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The fibula free flap for postresective reconstruction of the mandible in patients with advanced head and neck cancer

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Mandible reconstruction remains one of the most challenging problems for reconstructive surgeons. For the last two decades surgical techniques have significantly progressed from non-vascularized bone grafts through reconstructive titan plates to a wide variety of free flaps. Immediate mandible reconstruction associated with adequate skin resurfacing and soft tissue replacement may require composite flaps. The fibula has become the flap of choice for reconstruction of most segmental mandibular defects. Functional and aesthetic results are good-to-excellent for a majority of patients and donor site morbidity is minimal. This paper presents the indications, advantages and disadvantages of the fibula free flap. Basing upon own experience the authors present the anatomy and surgical technique of harvesting and insetting this flap.

Zastosowanie wolnego płata strzałkowego w poresekcyjnych rekonstrukcjach żuchwy u chorych na zaawansowane nowotwory regionu głowy i szyi

Rekonstrukcja ubytków poresekcyjnych żuchwy nadal pozostaje poważnym wyzwaniem dla chirurga rekonstrukcyjnego. Na przełomie ostatnich 20 lat dokonał się znaczący rozwój technik rekonstrukcyjnych, począwszy od nieunaczynionych przeszczepów kostnych poprzez zastosowanie płyt tytanowych do szerokiej gamy mikronaczyniowych kostnych płatów wolnych. Zdaniem wielu autorów skórno-podskórno-kostny wolny płat strzałkowy jest płatem z wyboru w rekonstrukcji większości poresekcyjnych ubytków żuchwy. Rekonstrukcja tym płatem pozwala na uzyskanie dobrego lub bardzo dobrego efektu funkcjonalnego i estetycznego u znamiennej większości chorych. W pracy przedstawiono wskazania, zalety oraz wady zastosowania tego płata. W oparciu o własne doświadczenia autorzy przedstawili anatomię oraz technikę chirurgiczną preparowania, modelowania rekonstruowanego odcinka żuchwy, wykonania mikrozespoleń naczyniowych oraz uzupełniania wyspą skórną płata tkanek miękkich.

Key words: fibula free flap, microanastomosis
Słowa kluczowe: wolny płat strzałkowy, zespolenie mikronaczyniowe

Introduction

The surgical treatment of mandibular and oral cavity tumours varies according to the histological type and stage of the disease. Immediate mandible reconstruction associated with adequate skin resurfacing and soft tissue replacement may require composite flaps. Although a variety of surgical techniques have been described for mandible reconstruction, the techniques that are commonly used include: nonvascularized bone grafts, reconstruction plates and vascularized osteocutaneous flaps.

Mandible reconstruction, especially of the anterior part is a true challenge for the reconstructive surgeon. Most of the defects consist not only of the bone, but also of soft tissues, i.e. muscles, mucosa and skin layer. Thus, it is necessary to use combined reconstructive modalities. Since large amounts of vascularized bone, soft tissue and skin can be transferred as a single flap, almost any defect of the mandible can be reconstructed within one, multistep operation. Of all the flaps currently known, the fibula has become the technique of choice [1, 2].

This fibula free flap (FFF) has recently become a more and more popular method of mandible reconstruction. It was initially described by Taylor in 1975 as a vascular bone transfer and subsequently it was presented by Chen & Yan in 1983 as a composite flap including the overlying peroneal skin. Most of malignant tumours of the mandible require composite resections wherein both the mandible and the affected extraoral and/or intraoral soft tissues are excised. Advantages of the FFF include ease of flap design and harvest, excellent quality and length of the bone, reliable skin paddle, two-team simultaneous work and low donor site morbidity [1]. Because the fibula receives both segmental and intraosseous blood supply, multiple osteotomies of the

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bone are possible to match the particular mandibular segment without devascularizing the osseous part of the flap [1-3]. Fibula bone lies in the deep posterior compartment lateral to the tibia. There are four muscles that surround it, i.e. the extensor digitorum longus, the posterior tibialis, the peroneal muscles, and the flexor hallucis longus. Blood supply is provided by branches of the peroneal artery, which lies with two concomitant veins between the tibialis posterior and the flexor hallucis longus muscles. The vascular pedicle (Figure 1) has sufficient length and it is of a large diameter [4].

