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Minimally invasive myo-osseous chimeric DCIA-flap without crest, spine and skin to reconstruct composite defects of the mandible using virtual surgical planning and CAD/CAM technology

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Abstract

Background The medial approach for minimally invasive harvesting of a deep circumflex iliac artery (DCIA) flap is described for reconstruction of the jaw. The associated preservation of the crest of the ilium prevents the raising of the abdominal internal oblique muscle (IO) in a standard fashion. However, reconstructive surgery of composite mandibular defects includes bone and soft tissue. To achieve this goal, we combined this technique with a new perforator-based raising of the IO for reconstruction of intraoral soft tissue.

Methods In this study, we present eight cases of patients with composite mandibular defects who underwent the myo-osseous DCIA flap procedure with an IO perforator. Virtual surgical planning was employed to preplan the size and configuration of the graft. Cutting guides were made using CAD/CAM technology. The surgical procedure followed the described medial approach for minimally invasive harvesting, leaving the iliac crest, spine, and skin intact. In addition, we completely cut and isolated the IO with its sole attachment being the ascending branch of the DCIA. We used either a surgical guide with a slot to lead through both the transverse branch of the bone and the ascending branch of the IO or a surgical guide consisting of 2 parts.

Results In all instances, the flap successfully survived with a 100% success rate. There were no signs of infection, wound opening, or bleeding in either patient. Furthermore, the patients did not exhibit permanent complications related to the donor site. The internal oblique perforator flap exhibited remarkable integration in all patients and underwent rapid transformation. Notably, the flap developed keratinized mucosa (KM) that closely resembled the attached gingiva.

Conclusion Our study demonstrated the effectiveness of a medial approach for harvesting a newly designed more flexible chimeric myo-osseous deep circumflex iliac artery flap. By incorporating virtual surgical planning and custom-made cutting guides for obtaining deep circumflex iliac artery flaps through the medial route along with an internal

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oblique perforator flap, we have established a highly promising method for the rehabilitation of patients with composite mandibular defects. This approach not only improves functional outcomes, but also enhances aesthetic results to maintain patients' quality of life.

Background

Oral and maxillofacial surgeons frequently encounter intricate mandibular defects resulting from severe osteomyelitis, benign and malignant tumors, or accidents. These defects often involve intricate reconstructive procedures that are both time-consuming and expensive. The aim of these surgeries is to restore the best outcome in terms of both functionality and aesthetics. To achieve this goal, a variety of different bone grafts are pivotal in the reconstruction process [1].

Currently, microvascular surgery has revolutionized the field of bone grafting. This innovation has significantly increased graft survival rates, and functional and aesthetic outcomes have improved since the introduction of vascularized bone grafts [2]. In facial bone reconstruction, some of the most commonly used bone grafts include those harvested from the fibula, scapula, and iliac crest. Many factors must be taken into consideration when deciding on which bone graft should be used. These factors include the size of the defect, its specific location, whether soft tissue grafting is needed, and the status of the recipient vessels. Additionally, the availability of suitable donor sites plays a pivotal role in this decision-making process [3].

The large quantity of highly vascularized bone, its anatomical shape, and its thickness make the deep circumflex iliac artery (DCIA) a commonly used choice for mandibular reconstruction [4]. One significant drawback associated with the use of DCIA flaps is the potential for postoperative donor site morbidity. This can manifest as difficulty in walking, leading to a diminished quality of life (QoL) for the patient, numbness in the hip region, bulging, and hernia formation [3, 5]. Therefore, minimizing postoperative donor site morbidity is highly important. Recently, computer-assisted maxillofacial surgery has attracted considerable interest and attention. With computer-aided design (CAD) and computer-aided manufacturing (CAM), many different conditions can be simulated accurately [6, 7]. In particular, for flap preparation at the donor site, three-dimensional modeling assisted by computed tomography (CT) provides helpful information regarding subsequent reconstructive surgery. By meticulously planning the surgery through the transfer of digital CT data and 3D software simulations into real-time actions, various critical aspects, such as the required graft size, pre-transection shaping of the graft at the donor site, and precise positioning of the bony flap can be achieved with far greater precision than what is achievable through conventional microvascular surgery methods [5]. Some of the advantages of computer-assisted surgery, despite being costlier and requiring more preoperative planning time, are a lower change in intercondylar distance, potentially reducing the number of postoperative temporomandibular dysfunctions.

Minimizing unnecessary harvesting of the iliac crest bone is crucial for reducing donor site morbidity and associated costs. Additionally, computer-aided surgery contributes to a reduction in ischemic time. Ischemic time is a major risk factor for transplant failure, so reducing this time span can significantly lower the risk of transplant failure. These advantages ultimately outweigh the increased costs and the additional time required during the preoperative planning phase [1].

The most frequently cited drawback associated with the use of the deep circumflex iliac artery (DCIA) flap is donor site morbidity. According to a study conducted by Valentini et al. 25.8% of patients experienced walking difficulties more than 60 days after the operation. Additionally, 38.7% of patients reported a noticeable loss in their hip profile due to the harvesting of their anterior superior iliac spine (ASIS) [8]. Modabber et al. described a medial approach to harvest a bicortical DCIA flap using virtual surgical planning (VSP) and a CAD/CAM technology-based cutting guide [5]. With this surgical approach, the ASIS and crest and therefore the physiological curvature of the hip could be preserved. Therefore, possible donor site morbidities resulting from the loss of important anatomical structures could be eliminated.

In theory, it is feasible to raise an osseo(myo)cutaneous (DCIA) flap that includes skin to cover substantial defects. However, several practical challenges can arise. The skin's thickness, limited mobility, and potential unreliability can pose issues in achieving optimal functional and aesthetic results for the patient. Furthermore, problems related to venous drainage often occur when this type of flap is used [3, 5].

The abdominal internal oblique muscle (IO) was initially introduced in 1984 as a free muscle flap based on the ascending branch of the DCIA for reconstruction surgeries of the extremities. Urken et al. described the use of the IO to conform three-dimensional defects of the head and neck [9, 10].

