Use of the Buccal Fat Pad in Maxillary and Sinus Grafting of the Severely Atrophic Maxilla Preparatory to Implant Reconstruction of the Partially or Completely Edentulous Patient: Technical Note

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Purpose: To examine the use of the buccal fat pad (BFP) for correction of maxillary osseous defects, preliminary to dental implant reconstructions, and to present patients in whom this technique was used. **Materials and Methods:** The blood supply of the BFP was investigated with a special laser Doppler flowmetry fiberoptic probe in situ before herniation and after placement of the pedicled BFP over maxillary bone grafts. **Results:** The possibility of using the BFP pedicle flap to provide an immediate blood supply to a recipient site was confirmed, as it promotes rapid neo-vascularization of the grafted material over which it is placed. No complications were seen in the present patients. **Discussion:** The BFP has an additional protective function of providing for a multiple-layer wound closure over all types of maxillary bone grafts, thereby preventing graft exposure and enhancing success. **Conclusions:** With its high blood flow, the BFP may offer protection and early blood supply to maxillary and sinus bone grafts. (Int J Oral Maxillofac Implants 2002;17:424–428)

Key words: bone grafts, dental implants, laser Doppler flowmetry, maxilla, maxillary reconstruction, regional blood flow, sinus graft, surgical flaps, titanium

The successful osseous reconstruction of small and major maxillary jaw defects by bone grafting is dependent on the early physical protection of the graft from trauma and micromotion and the establishment of a blood supply to the graft. Physical trauma to the region or movement of the graft can expose the graft and lead to non-union between it and the host tissues, and perhaps subsequent failure of the graft. Should a vascular supply to the graft not develop from the host tissues, then the graft may also fail. Both of these prerequisites can be aided by judicious use of the buccal fat pad (BFP) as described by Heister.[1] This structure was also referred to as the corpus adiposum buccae or Bichat's fat pad, after Bichat, who provided histologic detail on the structure of this tissue.[2] The BFP is an encapsulated, rounded, biconvex fatty structure located between the buccinator muscle medially and the anterior margin of the masseter muscle and the mandibular ramus and zygomatic arch laterally (Fig 1).

The BFP was first utilized in the closure of an oronasal fistula by Egyedi[3] and later as a free graft for intraoral defects by Neder.[4] Others have expanded on its use as a pedicle graft for particular oral defects,[5–16] while plastic surgeons have described its value in facial sculpturing for malar augmentation[17,18] and augmentation along the pyriform fossae for midface retrusion.[18]

The objective of this article is to provide and discuss a preliminary report on the clinical use of the BFP in maxillary and sinus bone grafts by the presentation of 3 cases, and to confirm the relative blood flow in the BFP by laser Doppler flowmetry (LDF).

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MATERIALS AND METHODS

Equipment

The technique and use of LDF follows the same procedure as previously reported.[19] In brief, the Doppler effect describes the frequency shift in radiation emanating from a moving object. Light beams interacting with stationary objects do not show the Doppler effect. For reflected light, this shift is proportional to the difference in velocity between light at the source and that returning from the object. Within tissues, moving blood cells and adjacent tissues scatter the incident light, but only the moving blood cells will cause a frequency shift to a monochromatic laser light according to the Doppler principle. The data observed are the blood flux (movement of blood).

The equipment used in this study was a laser blood perfusion monitor (DRT4) with laser Doppler probes (Moor Instruments, Axminster, United Kingdom), which utilized a low-power, temperature-stabilized laser light source output of 780 nm. The DRT4 is a dual-channel machine capable of recording from 2 separate probes simultaneously, together with a temperature sensor probe. The DRT4 bandwidth was set to the range 20 Hz to 15 kHz. The data acquisition rate was set at 40 data points per second with an integration time of 0.1 second and was recorded directly to the DRT4. A round-headed light-transmitting probe, with a diameter of 2.5 mm and flexible cable, was used to take multiple readings from the tissue surfaces and internal mass of the BFP. The probe was hand held and prepared by scrubbing with 4% w/v chlorhexidine gluconate (Hibiscrub, Zeneca, Macclesfield, United Kingdom), washed with saline, and then scrubbed with 70% medical-grade alcohol before being packaged into sterile instrument tubing ready for use. Blood flow or flux was expressed as arbitrary units (AU). The DRT4 was supplied calibrated by the manufacturer. Measurements of blood flow at each site were displayed and stored as a continuous graph. Five seconds was chosen as a standard noise-free period for recording, from which the average flux was calculated using DRTsoft software (Moor Instruments).