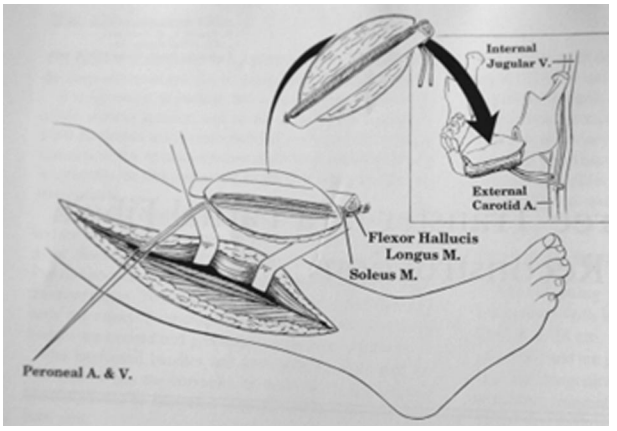


Figure 1. Anatomic relations of fibula, skin island and peroneal nerves

Cases reports and operative technique

Case No.1

A 47-year old man was admitted to the Dept. of Oncological Surgery of the Maria Sklodowska-Curie Memorial Cancer Centre and Institute of Oncology in Gliwice, with histopatologically proven squamous cell carcinoma of the lower left gingival, infiltrating the mandible and with a positive left submandibular node (T4 N1). The disease was staged basing on clinical examination, ultrasound, panoramic X-ray and CT.

Case No. 2.

A 57-year old woman was admitted to the Dept. of Oncological Surgery of the Maria Sklodowska-Curie Memorial Cancer Centre and Institute of Oncology in Gliwice. In this case the tumour of the menthal skin was diagnosed as squamous cell carcinoma with mandibular infiltration (T4 N2). Bilateral palpable submandibular neck nodes have been proven histologically in the course of fine needle aspiration biopsy.

In both cases the tumour was infiltrating the mandible, in the first case – the lateral and in the second case the anterior part of the bone. Radiotherapy as sole treatment would require dose escalation to achieve moderate probability of local control. Consequently, it could also result in the increase of the risk of severe complications including mandible necrosis and fracture. Therefore, combined treatment strategy was considered, i.e. resection plus reconstructive surgery with postoperative irradiation. The type of reconstruction being the best choice for the patients was the crucial issue. Basing on our experience we had decided to use the osseo-septo-cutaneous fibula free flaps (FFF) for reconstruction of composite post-resection defects of both the mandible and the soft tissues. Bilateral supraomohyoid lymphadenectomy with *en block* excision of the tumour plus partial mandibulectomy was performed (Figure 3a, 5b). The resection was macroscopically radical and histopatologically negative margins were proven by frozen sections. In the first case the left lateral part of the mandible, the gingiva and the floor of mouth were reconstructed and in the second patient the flap was ued

