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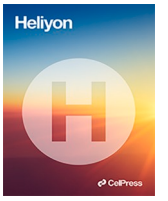

Case report

Short dental implants in microvascular free flap DCIA: A case report

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ABSTRACT

Placing dental implants in microvascular bone free flaps used for reconstructing the mandible or maxilla has been previously reported. However, there is scarce information available on the restorative protocol using short dental implants placed in a *deep circumflex iliac artery* (DCIA) microvascular free flap and the rationale behind it. This case report describes a 18-year-old patient referred to the hospital for numbness and dull pain of the left mandible, which she observed for three months. The patient underwent mandible resection and reconstruction using the DCIA free flap due to "giant cell lesion" on the left side of the mandibular angle. Short dental implants were placed and prosthetic reconstruction of the dentition involved in the resection was performed in a young patient with two integrated abutment crowns. The placement of short dental implants did not negatively affect the vascular pedicle and vitality of free flap. In our case report, two years after the healing, excellent aesthetic and function were accomplished with the DCIA flap followed by restoration with short implants.

1. Introduction

The introduction of free tissue transfer techniques revolutionized the field of reconstructive surgery and established the gold standard in mandibular reconstruction by allowing restoration of composite defects in a single stage. Vascularized bone grafts also provide a reliable medium for osseointegrated implants and allow surgeons to tackle previously overwhelming defects with much greater success [1]. Although the fibula free flap is the most popular and frequently used microvascular free flap for mandibular reconstruction, compared to the subscapula system and the iliac crest deep circumflex iliac artery (DCIA) free flaps, the latter may be

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the more favorable approach, when more bone stock is needed [2]. Also, a two-team approach may be employed in contrast to the scapula flap. The first report of a free tissue transfer from the superficial circumflex iliac artery, DCIA, the superior deep branch of the gluteal artery, and the ascending branch of the lateral circumflex artery was in the late 1970s [3]. Specifically to the reconstruction of the mandible, the first description of the application of an osseomuscular iliac crest flap was made by Urken et al., in 1989 [4].

The choice of an osseus flap is based on a conjunction of factors, such as the timing of reconstruction, the recipient site conditions, the location of the defect, and the amount of bone and soft tissue needed [5]. Fortunately, a network meta-analysis has shown that of 1513 patients receiving FFF, DCIA, scapula flaps, or osteocutaneous radial forearm flap, high and non-significantly different survival rates were observed for all these different flaps [6]. The DCIA free flap has been proposed as the first microvascular transplant choice for defects that involve the mandibular angle and body because of its dimensions and appropriateness for subsequent implant placement [7,8].

In a 10-year retrospective study of prostheses supported by implants placed in various osseous flaps, lower success was observed for fixed partial prostheses (93 %) compared to removable partial prostheses (100 %), although no difference was observed in survival between different flaps [9]. In contrast, different outcomes have been reported in another retrospective cohort, where 100 % survival was reported for implants placed in scapula flaps, 83 % in FFF, 80 % in radial composite free flaps, and 76 % in DCIA [10]. Remarkably, the implants failing were all standard diameter and length (4.1mm x 10–12mm length), according to a current classification system [11], and of a screw-tight fit design [10]. In a screw-tight fit implant design, extensive bone remodeling must take place after implant placement, since the osteotomy walls are commonly undersized in comparison to final implant diameter [12]. Therefore, significant bone remodeling occurs for osseointegration establishment [13], which may be challenging in an osseous microvascular flap. In contrast, plateau-root form implant designs have the diameter of the outer fins equivalent to the osteotomy walls, which eventually allow implants inner diameter to host the blood clot and form healing chambers, where bone rapidly evolves towards a haversian-like structure with increasing mechanical properties, as clinically corroborated [14,15]. Because there are contrasting findings in the survival of implants placed in osseous flaps, likely because safety protocols for implant placement, especially in head and neck cancer patients remain largely undefined [16], it seems important to explore more conservative approaches including rehabilitation with locking tapered short implants of a plateau-root form design. The survival rates of short implants varied between 74 % and 96 % at 5 years, depending on factors such as the quality of the patient's bone, primary stability of the implant, clinician's learning curve, and implant surface. Short implants can achieve results similar to those of longer implants in augmented bone and offer a treatment alternative that could reduce the need for invasive surgery and associated morbidity and be safer and more economical [17].