As a control, recordings were made of the blood flow inside the BFP in situ and the surface of adjacent oral tissues, including the vermilion border of the lips and mucosal aspect of raised buccal and palatal periosteal flaps within the same subject. Final blood flow readings were taken at the end of the procedure with the pedicled BFP in its recipient site prior to flap approximation and wound closure.
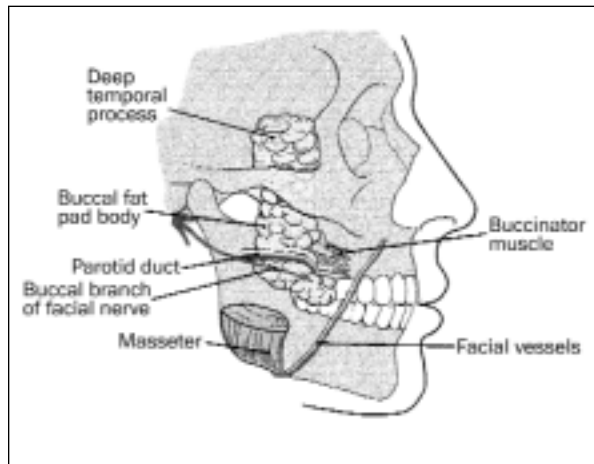

Fig 1 Anatomical location of the BFP relative to adjacent maxillofacial structures.

Clinical Procedures

Patients were given full information and details of procedures before giving written consent. A total of 3 subjects were included in the investigation.

Once routine bone bed preparations were completed with block grafts or particulate bone stabilized with titanium mesh and fixed with bone screws, the BFP was exposed. Incisions were made along the crestal region of the posterior maxillary alveolus, and full-thickness buccal periosteal flaps were raised from the posterior alveolus. A 1-cm incision was made through the buccinator muscle just behind the zygomatic buttress and the buccopharyngeal membrane. Blunt dissection to enter the BFP capsule was performed by direct probing with Mayo-Hegar forceps. Entry was signaled by the immediate herniation of some of the capsule's contents when external pressure was applied below the zygomatic arch. The forceps were then used to gently grasp the contents, which were drawn out of the capsule (Fig 2). This was done in a gentle, gradual teasing motion so as not to rupture the integrity of the mesentery that bound the fat cells together. Careful use of a blunt aspirator is recommended. Caution must be taken not to exert too much traction so as not to disrupt the membrane or damage the long buccal nerve branches of the facial nerve travelling in the fascial space with Stenson's duct. Once thoroughly freed, the fat omentum was extended up to the midline as a pedicled flap. Careful closure with resorbable sutures was used to fix this fat tissue over the bone graft onlays and/or particulate graft and titanium mesh.

Fig 2 Appearance of fat cells bound by mesentery after being drawn from the capsule.
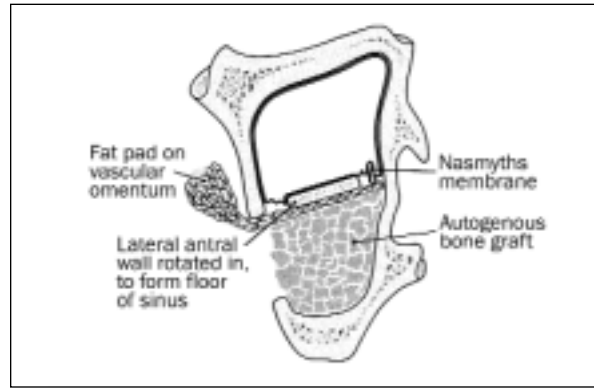

Fig 3 Diagram illustrating the concept of the pedicle flap of fat cells draped into the superior aspect of the maxillary sinus to lie beneath the elevated sinus membrane and/or the infractured lateral sinus wall, supported inferiorly by the sinus graft.