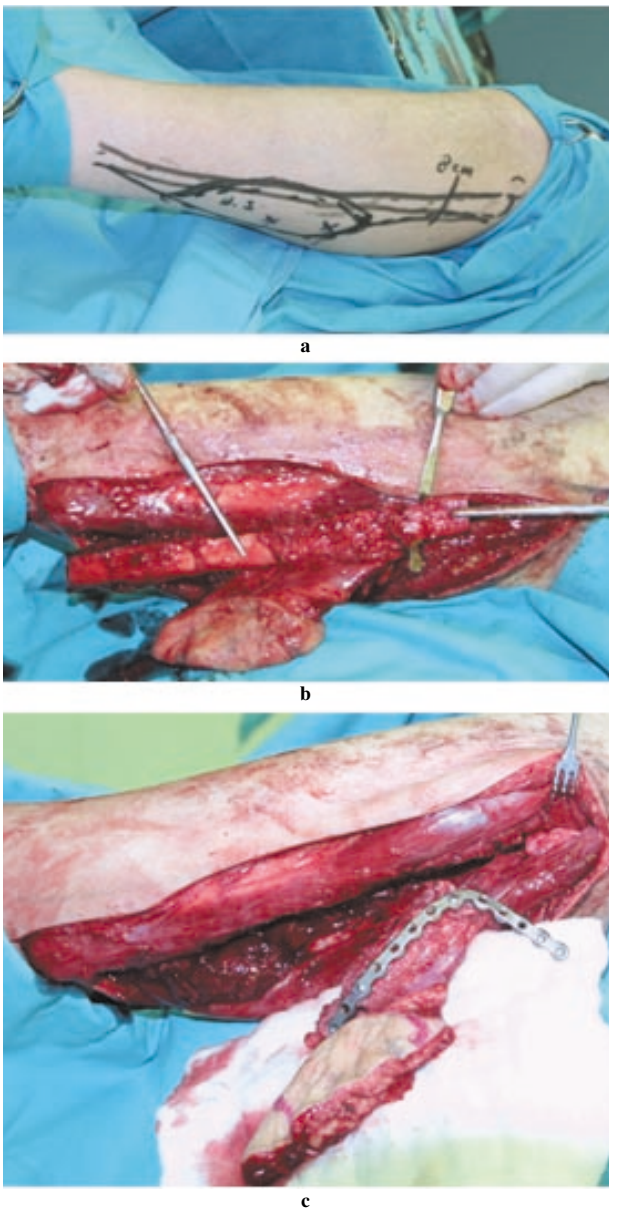
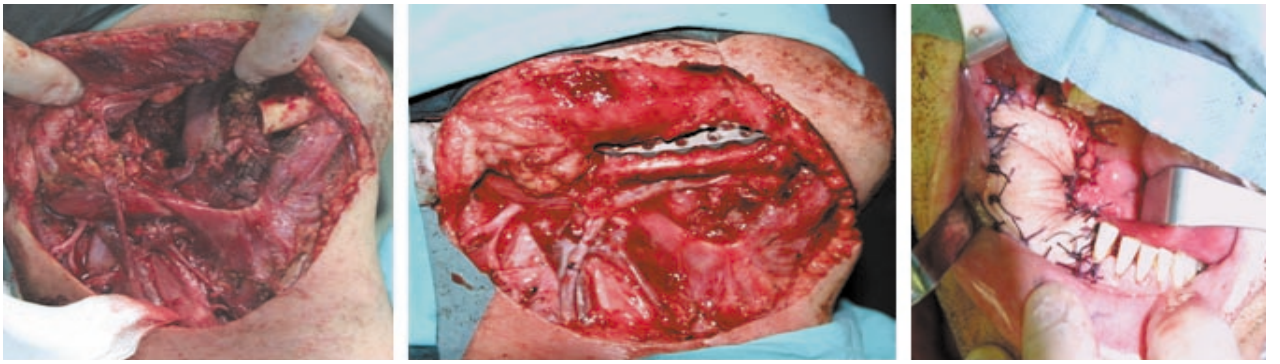


Figure 2. a. Case No. 1 – Design of fibula bone and skin island contour with three cutaneous perforators
b. Case No. 1 – Fibula free flap after harvesting
c. Case No. 1 – Shaping of the bone basing on a titanium reconstructive plate



a b c

Figure 3. a. Case No. 1 – Post-resectional defect of lateral mandible with surrounding soft tissues and mucosa ready for reconstruction
b. Case No. 1 – Fibula free flap after inset, the microanastomoses shown
c. Case No. 1 – Skin island of the flap used for oral mucosa resurfacing

Figure 4. Patient No. 1 – The mandible reconstructed with the fibula free flap; one month after treatment completion [surgery (resection and reconstruction) and postoperative radiotherapy]

to reconstruct the anterior mandibular defect together with the menthal skin.