2. Case report

In this patient's case, for the reconstruction of the angle of the mandible, we chose a DCIA flap from the crest of the pelvic bone, due to the necessary volume of the bone component in the area of the mandibular angle. Postoperatively, we placed short dental implants in the DCIA flap, followed by prosthetic tooth reconstruction. A DCIA flap has a large volume and quality of bone tissue for mandibular segmental defects, excellent aesthetic shape for re-establishing mandibular continuity, and for implant placement [18]. Informed consent was obtained from the patient.

An 18-year-old patient was referred to the hospital for numbness and dull pain of the left mandible, which she observed for three months. The patient's personal history was without general illnesses, chronic medication or allergies. As part of the diagnosis, we performed a panoramic radiograph (Fig. 1) and a computed tomography (CT) scan (Fig. 2) of the patient, which was dominated by a lytic lesion of the left mandibular angle with cortical destruction of approximately 33 × 27 × 40mm, with a peripheral border of irregular round ossification - vs. periosteal reaction. Abdominal USG and chest X-ray were completed without pathological findings.

Fig. 1. Panoramic radiograph of osteolytic lesion angle of the mandible on the left side.

Fig. 2. CT scan confirmed destructive process of the angulus mandibulae l.sin.

Fig. 3. Resection part of the surgery, photo shows resection angulus mandibulae l.sin.

One of our diagnostic challenges was to try to conduct a magnetic resonance imaging (MRI) examination, which was not possible because of a panic attack from the patient's side. Histological analysis of the tumor conducted under local anesthesia with the diagnosis "giant cell lesion" (giant cell lesion) of the mandible (WHO 2013). Considering the clinical picture (rapid growth, large size of the lesion and aggressive growth), the pathologist concluded the form as aggressive.

Four weeks after the first visit to the clinic, we performed radical surgery in the scope of resection of the mandible and reconstruction using a DCIA flap from the right hip.

We chose the approach to the resection of the mandible tumor from the preauricular approach, which we extended submandibularly to the border of the submental area, sparing the ramus marginalis of the facial nerve. The resection of the mandible was performed from an extraoral approach with the adjacent attachment of the masseter muscle, the ventral border of the resection was distally to the tooth number 35, distal border to the retromolar area approximately 1 cm above the level of the mandibular foramen, teeth 36 and 37 remain part of the resection (Fig. 3).

The DCIA flap was removed simultaneously by the second operating team. As recipient vessels for DCIA flap microanastomoses, we chose the facial artery and vein, which we sutured with Ethilon 8-0 to the circumflex profunda iliac artery and its concomitant vein (Fig. 4).

We closed the donor site by suturing the muscle layer, drilling fixation holes in the iliac bone and applying the *Parietene Covidien mesh (*mesh for open and laparoscopic ventral hernia repairs by Medtronic) which we fixed to the iliac bone and the inner surface of the external obliquus muscle. Fixation of the DCIA flap using two osteosyntheses plates anteriorly and two osteosyntheses plates (by Synthes) posteriorly (Fig. 5). Postoperatively, we checked the vitality of the flap using a control USG Doppler.

The patient's postoperative recovery was favorable and very fast, on the fifth postoperative day the patient was fully upright. The histological conclusion of the bone resection with negative marginal rapid sections confirmed the preoperative histological diagnosis of a giant cell tumor of the bone. The patient was discharged to home treatment in the early postoperative period, with the need to wear a hip belt.

As part of the post-operative checks, we performed a control CT scan to exclude the presence of recurrence a control OPG to assess the healing of the bone flap. The patient's post-operative bite and occlusion position were satisfactory. We performed the second surgical procedure one year after the reconstruction of the mandible, using a DCIA flap. It consisted in the removal of the anterior osteosynthesis plates which could create an obstacle during the dental implant placement. (Fig. 6).