As quality of life is an increasingly important criterion in oral and maxillofacial surgery, our aim was to prevent the raising of a second flap for soft-tissue coverage. In our approach, we aimed to combine the medial approach for minimally invasive raising of a DCIA flap under preservation of the crest and spine to minimize donor site morbidity with an IO flap to reconstruct compound defects. As the IO originates from the iliac crest, we had to modify the surgical procedure. We used an isolated abdominal internal oblique muscle perforator flap to acquire mucosa or attached gingiva to establish a robust foundation for dental implants, promoting long-term stability as part of the dental rehabilitation process (Fig. 1).

Patients and methods

Study design and patient population

In this prospective clinical trial, we included eight patients who underwent segmental mandibulectomy and resection of the mucosa (inner lining) (± soft tissue) as a part of their treatment plan at the Department of Oral and Maxillofacial Surgery, Medical University of Innsbruck, Austria, and at the Department of Stomatology, University Hospital Pilsen, Faculty of Medicine in Pilsen, Charles University, Pilsen, Czech Republic. All patients underwent primary reconstruction using a myo-osseous chimeric DCIA flap consisting of bone combined with an isolated internal oblique perforator flap.

These procedures were carried out in response to diagnoses of oral squamous cell carcinoma (OSCC, 4), Ewing sarcoma (1), keratocyst (2) and ameloblastoma (1).

Preoperative scans and virtual surgical planning

Prior to the reconstructive operation, CT scans (128-row, multislice, CT scanner, Somatom Definition Flash, Siemens, Erlangen, Germany) of the head, neck, and ilium were made. Vessel diameters and calibers, bone quality and quantity at the donor site and the dimensions of the mandibular defect were assessed. The CT data with less than 1 mm slice thickness for the head and neck and for the pelvis were imported into the platform of two companies (KLS Martin Group, Tuttlingen, Germany or TecuMed, Brno, Czech Republic) or processed for in-house planning. A high-resolution three-dimensional graphical visualization of all CT data was created. During the preoperative planning phase critical structures, measurements, and defects were assessed. A virtual testing procedure was employed, wherein the donor site was sectioned, and the transplant was then positioned into the mandibular defect in the correct three-dimensional orientation.

The final result of the planning data was then processed. To incorporate the virtual surgical plan into the

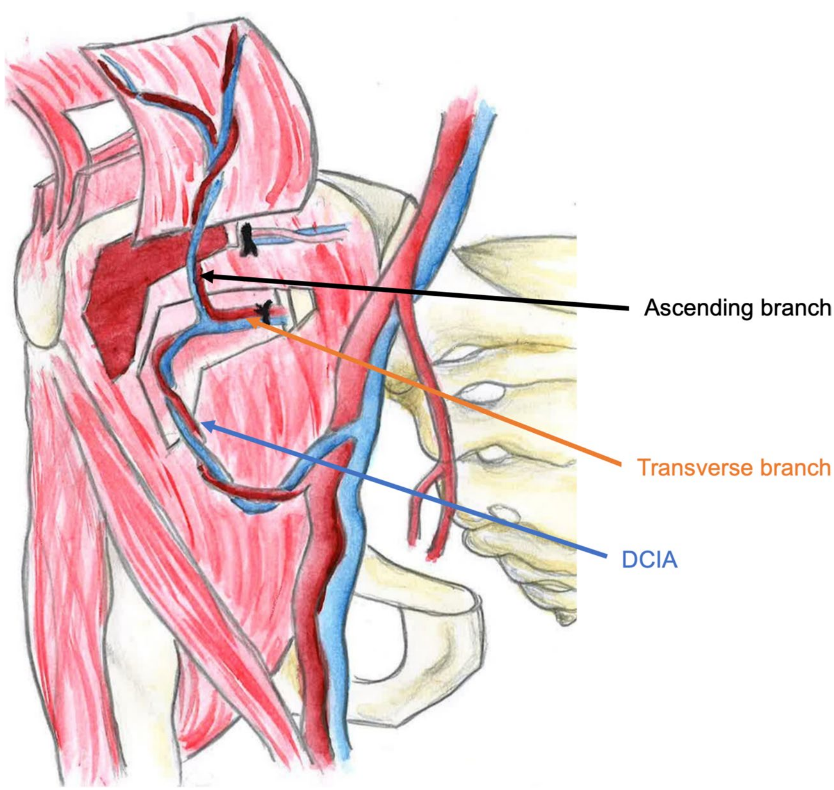

Fig. 1 Illustration of the DCIA flap combining the medial approach and raising of an isolated abdominal internal oblique muscle perforator flap

operation, flap cutting guides, mandible resection guides, and models of the ilium and mandible were produced.

Surgical technique (medial approach)

The common technique of raising a DCIA flap has been described previously [11]. We therefore focus on describing the special features of our approach. A skin incision was delineated, initiating 2 cm superior to the line connecting the ASIS and the pubic tubercle. This incision is subsequently extended posteriorly, tracing the anatomical landmark of the iliac crest. After the subcutaneous fatty tissue was incised, the inguinal ligament appeared. With careful severing of the aponeurosis of the external oblique muscle, the internal oblique muscle is revealed to identify the origin of the deep circumflex iliac artery. Meticulous dissection was performed following the course of the artery. The lateral femoral nerve crosses above the vascular pedicle, and we usually mobilize the pedicle in a nerve-preserving way. In most cases, around the ASIS, the ascending branch arises to enter the abdominal musculature, which is dissected freely [12]. We detach the periosteum of the attachment of the IO from the crest. The IO is then completely cut and isolated, with its sole attachment being the ascending branch of the DCIA, creating a chimeric flap (Fig. 2).

The DCIA follows a course along the inner surface of the ilium approximately two to three cm posterior to the ASIS and two to three cm inferior to the inner rim within the groove situated between the transverse abdominal muscle and the iliacus muscle [5, 11].

Following careful ligation and division of the distal DCIA, positioning of the cutting guide was performed. We used either a surgical guide with a slot to lead through both the transverse branch of the bone and the ascending branch of the IO, depending on the origin, or a surgical guide consisting of two parts. This outline of the flap aligns precisely with the preestablished virtual surgical plan, ensuring the preservation of at least 1.5 cm of both the ASIS and the iliac crest. The guides, designed at a position slightly less than 90 degrees to the lateral cortex, allowed the segment of bone to be raised medially as previously described [5] (Fig. 3).