Patients

Patient A, a woman aged 70 years, presented for maxillary reconstruction of an atrophic edentulous maxilla in preparation for dental implants, without sinus grafting, utilizing the iliac crest as a donor site under general anesthesia. The severely resorbed anterior maxilla was reconstructed with onlays of cortical iliac crest block grafts, which were then overlaid with titanium mesh, with particulate marrow and cancellous bone interposed between the blocks.[20] The BFP was accessed bilaterally and the contents were drawn to the midline as a pedicle graft to cover the whole bone graft site.

Patient B, a woman aged 65 years, had the same operation as Patient A plus bilateral sinus grafts. Anterior grafting followed the same procedure as for Patient A, but the BFP was utilized for the sinus grafts only. Following sinus access and elevation of the sinus membrane as previously described,[21] the BFP contents were draped into the sinus to line the internal surface of the elevated membrane (Fig 3). Once in place, the graft material was placed into the sinus and packed gently against the fat pad until all the space was filled. The access window was closed without a membrane by normal flap closure. In this situation there was insufficient volume of BFP for layering on the anterior maxillary reconstruction, which was similar to that for Patient A (cortical onlays together with titanium mesh and particulate marrow and cancellous graft).

Patient C, a 64-year-old woman, had premaxillary bone reconstruction using autogenous cortical blocks procured from the mandibular symphysis as onlays. At the same time, an oroantral fistula (OAF) was closed on the right side. In this patient, the pedicled BFP graft on the right was utilized to close the OAF; this was undertaken by gentle traction on the BFP to release approximately 4 cm of fat on its omentum and packing it into the OAF after appropriate preparation and excision of the epithelialized fistula.

Alternatives for closure of the OAF included: *(1)* filling the OAF abundantly and suturing with vicryl (Vicryl Rapide, Ethicon, Edinburgh, United Kingdom) allowing secondary epithelialization; *(2)* overlying the fat graft with an additional Thiersh free graft from the palate; or *(3)* utilizing an additional buccal advancement flap to establish a 2-layer closure. The left BFP was pedicled to cover the cortical blocks of the premaxillary reconstruction and secured using resorbable sutures (Vicryl Rapide).

RESULTS

Graphic displays of recordings demonstrated pulsatile effects in all the different tissue types sampled; namely, BFP contents, periosteal surface of palatal flap, buccal flap, ventral surface of the tongue, and the vermilion border of the upper lip. The strongest pulsatile flow signal was found in the BFP and the weakest in the raised buccal periosteal flaps. Results are listed in Table 1. The magnitude of blood flow in the BFP was reduced by over 50% when relocated to its recipient site as a pedicled flap.

Patients healed normally with no complications. Primary healing occurred in all sites. There were no exposures of either cancellous or cortical grafts closed with the pedicled BFP. At second-stage

surgery for implant placement, bone quality in the sinus grafts was deemed to be similar to D2 (dense to thick porous compact to coarse trabecular bone when drilling) according to Misch.[22]

DISCUSSION

The results of this preliminary investigation using LDF confirmed positive blood flow in the BFP in situ and as a pedicle flap. The second set of BFP data, obtained when the pedicled BFP was in its recipient site, revealed a 50% reduction compared to the previous readings. This suggested that the pedicled BFP could provide critical vascular support to the mucus membrane covering and to the bone grafts, promoting both calcified and soft tissue healing. The graft may serve as a bed for granulation tissue formation to reduce dehiscences in the soft tissue layer if the mucosal layer becomes perforated. The graft also physically obliterates dead space and acts as a soft tissue barrier to fluids and infection. In addition, the BFP pedicle graft facilitates a 2-layer closure of the overlying soft tissues, where graft exposures and dehiscences from oral function may lead to catastrophic failure of the procedure.

The data recorded by LDF ranged from 55.8 AU in the BFP in situ to 7.3 AU, recorded on the mucosal surface of buccal flaps. Flow in the BFP was much greater than in any other tissues measured. This may be explained by the fact that the sensory probe was placed directly into the BFP tissue, whereas for the other sites, only surface readings were made. The low values seen in the raised periosteal flaps reinforce the importance of maintaining the viability of flaps by well-placed incisions made carefully so that the vital blood supply is not critically reduced. In implant reconstructions, loss of a flap may result in exposure and failure of the procedure. A 2-layer tissue closure helps prevent this.