In region 37 we inserted a 4.5 × 6.0 mm short implant (Bicon LLC, Boston, MA, USA) and positioned it 4.5 mm subcrestally. Extrashort dental implants are placed subcrestally in bone microvascular free flaps because more bone remodeling is expected in such flaps when compared to implants placed in native bone [19]. The second was a 5.0 × 6.0 mm short Bicon implant which was inserted 5.0

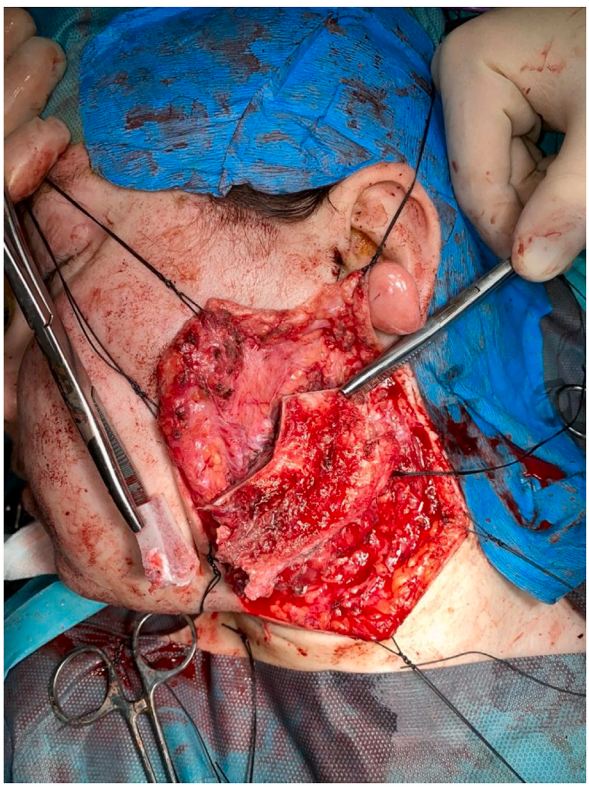

Fig. 4. Reconstruction of angulus with DCIA after microanastomoses.

Fig. 5. Panoramic radiograph after osteosynthesis angulus mandibulae with DCIA free flap.

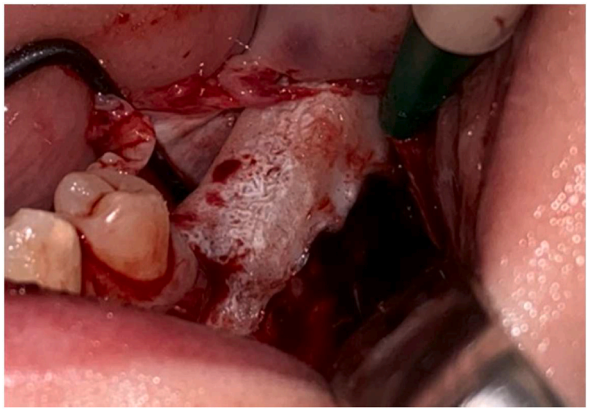

Fig. 6. DCIA free flap before placing dental implants.

Fig. 7. Panoramic radiograph after removal of osteosynthesis plates and insertion of short dental implants in DCIA free flap.

mm subcrestally in region 36. The bone chips obtained during implantation were applied to the area of the vestibular surface in region 37. The intraoral approach was sutured with a non-absorbable 5-0 monofilament. The postoperative panoramic radiograph showed successful implant placement (Fig. 7).

Finally, we introduced healing cups (Bicon LLC). Depending on the hypertrophy of the granulation tissues, we realized the individualization of the ingrowth rollers - their extension through the path of the laboratory, which enabled the modeling of soft tissues around the dental implants. Figs. 8–10.

For the restoration of this prosthodontic defect we used a full digital workflow (Fig. 11) and delivered two extra orally cemented zirconia crowns on universal abutments (Bicon LLC) 6 months after implant placement (Fig. 12). For both aesthetic and functional reasons we delivered a prepless composite overlay (Enamel Plus HRi) on the second premolar.