In this medial approach, there is no requirement to strip or detach the tensor fasciae latae, sartorius, or gluteus medius muscles from the lateral and anterior sides of the ilium. Finally, the bony flap is bicortically severed using an oscillating saw (Figs. 1, 4).

Selected patient cases

In this clinical trial, we included eight patients who underwent segmental mandibulectomy and resection of the mucosa (inner lining) (± soft tissue) followed by primary reconstruction using a myo-osseous chimeric DCIA flap consisting of bone combined with an isolated internal oblique perforator flap. These procedures were carried out in response to diagnoses of oral squamous cell carcinoma (OSCC, 4), Ewing sarcoma (1), keratocyst (2) and ameloblastoma (1).

Through the presentation of two representative patients, we aim to elucidate our methodology and

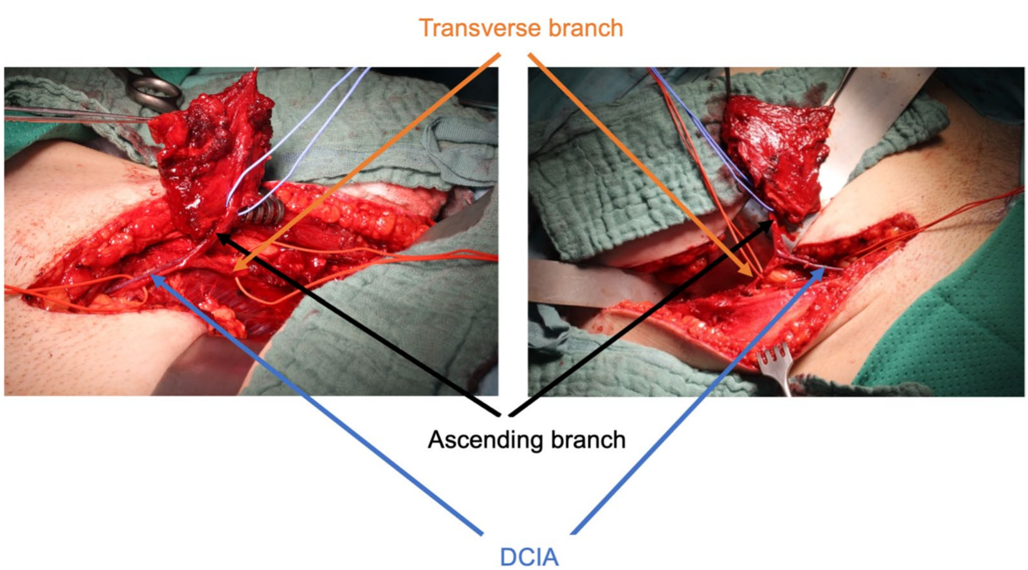

Fig. 2 Pictures showing the DCIA as the main nourishing vessel of the flap (blue), the transverse branch (orange), and the ascending branch (black) traveling to the internal oblique abdominal muscle