The flaps were designed on patients in supine position. The contour of the fibula and the skin islands was marked over the skin surface (Figure 2a, 5c). Septocutaneous perforators were identified with transonic Doppler. (One or two sizable perforators are sufficient to provide blood supply to a skin island of approximately 22-25 cm in length). At least 6 cm of the distal fibula was left intact to prevent ankle instability.

The outlined skin island was incised to above the deep fascia. Both the anterior and the posterior crural

a b c

Figure 5. a. Patient No. 2 – Squamous cell carcinoma of menthal skin. Design of skin incisions
b. Patient No. 2 – Post-resection defect of the anterior mandible with menthal and submandibular skin loss
c. Patient No. 2 – Design of the fibula bone and skin island contour with three cutaneous perforators

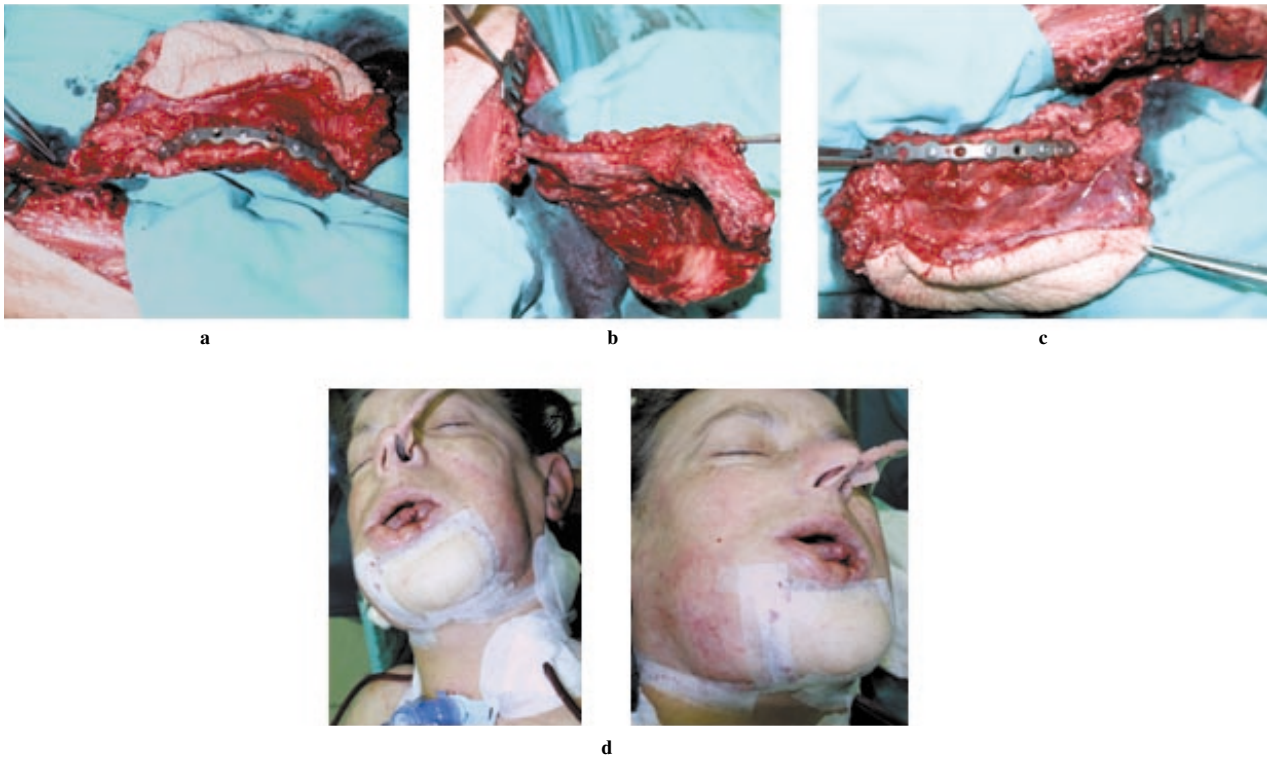


Figure 6. a, b, c. Patient No. 2 – The fibula free flap after shaping for anterior mandible reconstruction (still on the lower extremity)
d. Patient No. 2 – view immediately after surgery completion

