**Patient Profile**

A 58-year-old man previously had multiple reconstructive surgeries to correct a right maxillary oncologic deformity. The reconstructions included microvascular soft tissue flaps but no bony reconstruction. Bony reconstruction was now planned with a fibula flap so he can ultimately regain normal mastication.

The patient had received radiation in the past and therefore vascularized bone, in the form of a composite tissue flap, was required to reconstruct the right maxilla. In addition, multiple anastomoses performed on the right neck had exhausted most of the vascular pedicles. Thus virgin tissue from the contralateral side was preferred for this procedure.

A physical exam of the patient indicated good blood flow to the foot. There was no history of lower extremity injury, repair or vascular compromise. The patient’s overall health confirmed that he would be able to tolerate a prolonged operation for a successful microvascular tissue transfer.

Synthes ProPlan CMF computer generated images in Figures 1–3 illustrate the deformity. The difference between the right maxilla to the normal contralateral maxilla is shown.
Treatment Plan

Re-creation of the right maxillary defect was planned by identifying the bony buttresses for skeletal reconstruction. A tunnel from the right maxillary defect within the subcutaneous plane to the left facial artery and vein region would be established by the head and neck surgeons. Simultaneously, a second surgical team would harvest a fibula flap with a cuff of flexor hallucis longus muscle and a skin paddle.

Osteotomy sites for the fibula flap were identified in a preoperative planning session with a Clinical Engineer using Synthes ProPlan CMF. The planning software allowed for visualization of the fibula segments into a neo-maxilla and allowed for the design of a surgical guide for the osteotomies. The fibula segments would be shaped intraoperatively using a patient-specific planned outcome model as a guide. This fibula construct would then be transferred to the right maxillary defect. The re-shaped maxilla is then stabilized and inset into the defect area. Anastomoses would be performed to the facial arteries and veins and the leg closed primarily.
Preoperative Planning Session

A CT scan in 1 millimeter slices was performed on the patient. The data was uploaded into Synthes ProPlan CMF Connect and used to create three dimensional images for the planning session.

During the planning session, the relationship of the maxilla to the dentoalveolar complex was established to ensure normal post-surgical placement of osseointegrated implants. The number, location and orientation of fibula segments was determined. The fibula graft construct was planned to be secured at the pterygoid plate, with a turn near the level of the canine. Figures 4–5.

Synthes ProPlan CMF software calculated the overall length of the fibula segment to be removed as well as the length of the segments. A length of 6.3 cm was planned for the reconstruction. From these calculations an osteotomy guide was created to accurately transfer the plan to the OR for re-shaping the bone into a maxilla. Six centimeters from the malleolus was preserved distally and seven centimeters proximally, as required for ankle and knee stability. Approximately 15 cm of proximal bone needed to be removed to provide for sufficient vascular pedicle length for anastomosis. Figure 6.
Intraoperative Surgical Details
Two separate surgical teams worked simultaneously. The head and neck surgical team completed the dissection and created the defect for the fibula graft while a second team prepared the fibular osteocutaneous flap and pedicle.

Harvesting Fibular Osteocutaneous Flap
The fibular flap was marked preoperatively. A linear incision was then made along the posterior aspect of the fibula. Care was taken to visualize and protect the common peroneal nerve as dissection proceeded to reveal the peroneus longus tendon and muscle. A cuff of muscle was preserved around the bone to maintain periosteal blood supply. Access to the posterior compartment musculature was gained by incising the interosseous membrane. The posterior tibialis muscle was divided to gain access to the peroneal artery and veins. Dissection continued to lift the flexor hallucis longus muscle off of the posterior tibia.

Taking care to protect the medial structures, full thickness proximal and distal osteotomies were performed to gain further access to the flexor hallucis longus and vascular pedicle superiorly. At this point the tourniquet was released to check for bleeding and confirm vascular flow to the bone.

