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# Dental Silicone-based Surgical Guides to Harvest the Chimeric Scapular Flap: Preventing Iatrogenic Vascular Injury

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**Summary:** The angular branch of the thoracodorsal artery and the periosteal branches of the circumflex scapular artery can be easily injured while harvesting a chimeric scapular flap. Thus, we reported the use of 3D printed scapular models using CT angiography to prepare inexpensive surgical guides from autoclavable dental silicone impressions for scapular flap harvest. Mandibular and scapular models were prepared using a 3D printer for 11 patients undergoing chimeric scapular flap transfer following mandibular resection. During preoperative simulation surgery, we molded dental silicone accordingly with scapular models to produce surgical cutting guides. Six men (54.5%) and five women (45.5%) were included. The average age of patients was 65.4 years. Fourteen bone units were reconstructed as three patients needed two bone segments (27.3%) whereas eight patients required reconstruction of one bone segment (72.7%). The mean flap harvest time and total surgical time were 52.1 min and 633.8 min, respectively. The mean duration for osteotomies and bone plate fixation was 26.2 min. The difference between the length of the preoperative surgical model (64.92 mm) and the postoperative 3D-CT measurements (64.48 mm) was not statistically significant (0.95 mm, $P = 0.397$). No injuries were caused to the angular and periosteal vessels. Four patients exhibited donor-site seroma (36.4%). The cost of the dental silicone for surgical guide was only $5 per patient. Dental silicone-based surgical guides help minimize the risk of vascular injury while harvesting chimeric scapular flaps. The osteotomies were performed with precision and in a time-efficient manner.
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## INTRODUCTION

The substantial bone stock from the tip or lateral border of the scapula, and multiple possibilities of chimeric flaps, make the free flaps from the subscapular system an outstanding option for reconstruction of maxillomandibular defects.[1,2] However, the proximity of the infraspinatus muscle to the bone surface can be inconvenient while harvesting these flaps.[1,3] Also, to optimize the postoperative osseointegration progress of dental implants, the chimeric flap may require supercharging via the circumflex scapular artery (CSA) to enhance blood flow to the bone component.[4]

In this setting, it is important to preserve the integrity of the angular branch of the thoracodorsal artery and the periosteal branches of the CSA when performing the osteotomies to assemble the flap's bony framework. These

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vessels can be easily injured as the bulky muscular insertions to the scapula and variable fibrous tissue at the tip can obscure the plane of dissection and cutting sites.[5,6] Herein, we evaluated the use of preoperative 3D computed tomography angiography and 3D printed scapular models to prepare inexpensive surgical guides from autoclavable dental silicone impressions, aiming to better visualize the angular artery and periosteal branches during flap harvest.

## METHODS

A retrospective review was conducted to identify patients who underwent mandibular reconstruction with chimeric scapular flaps using surgical guides between 2018 and 2020. The scapular models were prepared using a 3D printer (3D Systems ProJet 460 plus; RICOH Co, Ltd., Tokyo, Japan) and a specialized software (Mimics, Materialise NV, Belgium).[7] Drill markings of the perforating angular and periosteal branches were added to the models with guidance of life-sized printouts of 3D computed tomography angiography images of the subscapular artery. A simulation osteotomy was carried out on the model (Fig. 1).

The osteotomized bone model was used to mold the autoclavable dental silicone surgical guide with Protesil Labor (Vannini Dental Industry, Grassina, Italia) for intraoperative use. (**See figure, Supplemental Digital Content 1,** which shows the molding process. **http://links.lww.com/PRSGO/C42**.) The angular artery and periosteal branches were located by placing the surgical guide on the muscle mass intraoperatively. All cases included harvesting a chimeric latissimus dorsi myocutaneous flap and serratus anterior muscle with the scapular bone flap (Fig. 2). The latissimus dorsi and the scapular bone were simultaneously harvested by two surgeons to reduce the surgical time.

### Statistical Analysis

The Wilcoxon rank sum test was used to calculate the mean difference ($\mu_d$) and confidence interval (CI) between the length of the preoperative surgical model and postoperative 3D-CT measurements. A $P$ value less than 0.05 was considered statistically significant.

