapy. Since
radiation commonly begins 6 weeks after surgery, much of the osseointegration process has occurred prior to accumulating higher doses of radiation. Previous literature has supported primary implant placement to have implants placed in nonradiated bone. Placement of implants primarily before radiation does not appear to decrease the rate of successful integration and may have a slightly improved survival rate.

Ch’ng et al studied the rate of implant loss in head and neck cancer patients implant placement in fibulas and native jaws before and after radiation therapy. They found a slightly increased rate of loss in fibulas (8.6%) compared with native mandible (2.6%) and maxilla (2.2%) although not statistically significant. Additionally, there was no significant difference in implant loss in patients who did and did not receive adjuvant radiation therapy. Sandoval et al specifically looked at effects of adjuvant radiation therapy in patients reconstructed with a fibula and primary implant placement compared with fibulas without implant placement and found no significant difference in adverse outcomes. Consideration must be given to oncologic follow-up in this population, as the temporary prosthesis may hinder tumor surveillance.

The implant success rate has historically been higher than the prosthetic success rate. A significant number of successfully integrated implants in fibulas are never restored with a dental prosthesis. This can be due to poor implant position/angulation, unfavorable fibula positioning, uncooperative soft tissue, and tumor recurrence. Smolka et al reported on 56 patients with a 92% implant survival rate, but only 42.9% of the patients were able to have a dental prosthesis. Similarly, Schepers et al noted a 97% implant integration rate but only 75% were restored with teeth.

A common challenge to consider is formation of reactive tissue around implants. Periimplantitis in fibula flaps has been rarely studied. Pellegrino et al found that the rate of periimplant mucositis and periimplantitis was 18.2 and 15.8%, respectively, at 10 years, and theorized this was due to the compromised soft tissue quality. In such cases, granulation tissue may need to be removed, skin grafts may need to be placed, and oral hygiene must be aggressively reinforced.

Conclusion

The Jaw in a Day surgery is a reliable and predictable treatment for select patients. Immediate dental implants and teeth minimize the negative psychosocial effects of edentulism and should improve quality of life. Improvements in digital technology with in-house 3D printing have reduced the time and cost while maximizing patient outcomes. Surgeons are expanding the indications into treatment of malignant pathology and patients requiring skin paddles. As the Jaw in a Day technique continues to evolve, more centers will be able to offer total jaw reconstruction in a single operation.

Conflict of Interest

None declared.

References

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