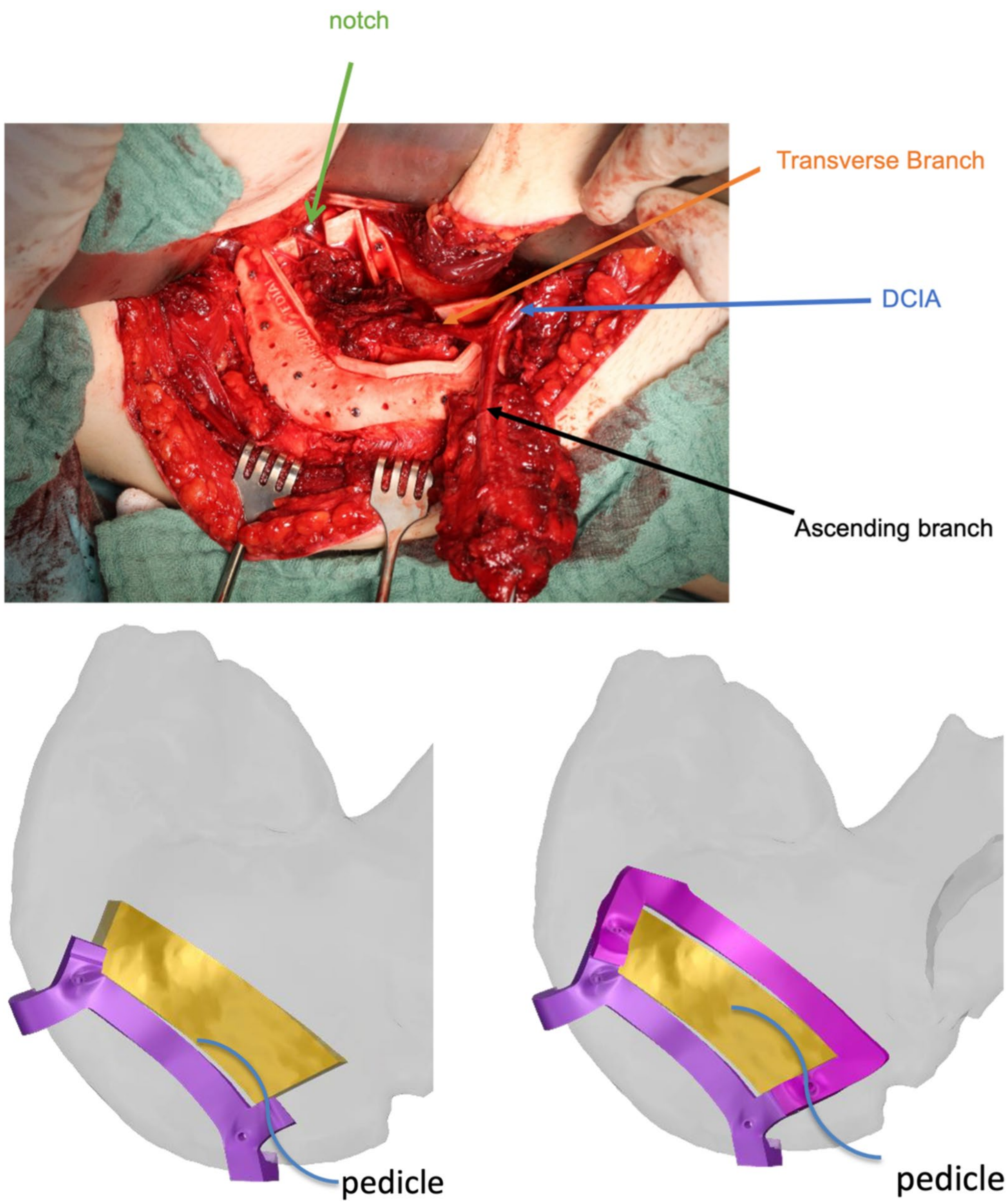

Fig. 3 First 'Negative' cutting guide (top left) based on Moddaber et al. for medial osteotomy without crest and spine of the iliac bone in place. DCIA, transverse (TB), and ascending branch (AB) can be easily identified, as can the slot for the pedicle, including the AB (arrows). Second 2-part 'Negative' guide after the first part (bottom left) has been placed on the crista; the pedicle is 'pulled through' to be protected when the second part (bottom right) is placed

provide insight into the medial approach with simultaneous raising of the IO:

Patient 1: A 27-year-old female patient was diagnosed with Ewing sarcoma in the right mandible (Fig. 5). The patient underwent neoadjuvant chemotherapy followed by surgery and adjuvant radiochemotherapy.

In this case, surgery was planned in-house with a 3D printer (Hage3D GmbH, Obdach, Österreich). A model of the ilium and mandible was generated. After alignment with the mandibular defect during the virtual planning stage, a personalized surgical cutting guide was fabricated (PMMA, ProBase Pink, Ivoclar Vivadent, Schaan, Liechtenstein). This guide delineated the dimensions of the flap, the osteotomy lines, and the desired cutting angulation while preserving the anterior superior iliac spine (ASIS) and the iliac crest with the goal of reducing donor site morbidity (Fig. 6). The mucosal and soft tissue defects were covered with the IO perforator flap. The

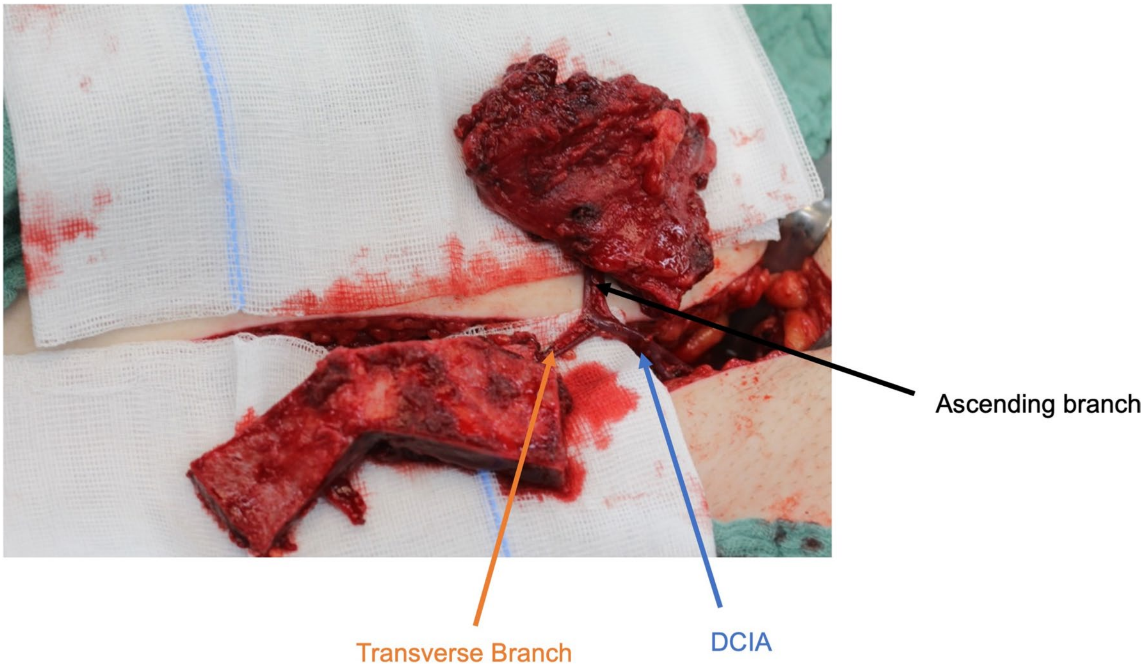

Fig. 4 Iliac bone after bicortical osteotomy performed with an oscillating saw. The ascending branch nourishing the IO muscle can be seen (black arrow)

results of the raised flap and reconstructed mandible are shown in Fig. 7.

Patient 2: A 28-year-old male patient with a keratocyst in the left mandible who underwent segmental resection and primary free flap reconstruction [13, 14]. Virtual surgical planning and CAD/CAM technology-based cutting guides were used (KLS Martin group, Tuttlingen, Germany) (Fig. 8). The IO flap was also chosen to cover the mucosal defect.

Results

The medial approach for raising the myo-osseous DCIA flap was performed in eight patients. By virtually planning the surgery, no intraoperative measurements were necessary. The process was further facilitated by temporarily securing the cutting guide onto the medial pelvis. The mobility of the isolated internal oblique perforator flap could be used to cover the mucosal defect (and, if needed, the soft tissue defect) to prepare for optimal conditions for dental rehabilitation.

