British Journal of Plastic Surgery (1987), **40**, 274–277

Reconstruction of the middle third of mandible

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Summary—The radial forearm flap is established as a suitable method of providing bone with soft tissue lining or skin cover in reconstruction of the mandible. A simple and effective method of modelling the radius to provide the appropriate contour to the anterior arch of the mandible is described.

The free radial forearm flap ("Chinese flap") was originated in 1978 by Drs Yang Guo Fan, Chen Bao Qui and Gao Yu Zi in Peking (Song, 1982). Mühlbauer *et al.* in 1982, Soutar *et al.* in 1983, Matthews *et al.* in 1985 and others have comprehensively discussed the technique of raising the flap and mentioned advantages over other potential flaps in the reconstruction of mandibular defects. About 14 cm of radius can be harvested within the free flap thus providing a long segment of bone for reconstruction. There is, however, little information in the literature on methods of modelling the radius to provide a good contour to the anterior mandible. We have used a simple method of riberration of the hemi-radius within the free flap combined with Champy plate fixation to provide a satisfactory reconstruction of this region in two patients.

Case 1

A 67-year-old ex-smoker (HS) was admitted with a mandibular defect following resection for osteomyelitis. He originally presented in early November 1982 with persistent toothache, weight loss and an ulcer on the anterior lower alveolus. Biopsy of this showed poorly differentiated carcinoma and a portion of the mandible was resected. The defect was reconstructed with an iliac crest bone graft using nasolabial flaps to cover the floor of mouth defect. This graft became infected and was removed together with adjacent mandible. The resultant defect was reconstructed with a bone graft from the opposite iliac crest. When this became infected it too was removed with more adjacent bone. The defect was splinted with a plate and when this became infected, the patient was referred to us.

In January 1984 the plate with adjacent bone was removed and a Halo frame fixator was used (Fig. 1) to retain the position of the remaining vertical rami of the mandible. The wound was allowed to heal and the whole anterior arch of the mandible from angle to angle then required reconstruction. In March 1984 the Halo frame was removed and the mandibular defect surgically exposed. A vascularised free left radial forearm flap was elevated including 14 cm of radius with a skin paddle to provide external cover. A series of vertical and parallel cuts were made in the anti-periosteal border of the hemi-radius using a dental drill whilst the flap was perfusing *in situ*. The cuts penetrated about one-half of the bone thickness and the remainder was gently manipulated into the shape required for the reconstruction. A long Champy plate was bent to fit the inner aspect of the newly shaped radius and stainless steel monocortical screws fixed the plate to the bone (Figs 2 and 3). Each segment of bone was seen to bleed whilst still *in situ*. The flap was then elevated and transferred to the defect. The hemi-radius was attached to each of the mandibular remnants using Champy plate fixation. Bleeding was observed from each segment of the riberrated bone after revascularisation. The skin paddle was used to provide skin cover to the reconstructed mandible and also served as a monitor for flap perfusion.

Late results show a satisfactory chin contour (Figs 4 and 5) and eradication of sepsis.

Case 2

A 61-year-old male smoker (SB) was admitted in August 1984 with a painless ulcer in the floor of his mouth and weight loss of one stone in 1 month. He had a long history of alcohol abuse. On examination there was a necrotic fungating carcinoma under the base of the tongue. Tumour extended from the right lower 7th to the left lower 3rd tooth and involved most of the floor of the mouth.

On 21 September 1984 a right neck block dissection and *en bloc* excision of tumour with segment of mandible was performed. A vascularised left radial forearm flap containing 14 cm of radius was raised and the bone was riberrated in a vertical direction on the proposed buccal surface, whilst still *in situ*, using a dental high speed drill.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Figure 1—*Case 1, HS.* Frontal view in halo frame fixator. Figure 2—*Case 1, HS.* Riberrated, moulded radius with Champy plate fixation. Note the *in situ* flap. Figure 3—As figure 2, but different view. Figure 4—*Case 1, HS.* Frontal view after anterior mandibular reconstruction. Note patient fitted with lower denture. Figure 5—*Case 1, HS.* Lateral view after anterior mandibular reconstruction.

The segment of radius with attached soft tissue was moulded and held in a suitable position by the use of a long Champy plate screwed to the buccal aspect of the hemi-radius segment.