septum was identified. Dissection of the fibula proceeded in the anterior plane. The anterior muscle compartment was detached from the bone. Next, we performed distal and proximal osteotomies. Then the anterior crural septum was divided and the extensor muscles were detached from the bone. The interosseous membrane lying under those muscles was cut. During this step the distal ends of the peroneal vessels were cut and ligated. Then, the vessels were easily identified in the proximal part. A minimal cuff of muscle was included with the peroneal vessels to prevent the sectioning the septocutaneous perforator vessels. After that the soleus muscle was separated from the fibula. Finally, the pedicle was followed proximally to its origin in the tibioperoneal trunk.

The reconstruction titan plate was shaped according to the natural curvature of the mandible. The osteotomies and shapings were performed before detaching the flap from the leg to decrease the time of ischemia (Figure 6a, b, c). Once the flap was detached, it was transferred to the recipient site and the bone ends were fixed to the mandible. Our goal at this step was to reproduce the inferior mandibular border contour. After that, in the first case the skin island was used for intraoral resurfacing and, in the second case, for menthal skin defect reconstruction. Finally, the peroneal vessels were anastomosed

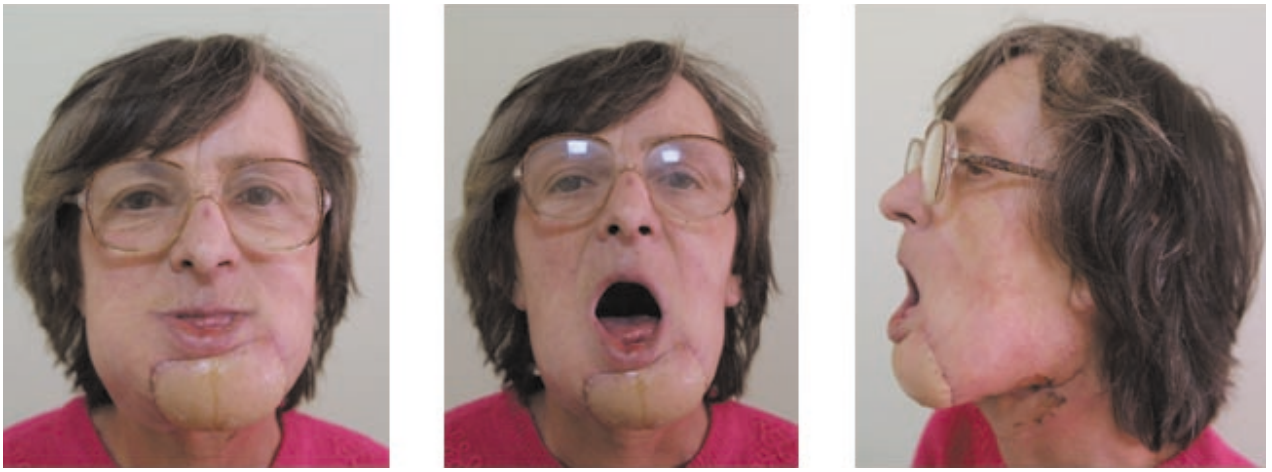


Figure 7. Patient No. 2 one month after treatment completion [surgery (resection and reconstruction) and postoperative radiotherapy]

under the microscope. In both cases the facial artery was selected as the recipient vessel. He internal jugular vein was chosen for the end to site anastomosis. The donor sites were closed with a skin graft after dividing the pedicle. Conventional Doppler was used to monitor the vascular pedicle of the flap. Postoperatively the quality and quantity of the pedicle blood flow was also monitored by angiotomography.