The flap survival rate was 100%. Postoperatively, the perfusion could easily be checked by the clinical appearance of the muscle. In addition, the perfusion was postoperatively checked at regular intervals using Doppler ultrasound (Huntleigh Dopplex DMX, Malmö, Sweden). No signs of infection, wound dehiscence or bleeding were observed. Preoperative occlusion was retrieved. Neither main complications at the donor site nor subjective complaints about temporary hypoesthesia in the N. cutaneous femoris lateralis innervation territory, walking issues, or loss of the anatomical profile of the hip were reported. Postoperative orthopantomograms and 3D computed tomographic scans (not shown) illustrate the accurate reproduction of the preoperative virtual surgical plan (Figs. 9, 10). The internal oblique perforator flap exhibited excellent integration in all patients and underwent metaplasia over time, showing keratinized mucosa, notably resembling the attached gingiva. All dental implants showed clinical and radiological signs of osseointegration (if inserted).

Discussion

Through the use of virtual surgical planning, patient-specific cutting guides and titanium plates, it is possible to attain a higher level of precision, greater acceptance, and reduced variation in the reconstruction of composite mandibular defects [15]. Additionally, this approach reduces the overall ischemic time of the flap and streamlines the flap shaping process [5, 16].

The basis of the described approach is similar to that of the minimally invasive medial approach for obtaining avascular iliac bone grafts, which is currently routine for augmentative procedures [17]. Modabber et al. described the extension of this approach to raise a bicortical microvascular flap under preservation of the ASIS and the iliac crest. We again extended the possibilities to reconstruct

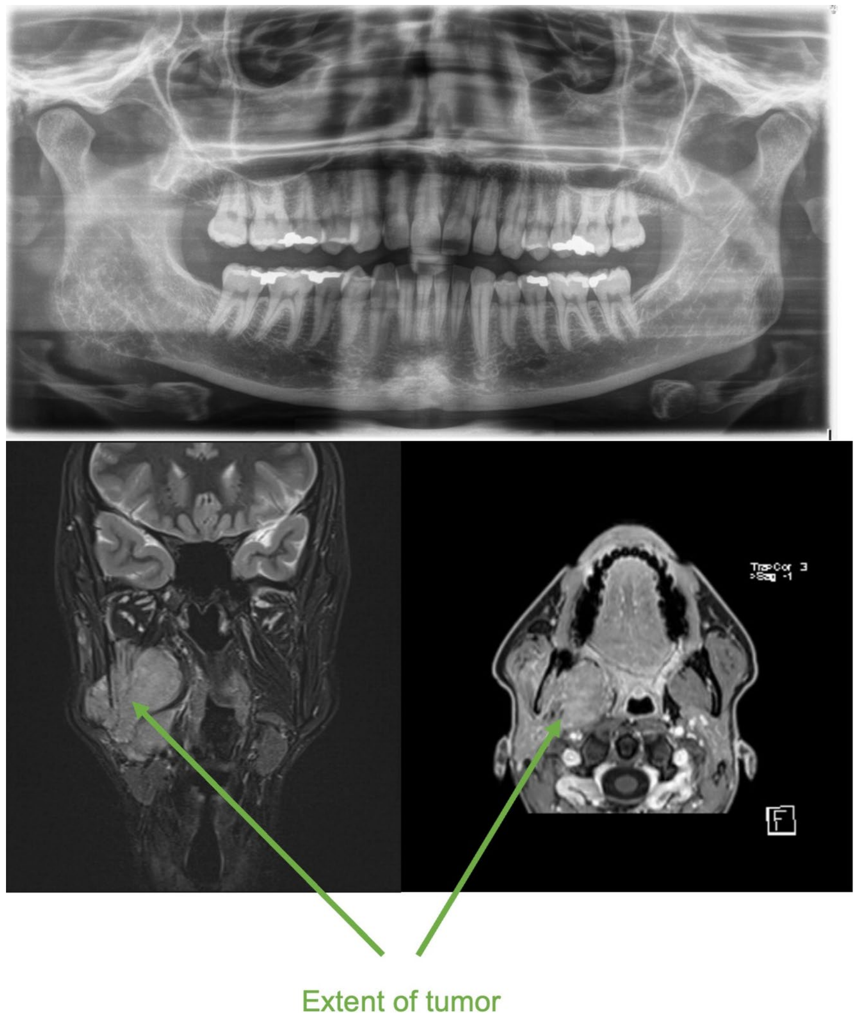

Fig. 5 The orthopantomogram above depicts our patient who was diagnosed with Ewing sarcoma in the right mandible. In the two MRI images below, the extent of the tumor is evident, ranging from the subcutaneous tissue to the pharynx, infiltrating the masseter and pterygoid muscles in close proximity to the carotid vessels

compound defects by combining this technique with a new perforator-based raising of the internal obliquus muscle for reconstruction of intraoral soft tissue [5].

After undergoing reconstructive surgery, patients need to be dentally rehabilitated as soon as possible to improve their speaking ability, mastication, swallowing, and overall aesthetic appearance. To ensure a high QoL and successful reintegration into society, it is crucial to establish close collaboration among maxillofacial surgeons, restorative dentists, and dental technicians [18–20].

Osseointegrated dental implants play a crucial role in this process [21]. The DCIA flap, with its distinctive anatomical characteristics, represents a valuable technique for reconstructing extensive mandibular defects for maxillofacial surgeons. It allows for the harvest of substantial bone quantities, ensuring both the quality and quantity of bone that serve as a robust foundation for implant placement. By opting for the medial approach and safeguarding the integrity of the ASIS and the iliac crest, as outlined by Modabber et al. [5], postoperative morbidity is reduced. This approach eliminates the need to detach the gluteus medius, tensor fasciae latae or sartorius muscles, leading to a smoother recovery process for patients. Compound defects involve two layers: "bone and oral lining" or "bone and external skin" [22]. For the latter defects, a modified deep iliac circumflex osteocutaneous flap is described in which the musculocutaneous terminal part of the DCIA is used as a skin island for extremity reconstruction. This should allow improved mobility between the skin and the bone, and the bulk can be reduced compared to the osteomusculocutaneous branches nourishing the bone of the 'classic' DCIA flap and its overlying skin [12]. The authors advanced the flap from a composite flap to an intrinsic chimeric flap;