Following prosthodontic reconstruction, the patient is fully oral rehabilitated. At the end of our surgical and implant treatment we suggested orthodontic treatment due to bite edge to edge, but it was the patient's occlusion prior to surgery and it was her choice not to treat it. Postoperatively soft diet was recommended for two months. Masticatory function evaluation was beyond the scope of this case report.

3. Discussion

The need of tissue restoration due to trauma or oncological resection can be tackled by microsurgical transfer of tissue from multiple donor sites. Among the several types of bone free flaps, the relevance of DCIA has been less reported when compared to other treatment modalities [20]. DCIA free flap is an ideal type of microvascular bone free flap for the reconstruction of the mandibular angle due to its suitable volume and shape. It has been reported that a substantial bone area (22.8 cm^2) and length (7.79cm) can be transferred with the DCIA flap, along with a skin paddle surface area (117cm^2) which can be incorporated for integument and mucosal resurfacing [21]. The cortical bone of the ilium has been used to replace the mandibular or maxillary alveolar process, generating sufficient space for osseointegrated implants [22,23]. The pooled failure rate of the DCIA free flap has been reported to be 4 % and the complication rates for head and neck 57.37 % and of 40 % for limb reconstruction [21]. However, the literature seems scarce regarding the placement and restoration of short and extra-short dental implants in microvascular free flaps, and there are limitations in discussing data in this scenario.

The rationale for short dental implant placement in bone microvascular free flaps was the reduced ostetomy implant site preparation as well as the use of low speed drilling which allows the collection of bone from the drills for reinsertion around healing plugs. The use of low speed drilling compared to conventional drilling techniques have shown to result in comparable biological outcomes [24]. Also, from a prosthetic standpoint, bone maintenance around implants placed in the graft is of utmost importance. The presence of a gap at the implant-abutment interface has been associated with the presence of an inflammatory cell infiltrate and potential bone loss around implants [25]. The implant-abutment connection used in this case report is a purely tapered interference fit [26], also known as locking taper, which is a screwless connection with close fit to the implant well shown to be impervious to bacteria [27]. Previous clinical research has shown bone maintenance around locking taper connection and even bone gain in some circumstances [28,29]. In contrast, screwed implant-abutment connections such as tapered integrated screwed-in must have shown to present space at the implant-abutment interface which is prone to bacterial leakage, although evidence is yet to be presented regarding its correlation with bone crest loss [30].

Splinting or not-splinting implants has been a controversial topic, where several suggest that splinting must be made to increase resistance to lateral loads, decrease the risk of implant component fractures and reduce abutment screw loosening [31,32]. A meta-analysis comparing short implants to standard length ones have shown that clinical outcomes were not significantly different for splinted compared to non-splinted crowns, but improved peri-implant outcomes were observed for cemented (as in our case report) relative to screw-retention [33]. Comparable clinical survival has been reported previously for non-splinted compared to splinted short implants [34,35]. A 14-year follow-up study also reported the absence of differences for single and splinted implants showing similar respective outcomes of MBL (0.46 $\pm$ 0.75 and 0.37 $\pm$ 1.12 mm), success rate (93.86 % $\pm$ 24.11 % and 92.79 % $\pm$ 25.98 %), and survival rate (96.30 % $\pm$ 19.00% and 98.86 % $\pm$ 10.66 %) [36].

Comparison of implant survival among different free flaps are scarce, specially using short implants. One study has reported peri-implant bone remodeling of 14 fibula and 14 DCIA bone flaps treated with dental implants. Follow-up was carried out up to 3 years and although peri-implant bone resorption increased overtime, no significant difference between implants placed in fibula and DCIA flaps was observed [37]. The authors placed two types of screw tight-fit implant designs (Straumann and Camlog), and indicated that implant treatment in microvascular free flaps does not present long-term peri-implant stability. It was also suggested that close collaboration between surgical and restorative teams is key, since one important issue is the unfavorable implant-crown ratio and the mucosal hypertrophy [37]. Prospective clinical studies of different free flaps restored with plateau-root form implants, as used in this case report, are warranted.