The contoured hemi-radius was then attached to the remaining left and right mandibular segments by means of two separate miniature plates and the flap was revascularised. Bleeding was noted from each segment of riberrated radius. The skin paddle was used to provide lining to the floor of mouth, thus covering the fixation

plates and also acting as a flap monitor. Late results show a good chin contour (Fig. 6).

Discussion

The radial forearm flap containing hemi-radius provides good quality skin with a thin layer of subcutaneous fat and is relatively hairless. It has relatively large calibre vessels with long pedicles which allow revascularisaton well away from the site of previous surgery or radiotherapy. The main disadvantage is of a skin grafted donor site in the forearm. Potential complications include fracture in the remaining radius, anaesthesia in the distribution of the radial nerve when this is included in the flap, and acute ischaemia of the hand (Jones and O'Brien, 1985). The hemi-radius included in the flap is of sufficient length to allow the replacement of a considerable portion of the mandible and the regular thickness of vascularised bone allows easy shaping. The riberration technique described involves raising the forearm flap with a measured segment of radius attached via intact periosteum and perfusing *in situ*. The periosteum obviously provides a blood supply to the bone and should be preserved to each of the riberrated segments. By the careful use of a dental drill the radius is cut vertically on the anti-periosteal border to a depth that will allow gentle manipulation to fracture the bone but not strip or tear the periosteum. There is not a set number of riberrations involved in the reconstruction, but the number and positioning will depend on the ability to bend the miniplate gently into a shape that does not weaken the plate and which also allows the screw holes in the plate to be opposite intact cortical bone. Not every segment of radius requires screw attachment to the long Champy plate but a compatible curve on the plate is desirable to help reinforce the bone. The bone itself tends to develop significant greenstick fractures at two or three points but the net effect is to provide a series of stable wedge osteotomies that allow intimate contact between the plate and the modelled bone. Obviously the plate must be applied to the anti-periosteal border of the bone to prevent disruption of the blood supply. The technique of riberrating the hemi-radius *in situ* prior to elevating the flap has the obvious benefits of reducing the warm ischaemia time and allowing care and precision in the placement of the cuts and the attachment of the Champy plate. The reshaped hemi-radius is then fixed to both mandibular segments by means of two separate Champy plates, again taking care to preserve the periosteal attachments to bone.

Fig. 6

Figure 6—*Case 2, SB.* Semi-lateral view after anterior mandibular reconstruction.

Miniature screw and plate fixation has been used for some years in mandibular surgery. Champy *et al.* in 1978 described the technique of monocortical osteosynthesis without compression or intermaxillary fixation (IMF). Recently Cawood (1985) compared this technique alone with IMF in mandibular fractures and concluded that normal jaw function recovers faster with small plate osteosynthesis. It appears, therefore, that the malleable stainless steel plates have sufficient strength to achieve a high degree of stability when used to reshape and fix the hemi-radius for the purpose of providing anterior mandible contour. It is generally accepted that for strength and bony union a high degree of stability of the mandibular segments must be achieved. If Kirschner wire

fixation with direct loop wiring techniques are used (even with the use of mortised joints) then IMF is usually required for satisfactory union (Cohen and Schultz, 1985). Some authors, however, appear to achieve union with minimal bony fixation, *i.e.* direct loop wiring with transfixing Kirschner wires (McGregor, 1985). The risks of IMF can be overcome by using miniature plate fixation and the stability of the bony fixation guaranteed with some confidence. By using Champy plates we can not only avoid 4 to 6 weeks of inconvenience, discomfort and risk of poor access to airway in an emergency, but we can also remove the small, but real, potential risk of Kirschner wire introduced bony sepsis after transfixion of dental apices.

There are potential complications associated with the use of miniplates directly, such as exposure of metalwork and persisting infection. These can be minimised by providing adequate soft tissue cover, being gentle with the tissues, correcting nutritional deficiency, performing good oral hygiene and using prophylactic antibiotics. Having noted preoperatively the excellent blood supply to all fragments of bone for some time after remodelling, we believe it is safe to use this technique in irradiated tissue providing an adequate bulk of vascularised soft tissue is included in the flap.

With a satisfactory follow-up of 28 and 22 months respectively we believe that these two cases illustrate a technique which adds versatility to mandibular reconstruction using the radial forearm flap.

Acknowledgement

We would like to thank Mr Derek Ellis for his photographic work.

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