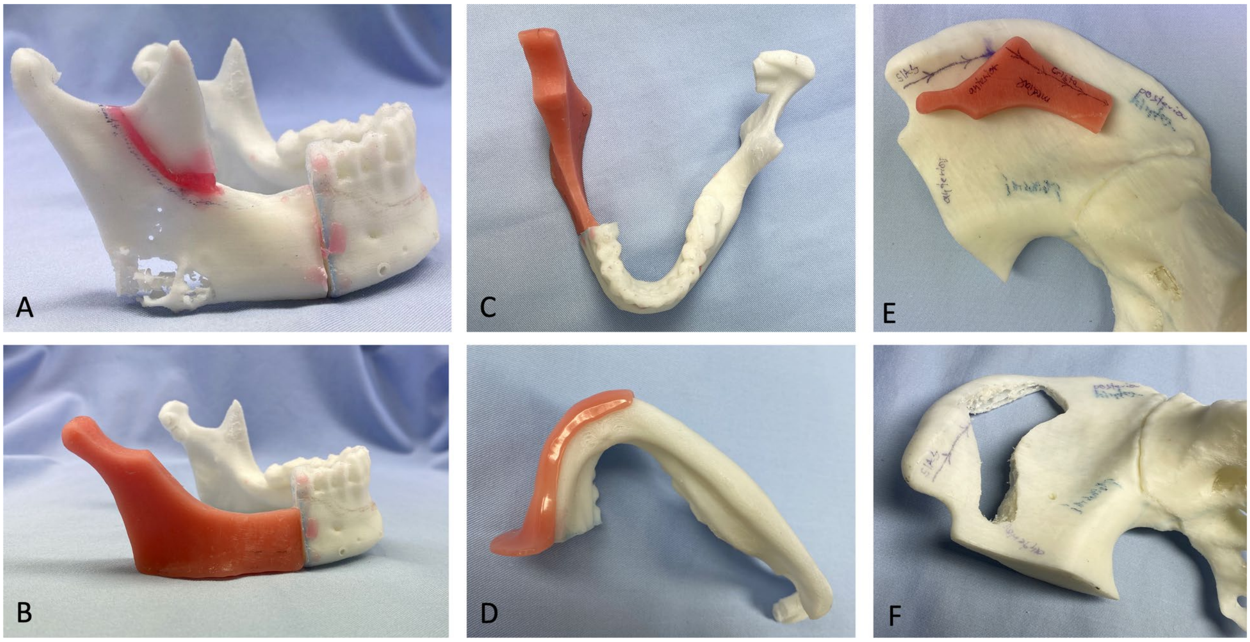

Fig. 6 In-house planning for surgery with 3D-printed models: resected mandible distal to tooth 45 (**A**). 3D-printed 'positive' cutting guide matching the mandibular defect seen from a lateral (**B**) and cranial point of view (**C**). Resection guide used for dissection of the mandible (**D**). Cutting guide in place for the medial iliac approach to harvest the DCIA flap (**E**). Stereolithographic model of the right ilium after the flap was cut (**F**)

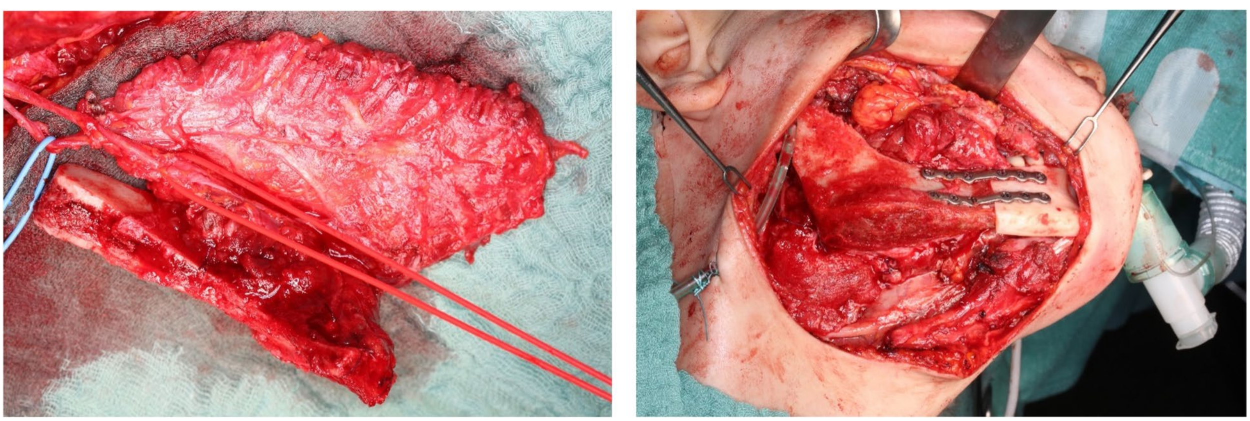

Fig. 7 Raised DCIA flap and reconstructed mandible

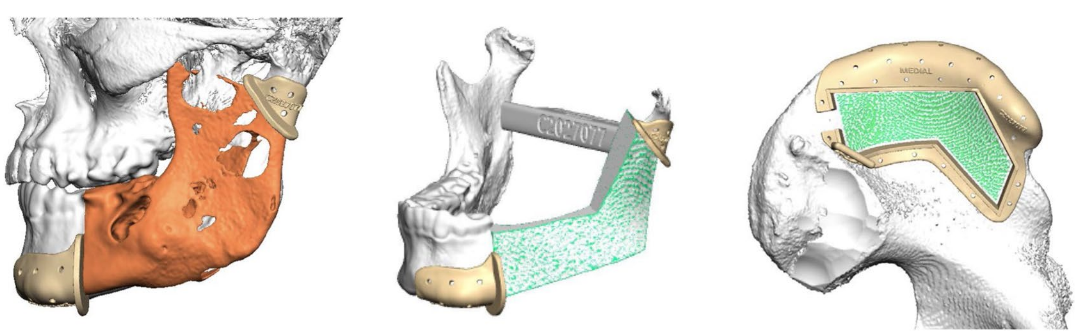

Fig. 8 Individualized CAD/CAM-based cutting guides after virtual surgical planning

Fig. 9 Upper left: orthopantomogram after plate removal following reconstructive surgery (Ewing sarcoma diagnosis, 27-year-old female patient). Lower left: en face image of the patient after reconstructive surgery; right: postoperative images after healing of the DCIA flap with the IO muscle