A retrospective study of 41 implants placed in 13 patients who received DCIA flaps and were followed-up for a mean period of 48 months showed that only 3 implants were removed. One implant was removed due to peri-mucositis accompanied by gingival swelling, and two were removed at the request of the patient. Although no sign of peripheral bone loss was observed in 39 implants, peripheral gingival swelling and pain were reported and such implants were removed due to the risk of peri-implant mucositis. Conclusions should be drawn with caution since 4 different types of screw-tight fit implants were used in a small sample size. The authors suggested that the DCIA flap was suitable for reproducing the original contour of the 10 cases performed in the mandible and the other 3 in the maxilla [38].

Bone microvascular free flaps are frequently accompanied by vascular pedicle, which is in close proximity to the bone. It may be

Fig. 8. Intraoral view, after placing healing cups.

Fig. 9. Intraoral occlusal view, after placing healing cups

Fig. 10. Panoramic radiograph with individual healing cups.

speculated that by using short dental implants, the vascular pedicle and vitality of free flap was protected. In our case report, two years after the healing of the tumorous lesion, excellent aesthetic and function were accomplished with the DCIA flap followed by restoration with short implants.

Ethics statement

Informed consent was obtained from all patients for the PUBLICATION of all their data and/or images.

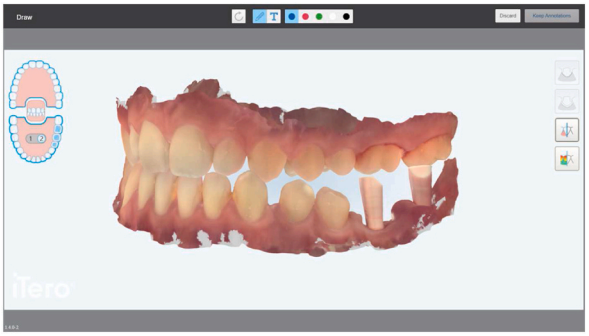

Fig. 11. Restoration of the defect with a digital workflow, last control in November 2023. Patient is satisfied with result, working in kindergarten as a teacher, without problems with eating, chewing and speaking.

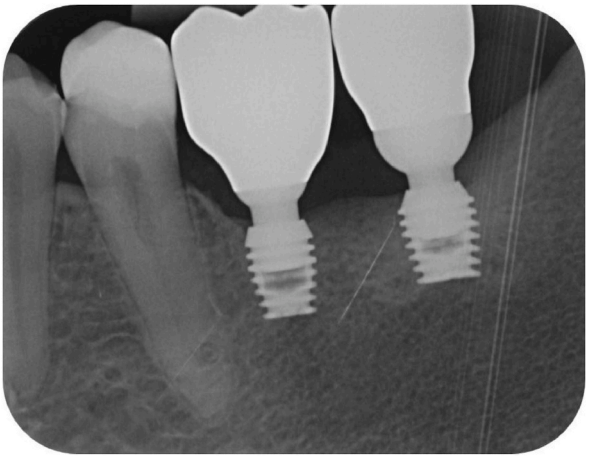

Fig. 12. Restoration of the defect with a digital workflow, last control in November 2023. Patient is satisfied with result, working in kindergarten as a teacher, without problems with eating, chewing and speaking.

Data availability statement

No research data to be shared has been collected since this is a patient case report. All patient information and data required for transparency of the work has been reported in this manuscript.

CRediT authorship contribution statement

Barbora Hocková: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Rastislav Slávik:** Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Basel Azar:** Writing – review & editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Jakub Stebel:** Writing – review & editing, Writing – original draft, Visualization, Validation, Investigation, Data curation, Conceptualization. **Dušan Poruban:** Writing – review & editing, Writing – original draft, Validation, Supervision, Investigation, Data curation, Conceptualization. **Estevam A. Bonfante:** Writing – review & editing, Writing – original draft, Validation, Supervision, Investigation, Conceptualization. **Rolf Ewers:** Writing – review & editing, Writing – original draft, Validation, Supervision, Investigation, Formal analysis, Conceptualization. **Adam Stebel:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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