### Takeaways

**Question:** The key problem of this study is that the angular branch of the thoracodorsal artery and the periosteal branches of the circumflex scapular artery can be easily injured while harvesting a scapular flap.

**Findings:** We prepared inexpensive surgical guides from autoclavable dental silicone. The difference between the length of the preoperative model and the postoperative 3D-CT was not statistically significant. No injuries were caused to the vessels. The cost of the dental silicone was only $5 per patient.

**Meaning:** Dental silicone-based surgical guides help minimize the risk of vascular injury while harvesting chimeric scapular flaps.

## RESULTS

Six men (54.5%) and five women (45.5%) fulfilled the inclusion criteria. The average age of patients was 65.4 ± 7.9 years. Three patients presented with an ameloblastoma (27.3%), three with medicine-induced osteonecrosis (27.3%), four had mandibular gingival squamous cell carcinoma (36.4%), and one patient presented radiation-induced mandibular osteonecrosis (9.1%). Fourteen bone units were reconstructed, as three patients needed two bone segments (27.3%), whereas eight patients required reconstruction of one bone segment (72.7%). (**See figure, Supplemental Digital Content 2,** which shows the reconstruction of two mandibular segments in a female patient. **http://links.lww.com/PRSGO/C43**.). The mean flap harvest time and total surgical time were 52.1 ± 13.5 min and 633.8 ± 36.8 min, respectively. The mean duration of osteotomy and bone plate fixation was 26.2 ± 6.18 min. The difference between the length of the preoperative surgical model (64.92 ± 22.49 mm) and the postoperative 3D-CT measurements (64.48 ± 23.19 mm) was not significant ($\mu_d$, 0.95 mm; 95%CI 0.85–1.8 mm; $P$ = 0.397).

All flaps exhibited adequate perfusion. None of the patients had flap necrosis, fistulae, or surgical site infections. No injuries were caused to the angular and periosteal

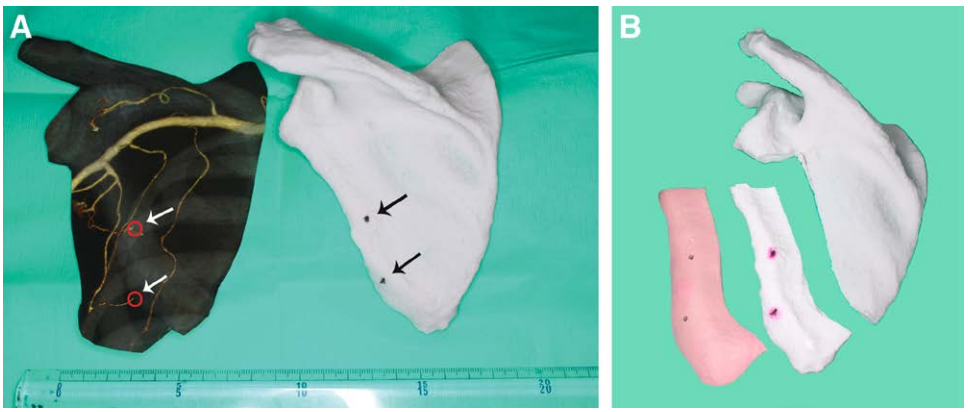


**Fig. 1.** A, Life-size printouts of 3D-CT angiography and drill markings of the perforating angular and periosteal branches. B, Silicone-based surgical guide molded with scapular bone models. After hardening for 6 minutes, the shape of the scapular bone was reproduced. The new guide was then autoclaved at 121°C for 20 minutes.