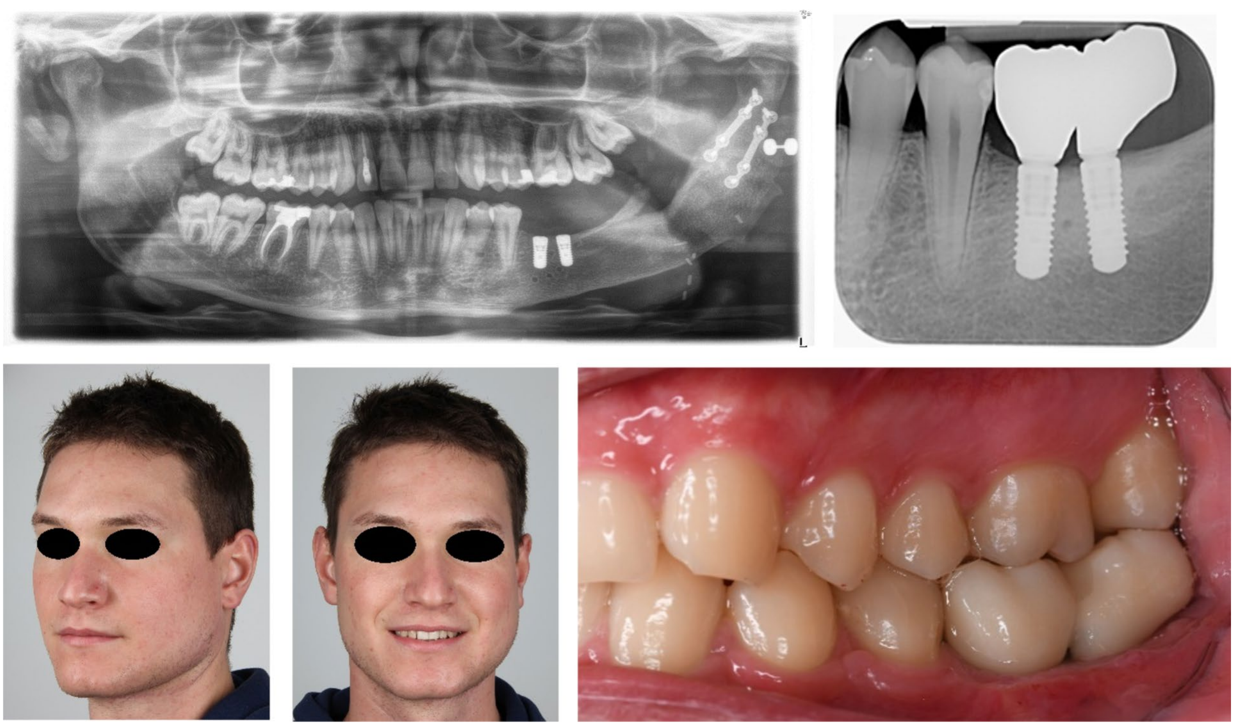

Fig. 10 Upper left: orthopantomogram after reconstructive surgery (keratocyst diagnosis); upper right: X-ray after dental implant placement; lower left: en face pictures of the patient after reconstructive surgery; lower right: postoperative outcome after dental rehabilitation

however, they reported lower reliability than fibula and scapula flaps [23]. In terms of compound defects involving the two layers “bone and oral lining”, raising an internal oblique flap pedicled by the ascending branch of the DCIA offers several advantages over a bulkier skin island approach. Its structural qualities as a pliable and thin graft prove to be valuable assets, simplifying the process of delineating intraoral and mucosal defects. In the standard fashion of raising the IO, the muscle remains attached to the crest in terms of a composite flap. If the crest is located caudally and the pedicle is located medially, the muscle is rotated medially (in terms of the ilium) and used to cover the defect above the bone and to cover the plate to avoid perforating the skin over time. However, this maneuver carries the risk of creating undue torsion or tension within the pedicle of the DCIA. As a result, not only the IO, but also the bone is at risk. With our new approach, we have to detach at least the attachment of the IO from the bone because the crest is preserved. In rare cases, there is no evident main ascending branch or an atypical course or origin of the vessel, so we cannot isolate one perforator. However, normally, the IO is completely cut and isolated, with its sole attachment being the ascending branch of the DCIA, whereby the flap is developed further from a composite flap to an intrinsic chimeric flap. Owing to its resulting (relatively) longer and more flexible pedicle, the flap can be positioned with increased autonomy and safety from the bone in comparison to the standard technique of raising an IO or a skin island [24].

In our experience, it is important to confirm the origins of the deep circumflex iliac artery and the ascending branch. The ascending and transverse branches should be distinguished first by tracing medially to the origins of the deep circumflex iliac artery and ascending branch to avoid confusion between the two branches of the DCIA [25]. In 4.3% of patients, the ascending and transverse branches originate directly from the external iliac artery [25]. In our experience (also the standard technique), this was never the case, and we had only one common trunk to anastomose.

Limitations represent (extended) mandibular composite defects, including large intraoral and extraoral fistulas due to the involvement of mucosa, mandible and skin (+soft tissue).

While an osseomyocutaneous flap can be utilized to reconstruct both mucosal and skin defects (composite defects), certain challenges accompany this approach using a DCIA [5]. The skin island can be bulky and somewhat challenging to position due to the susceptibility of the nourishing perforators to shearing and torsional forces. This becomes especially problematic when addressing mucosal intraoral defects since the skin paddle is situated on the external iliac crest bone [26]. One solution may represent sandwich flaps as a feasible solution for the management of huge mandibular composite tissue defects, including the obliteration of dead spaces, as described by Weitz et al. [27]. However, the utilization of a second flap (multiple flaps) for soft tissue involves two donor sites, requires two pairs of recipient vessels and can lead to prolonged surgical duration and heightened associated risks, such as higher rates of operating room take-backs for anastomotic issues and longer hospital stays than chimeric flaps [28, 29]. Another solution (which we prefer) represents chimeric bony flaps [29], i.e., subscapular system free flaps and peroneal artery-based flaps. However, these methods require sophisticated skills because of the advanced microsurgical perforator dissection experience needed. An evaluation from our experience is to be published.