The success of sinus grafting is dependent primarily on the neo-vascularization of the graft mass, which is reported to derive mainly from the sinus floor. Similarly, studies have shown that the greatest amount of new bone formation occurred in regions closest to the sinus floor, independent of the materials used.[23–26] Wong[19] observed the blood supply of the elevated sinus membrane (approximately 12 mm above the sinus floor) to be similar to that of the graft beneath it at 6 months healing time using irradiated cancellous allograft alone. The blood flow in this region was 30% lower than that within 5 mm of the sinus floor. In addition, the same region was histologically verified by quantitative backscattered electron imaging to be of low bone volume com-

Table 1	Mean Blood Flow Readings	
Location	**Blood flow (AU)**	**SD**
Buccal fat pad in situ	55.0	3.0
Buccal fat pad pedicled	22.9	3.2
Buccal flap mucosal surface	7.3	1.4
Palatal flap mucosal surface	16.0	3.6
Vermilion border upper lip	42.5	6.8

pared to regions within 5 mm of the sinus floor.[19] BFP was used by the authors in this investigation to overlay the superior aspect of sinus grafts so as to provide an additional and immediate blood supply to the graft and thereby improve graft vascularization and bone formation. This layer then lies beneath the overlying elevated sinus membrane to provide additional protection and, particularly, an additional nutrient supply to the graft. The BFP pedicle flap so placed fulfils a function as described above for jaw reconstruction and correction of defects. The authors are not aware of any data or histology currently available to provide evidence of value. Although anecdotal, the authors have noted good-quality bone formed in regions overlaid with the BFP pedicled flap. Sinus grafts treated by this procedure exhibited a bone quality of D2 as described by Misch[22] in site preparation for implants.

Unfortunately, in maxillary reconstructions when the anterior maxilla is to be grafted at the same time as sinus grafts, the BFP will be insufficient in volume to serve both functions bilaterally. Patient B demonstrated a solution: the BFP was used for sinus grafts, and titanium mesh and particulate marrow and cancellous bone, as described by Boyne,[20] were used for the anterior grafting. This type of graft is purported to have greater resilience against infections when dehiscences do occur.

After 2 years, there have been no abnormal facial disturbances in the use of the BFP, but caution must be advised in the use of this technique in patients who present with poor facial skin tone, associated with deep facial lines, as reduction of the BFP in situ may accentuate narrowness of the face and perhaps accentuate these features. In those patients who would benefit from this technique, the problem should be discussed whereby cheek augmentation and or free fat grafting can be offered concomitantly.

Ramirez[18] observed less than 1% temporary paresthesia of the long buccal nerve in 150 cases of BFP use, but also reported temporary weakness of the orbicularis oris and buccinator muscles in 1 patient, who also underwent fat injection techniques for correction of facial contours. It was not known

which procedure was responsible for the muscular weakness. In the present experience in 2 patients not reported here for OAF closure, such complications were the result of tension on the facial nerve branch. Both occurrences were temporary and generally resolved after a period of about 4 weeks. These complications can be avoided by careful wound closure, with sutures that avoid the nerve structures. Facial swelling will occur if lymphatic drainage is disrupted by careless mishandling, ie, tearing of the BFP capsule. Atraumatic handling and gentle herniation with use of a blunt-ended aspirator will help to prevent complications.

Contraindications to this technique are: presence of pathology, lipodystrophy, angioneurotic edema, sarcoidosis, and surgical history of cosmetic surgery in this region, where liposuction may have previously depleted the volume of BFP. The main advantage of this technique is that the surgical procedures are relatively simple, do not require specialist microsurgical skills, and are performed with minimal divergence of the surgical field. It is important that operators are familiar with the surgical techniques and anatomy of the region to avoid unnecessary complications.

CONCLUSIONS

This preliminary study revealed a high blood flow inside the BFP in situ, with an expected temporarily reduced vitality as a pedicled flap. All the patients treated with the BFP were observed to follow satisfactory healing with no complications of graft exposure or sensory change in donor or grafted regions. The use of the BFP may offer additional advantages for protection and early blood supply to maxillary and sinus bone grafts.

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