Postoperative radiotherapy was started 35 days after surgery and a total dose of 60 Gy, conventionally fractionated, was delivered in 42 days. Radiotherapy tolerance was quite good and acute tissue reactions were moderate (Figure 4, 7).

Discussion

Patients with locally advanced cancer of the base of skull and oral cavity infiltrating bone structures still form a therapeutic problem. Radiotherapy as a sole treatment is sporadically radical and the risk of severe late complications usually exceeds the probability of long-term local control.

From the point of view of reconstructive surgery the effect of mandible reconstruction depends on the patient's age, general health, lifestyle, tumour localization, stage of disease, infiltration of surrounding tissues and also on the experience of the surgical team. It may range from conservative (but oncologically correct) cancer resection alone to a major resection followed by soft tissue and osseous reconstruction, alveolar ridge extension and osseo-integrated dental implants.

The mandible is essential to maintain correct mastication, deglutition and speech. Mandibular defects, particularly involving the lower border of the mandible cause significant deformity. Functional deficits after mandibulectomy depend upon the extent and localisation of the resection [5]. It is essential to reconstruct the segmental mandibular defect immediately because it provides optimal esthetic and functional result and is indicated for the majority of patients [6].

Mandible reconstruction is commonly performed either with reconstruction plates and regional flaps or with microvascular free flaps. It is well recognized that osseous reconstruction of the mandible remains necessary for optimal restoration and occlusion. In the past a variety of metal/plastic elements have been used to restore mandibular continuity. The advantage of these techniques was that they did not require further surgery for a donor site. Their disadvantage, however, was the possibility of soft tissue dehiscence, fracture of the implant and plate loosening. Although non-vasculrized bone grafts are acceptable for small mandibular defect reconstruction, they nevertheless have some drawbacks. These tissues are limited in width and length, their blood supply is random and therefore its viability is not ensured. Vascularised bone offers significant advantages over conventional or traditional methods of bone grafting [7]. Microvascular surgery has opened up a new perspective for head and neck reconstruction and the defects, which were previously unimaginable, now can be satisfactorily reconstructed. It also provides the possibility to perform resections that were previously considered impossible. Osseous free flap usually allow for the best functional and aesthetic results. These procedures consist of many steps, which include harvesting, shaping and fixation, insetting, microvascular anastomoses and soft tissue closure. Correct preoperative planning increases the safety and improves the aesthetic and functional results. The fibula free flap has proven to be a very reliable source of vascularised bone and, also, the overlying skin has a reliable vascular pattern. The cortical nature of this long bone gives it tremendous strength. It is also suitable for osseo-integrated implants and is truly a class of its own for extensive reconstruction. The FFF is indicated for all anterior and most lateral defects. It is the flap of choice for the majority of mandibular defects, except for a few select situations in which the radius, the scapula or the iliac crest may constitute a better choice [2].

The major disadvantage of the fibula is that it has a relatively short vascular pedicle, although it can be elongated by stripping some of the periosteum and sitting the bone graft more distally. The fibula provides a highly acceptable donor site, but special care must be taken to preserve sufficient fibula length both proximally and distally to in order to provide knee and ankle stability. It is also important to put some effort into protecting the common peroneal nerve. In those clinical situations in which more bulk is required a part of the soleus muscle can also be included within the flap.

Although the indications for free flap reconstruction are considered individually, there is no doubt that in those cases where surgery has to be combined with post-operative radiotherapy, long-term functional and aesthetic resulta are significantly better than with other reconstructive techniques. The presented cases support the opinion that reconstruction of the mandible with free flaps significantly increases functional and aesthetic outcome and quality of life, as compared with non-vascularized bone grafts or titan plates, and moreover, it may offer higher chances of local tumour control.

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