According to the approach of Modabber et al. [5], we used a surgical guide with a slot to lead through the pedicle of the flap before fixation. As a consequence, depending on the origin and course of the ascending branch of the DCIA, it also has to be led through the slot to enable secure positioning of the surgical guide. This requires precise preparation.

Due to the weakening of the frame of the guide by the slot, the surgical guide showed mobility in its structure, which became noticeable when it was put on. Due to the unclear size of the distance between the edges of the slot, errors can occur in the exact transfer of the planning regarding the flap design. To rule this out, we created a rigid guide consisting of two parts enabling a frame without a slot that minimizes residual mobility and protects the pedicle.

If you use the guide with the slot, you could alternatively (after the pedicle is directed through the slot) place an additional spacer into the area of the slot to ensure the correct distance.

Our approach is particularly beneficial for reestablishing tongue mobility and facilitating early dental rehabilitation, which are pivotal aspects of effective oromandibular reconstruction. Over time, the flap undergoes denervation atrophy and transforms into keratinized mucosa, remarkably resembling attached gingiva [10]. Compared to bulky intraoral resurfacing with skin paddles, this method not only enhances tongue mobility, but also establishes ideal conditions for subsequent dental implantation.

When combined with associated fixed prostheses, dental implants exhibit a notably high rate of survival [30, 31]. Hence, dental implants hold paramount importance not only for edentulous patients but especially for oncologic patients undergoing rehabilitation after the reconstruction of composite defects. There are different opinions on the ideal timing of implantation. Immediate dental implant placement (IDIP) aims to achieve early osseointegration, potentially allowing for comprehensive dental rehabilitation at an earlier stage [32]. Allen et al. asserted that IDIP is a reliable approach for implant placement, with no notable differences in short-term complication profiles, and it does not hinder the initiation of radiotherapy, if necessary. Additionally, it appears to enhance the prospect of full dental rehabilitation [33]. Remarkably, in this series, 78% of patients who underwent IDIP completed dental restoration compared to only 15% of patients whose implants were placed in a delayed setting [33]. Other studies have raised concerns regarding immediate placement in patients with DCIA flap reconstruction: implant placement is time-consuming, thereby prolonging the surgical procedure and ischemic flap duration, which carries substantial risks related to the relationship between ischemic time and flap survival rate [15, 34]. Therefore, we insert dental implants after anastomosis. Using VSP and CAD/CAM technology, IDIP insertion at the correct angle and position is possible without any significant delay in the context of jaw reconstruction with microvascular surgery using a free flap. Nevertheless, in our clinical practice, we decide individually from case to case if we choose immediate or delayed implant placement.

Mobile peri-implant tissue can have a significant impact on the long-term stability of implants for overdentures. The absence of keratinized gingiva is associated with increased plaque accumulation, gingival inflammation and bleeding on probing [33, 35]. Additionally, a narrow width of keratinized tissue is associated with an increased risk of peri-implantitis, mucosal recession, marginal bone loss, and greater patient discomfort [36].

According to the extant empirical data, there is a discernible correlation between inadequate keratinized mucosa surrounding endosseous dental implants and increased plaque accumulation, exacerbated tissue inflammation, an elevated probability of mucosal recession, and increased attachment loss [37–40]. A substantial proportion of sites with keratinized gingiva measuring less than 2 mm consistently exhibit persistent inflammation, even in the absence of plaque accumulation [41, 42].

Bouri et al. [43] also reported that the deficiency of keratinized mucosa surrounding dental implants increases the vulnerability of the peri-implant region to tissue destruction caused by plaque. In the context of mandibular reconstruction through autologous bone grafting, it becomes imperative to proactively mitigate any form of inflammation to ensure the viability of the graft and prevent subsequent bone resorption.

For patients who have undergone reconstructive surgery, the early reestablishment of a durable and stable dental situation forms the cornerstone of quick rehabilitation. By minimizing the potential for complications and implant failure, we lay the foundation for successful reintegration of these patients into society. The use of the internal oblique perforator flap has demonstrated a swift transition into keratinized attached gingiva, making it an ideal choice for both immediate and delayed implantation a few months after the surgical procedure.

Conclusion

We have outlined a virtually planned technique for obtaining myo-osseous chimeric DCIA flaps using CAD/CAM cutting guides. The minimally invasive medial approach to raise a bicortical microvascular flap to reconstruct the jaws was extended to reconstruct composite (compound) defects by combining this technique with a new perforator-based raising of the internal obliquus muscle for additional reconstruction of intraoral soft tissue. This innovative approach preserves the ASIS and the iliac crest while also preserving crucial muscles, such as the gluteus medius, tensor fasciae latae or sartorius muscles, with reduced donor site complications. Consequently, it enhances both functional and aesthetic outcomes by utilizing a pliable and easily positionable internal oblique perforator flap, which transforms into an attached gingiva over time. This provides ideal conditions for early dental rehabilitation, enhancing quality of life.

Abbreviations

ASIS	Anterior superior iliac spine
CAD	Computer-aided design
CAM	Computer-aided manufacturing
CT	Computed tomography
DCIA	Deep circumflex iliac artery
IDIP	Immediate dental implant placement
IO	Abdominal internal oblique muscle
KM	Keratinized mucosa
OSCC	Oral squamous cell carcinoma
PMMA	Polymethylmethacrylate
QoL	Quality of life
VSP	Virtual surgical planning

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Author contributions

Oliver Bissinger and Elisabeth Maier have contributed equally to this work as first author. OB and EM designed the study. OB, EM (Innsbruck) and PP (Pilsen) performed the interventions. OB, EM and PE took the pictures and edited them. OB, EM, PE and PP wrote the manuscript. All authors were involved in the data collection, the evaluation and revised the manuscript. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki and the Ethical Committees of the Medical University of Innsbruck, Austria, and of the University Hospital and the Faculty of Medicine, Charles University in Pilsen.

Competing interests
The authors declare no competing interests.

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