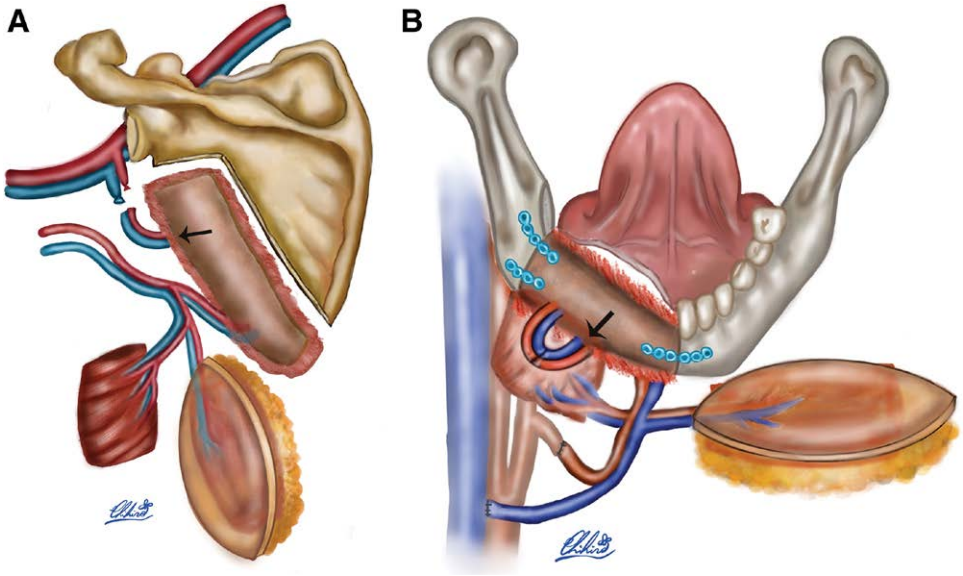


**Fig. 2.** A, Chimeric latissimus dorsi and serratus anterior muscle flaps with the scapular bone flap. B, Anastomosis of the thoracodorsal artery and vein to the superior thyroid artery and internal jugular vein, respectively. Anastomosis of the CSA and vein to the facial artery and vein.

vessels. All patients had adequate postoperative shoulder function. Two patients exhibited transient hypoacusis (18.2%), whereas four patients exhibited donor-site seroma (36.4%). All patients had adequate postoperative oral intake. Four patients had dental implant procedures obtaining good occlusion. The surgical guide preparation was covered by government insurance ($200 per bone model), whereas the cost of the dental silicone was only $5 per patient.

## DISCUSSION

The optimal pedicle length, bony contour, and steady intraosseous blood flow make scapular-free flaps a desirable option for head and neck reconstruction.[2,8] Nonetheless, the selection of the osteotomy site can be difficult due to the unfamiliarity with the subscapular system and variability in shape and thickness of the scapular three-dimensional configuration.[1,9]

Although virtual surgical planning (VSP) has been previously described for free fibula-based mandibular reconstructions,[7] the current evidence on this matter for scapular flaps is limited.[1,5] The authors here propose a novel, inexpensive autoclavable surgical guide to harvest a chimeric scapular flap based on the thoracodorsal vessels supercharged with the CSA. Using this approach, we determine the exact location of the blood vessels while performing the required osteotomies and minimizing the risk of iatrogenic vascular compromise. In fact, no vascular injuries or recipient-site complications were encountered.

This study is the first description of surgical cutting guides made from dental silicone, incorporating angiographic data, designed to protect the perforator around the scapula during osteotomies. Despite initial debates regarding the cost-effectiveness of VSP, its implementation has been demonstrated to reduce the total cost of treatment in matched cohorts with highly complex cases; most of this cost-saving effect is achieved by decreasing the operative time and length of stay.[10] Certainly, the mean operative time for reconstruction with VSP and dental silicone surgical guides in our series was comparable (633.8 ± 36.8 min) with previous reports using VSP (738 min and 540.12 min).[1,10]

Finally, in accordance with previous reports showing the superiority of VSP in terms of successfully reconstructed subunits, successful bony contact between segments, and a higher percent of segments in anatomic position,[1,10] we did not see a significant difference between the length of the preoperative surgical model and the postoperative 3D-CT measurements ($P = 0.39$). This demonstrates the high accuracy and precision of VSP with inexpensive dental silicone surgical guides.[1]

## CONCLUSIONS

The use of preparable surgical guides using sterilizable material allows surgeons to carry out precise scapular osteotomies without vessel injury while harvesting the chimeric scapular flap. This method has been shown to be accurate using pre and postoperative measurements. The proposed guide is inexpensive and readily available in all clinical settings in comparison with existing models.

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*This investigation was conducted according to the principles expressed in the Declaration of Helsinki. The study was approved by the institutional review board.*

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