A total length of approximately fifteen centimeters of pedicle length was dissected from the proximal portion of the fibula to be transferred to the right maxillary defect. Figure 7
Osteotomies of the fibula
The fibula flap was osteotomized in situ using a surgical guide based on Synthes ProPlan CMF preoperative planning. Figures 8–9, virtual and actual images. The surgical guide insured the segments were cut to the length and that angular wedge osteotomies were created as planned preoperatively. Taking care to protect the vasculature, Synthes Power Tools Electric Pen Drive with reciprocating attachment and blade were used to cut through the 1 mm slots. While still being profused, the two segments were shaped using the sterilizable Synthes ProPlan CMF-planned outcome model. A Titanium Oblique L-Plate, 3 x 4, left, 0.8 mm thick was pre-contoured with the planned outcome model and then used to stabilize the construct. Figures 10–11.
Inset into maxilla

The fibula construct with its pedicle and skin paddle was positioned into the right maxilla posteriorly and then anteriorly, using the planned outcome model as a guide. The construct was seated on the posterior pterygoid plates and anterior maxillary segment. Adequate height was confirmed and the inferior aspect of the fibula was at the level of the maxillary dental alveolus. The fibula construct was burred using Synthes Power Tools Electric Pen Drive System with a pear-shaped burr and medium burring attachment to ensure good bony contact by smoothing out any prominences that would create sharp interferences.

Once good apposition of the bone was achieved, a Titanium Adaption Plate, 20 holes, 0.8 mm thick was contoured and cut to length to stabilize the fibula construct to the left maxilla. Figure 12. The flat, lateral surface of the fibula tends to be an ideal position to place on the facial surface and readily accommodates fixation screws and plates.

The peroneal vascular pedicle was ligated and divided beginning the warm ischemia time. The fibular construct was transferred to the maxillary defect and the vessels were passed through a tunnel into the left facial artery and vein proximally. The facial artery provides the inflow for the peroneal artery and the facial vein provides outflow for the peroneal vein. A subcutaneous pocket from the facial veins to the maxillary segment was created.

Microvascular reconstruction was performed in an end-to-end fashion using 9.0 nylon to the left facial artery and vein. Doppler confirmed excellent inflow and outflow with superb audible signals. The color of the muscle flap was healthy.

Any excess flexor hallucis longus muscle was removed. In 4–6 weeks it will atrophy into mucosa-like tissue and provide intra oral cover for the bone. The left gingival buccal axis for plating of the fibula to the left maxillary construct was closed followed by the left facial incision where the recipient vessels were identified.

The leg was closed primarily and casted with a posterior splint.

Results
Post-operative CT scans indicate that the maxillary reconstruction was performed as planned preoperatively. The fibula segments are in the location and orientation as determined to allow for placement of osseointegrated implants. Figures 13–16.

Essentially a lower extremity fracture was created during the fibula flap harvest and this will take approximately 3-6 months to normalize. During that time, however, the maxilla will heal and the muscle will atrophy over time. The patient should develop a supportive vestibule with the use of the muscle. Some additional vestibular work may be needed to deepen the fold under the care of a prosthodontic expert for placement of osseointegrated implants.

Discussion
Significant OR time is saved in a tri-fold fashion. Two surgical teams worked simultaneously preparing the defect and harvesting the fibula free flap. Secondly, the use of computer-aided preoperative planning provided dedicated time to determine the requirements of the construct, pedicle length, and positioning of the plates and screws. The exact location of the fibula osteotomies is identified prior to incision. The plan is then accurately transferred to the OR through the osteotomy guide and planned outcome maxilla model. Lastly, a low-profile plate was pre-contoured based on the outcome model.

Overall time savings is estimated to be two to three hours. Previously, without computerized surgical planning, the fibula flap would be harvested and then the team would wait for the re-creation of the defect. A plastic ruler would be used to create a template of the defect and then the osteotomies of the fibula would be planned.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.
Product Information

Osteotomy Guide and Model

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<td>SD900.102</td>
<td>Fibula Guide</td>
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<td>SD900.233</td>
<td>Planned Outcome Model</td>
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Implants Used

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<td>04.503.385</td>
<td>Titanium Oblique L-Plate, 3 x 4 holes, left, 0.8 mm, gold</td>
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<td>04.503.396</td>
<td>Titanium Adaption Plate, 20 holes, 0.8 mm thick, gold</td>
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<td>Titanium MatrixMIDFACE Self-Tapping Screws</td>
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## Synthes Power Tools

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<td>01.001.580</td>
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<td>05.001.046</td>
<td>Burr Attachment, medium</td>
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<tr>
<td>03.000.077S</td>
<td>Pear-shaped burr</td>
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Surgeon Profile

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