

problem of providing adequate nutrition and avoids the local sepsis and unpleasantness associated with longstanding nasogastric tubes.

However, even when control of the neoplasm and effective reconstruction of the oropharynx has been successful, retraining of the patient to swallow and speak may present considerable problems. The older patients, particularly, may take many months to acquire their new technique for which they require both patience and motivation.

#### *Reconstruction of the Mandible*

The functional integrity of the lower one-third of the face is carried primarily by the mandible and its associated musculature. Loss of part or the whole of this bone jeopardises that function and the problems of reconstruction are considerable. Novack (1972) has considered these in some detail stressing amongst other basic principles: (1) Primary replacement will usually not survive in the presence of irradiated tissue, salivary fistula or constant motion and infection. (2) Secondary reconstruction of the mandible after complete healing of all tissues is probably the procedure of choice. (3) Preservation of the mandibular arch is more important than replacement.

It is of course tempting to introduce a bone graft, Kirshner wires or a preformed implant into the surgically produced defect at the time of primary resection. Experience shows that in the irradiated oral cavity this is invariably unsuccessful. The problems associated with resection of the angle or horizontal ramus alone are not so great. If teeth still remain, drift may be avoided by the use of arch bars or interdental wiring. Some external deformity is unavoidable (Fig 2) but has never in my experience justified reconstruction at a later date.

More extensive resection or hemimandibulectomy produces both facial deformity and deviation of the remaining mandible with adverse effects on mastication, phonation and occlusion. Displacement of jaw segments can only be prevented by splinting or the introduction of a prosthesis, for the scar tissue which may develop between the segments gives no rigidity nor does it provide support for an intraoral prosthesis. Unfortunately, there is as yet no material which can be successfully implanted in an irradiated site with any prospect of constant success. Recurrence of squamous carcinoma in the oral cavity usually occurs within the first year and reconstruction should therefore be delayed for that period of time.

It is less easy to adopt a didactic attitude to those patients with radiation-failed neoplasms who need a total mandibulectomy for possible

cure. The prospect of a hypognathic deformity, even in the absence of local disease, is so daunting that attempts at primary reconstruction may be justifiable. The mandible must be resected to include one or both inferior dental canals thus leaving sufficient bone posteriorly to support a prosthesis or perhaps the frozen autogenous stent-graft described by Weaver & Smith in 1973. However, local recurrence in the residual tongue is common with this disease and the prognosis is poor.

There is little doubt that the management of oral cancer is at present most unsatisfactory. Failure of early diagnosis has resulted in a high proportion of advanced cases, where radical excision has proved unacceptable to many patients. Failure of radiotherapy to cure or even control these patients has placed a difficult technical burden upon the surgeon, frustrating his attempts at primary reconstruction. Certainly the mandibular arch must be spared where feasible but one wonders whether the role of radiotherapy as the primary treatment should now be critically reviewed.

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**Mr J S P Wilson and Mr J F Towers**  
*(St George's Hospital, London SW1)*

#### **Mandibular Reconstruction**

The cardinal principal of repair following mandibular resection has been to restore the continuity of the mandible in order that defects of contour could be corrected, function preserved and a fixed point for hyoid support in central arch excisions provided. The 'flattened cheek' following hemimandibulectomy (Fig 1A), or the 'Andy Gump' (Fig 1B), from symphyseal resections were considered the sequelæ of failure to provide adequate support. The accepted mechanism was that the lack of continuity of the mandible allowed any remaining posterior fragment to be rotated upwards by the temporalis - pterygoid sling. The

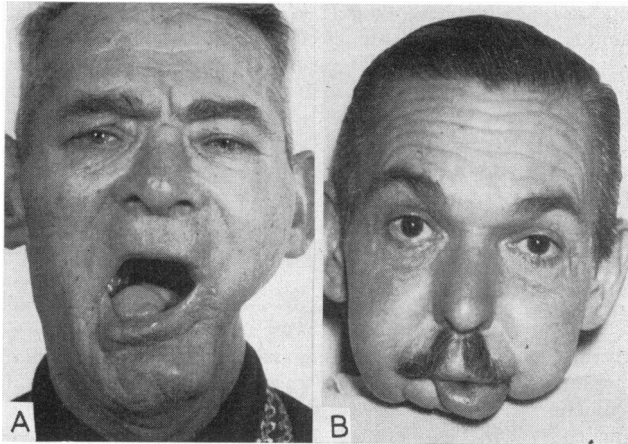


Fig 1A, deformities following lateral arch resection without reconstruction. B, deformity following central arch resection without reconstruction

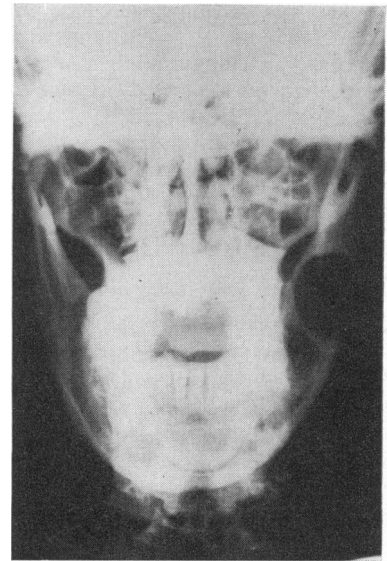


Fig 3 Radiograph of advance adamantinoma with associated pathological fracture of the left mandible

symphyseal region was drawn to the affected side by the unopposed action of the contralateral mylohyoid and digastric muscles (Fig 2) (Edgerton 1950). It is certainly true to say that once these deformities had been established, muscle shortening and fibrosis rendered complete correction impossible. However, on examination of these patients, a thick intraoral scar band was inevitably found between the remaining mandibular fragments. The provision of a definitive bone graft often failed to correct the deformities and intraoral function was poor. Indeed a proportion of these patients presented the picture of oral crippling that was so well described by Conley in 1962.

The introduction of intraoral lining by a regional flap with sufficient fat, adequate to fill the 'tissue vacuum', allows mobility of the tongue and floor of mouth for speech and mastication (Lee & Wilson 1973). In many cases an accept-

able degree of restoration of contour is achieved. Mandibular reconstruction must, therefore, be considered an ideal, but not the vital component of a repair that will ensure the social acceptance of the patient. Even if immediate bone grafting is not to be done the final result can be greatly improved if a prosthesis is used as a temporary expedient to maintain the mandibular fragment in the correct position while the soft tissue repair is established.

*Reconstruction Following Mandibulectomy with Minor Soft Tissue Loss*

The restoration of mandibular continuity is not a problem following the excision of benign or

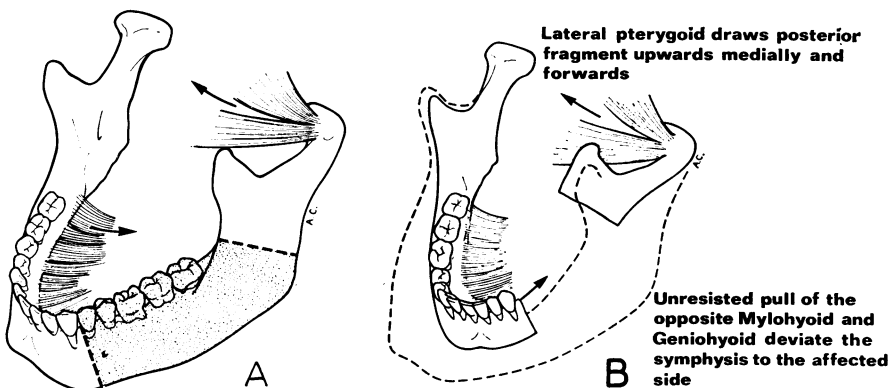


Fig 2 Muscular action causing distortion of the mandible

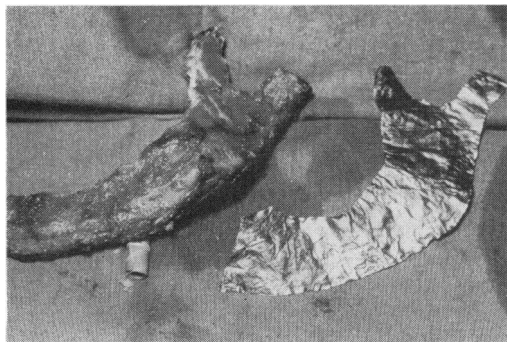


Fig 4 Hemimandible carved from the iliac crest

locally malignant tumours in that immediate bone grafting is possible. In the case of adamantinoma, if the tumour has ruptured the periosteum and invaded the mucosa, the sacrifice of the intraoral lining becomes mandatory, but the small defect produced is easily closed by advancing mucosal flaps. However, immediate bone grafting is ill advised but can be safely performed later when the wound is soundly healed. There is little doubt that bone is the ideal replacement as, once union has occurred, the bone is modelled to the correct shape and a strong permanent repair achieved.

These principles are well illustrated in the case of a Merchant Navy Officer with an advanced adamantinoma of the mandible, which had developed a pathological fracture while he was at sea (Fig 3). The extent of the disease required the removal of the hemimandible and the involved mucosa, but the articular disc was maintained to prevent subsequent ankylosis, as suggested by Manchester in 1965. Three weeks later, when an intraoral seal had been achieved, a hemimandible was carved from the ipsilateral iliac bone and shaped from a pattern taken off the operative specimen (Fig 4). Fixation was achieved by

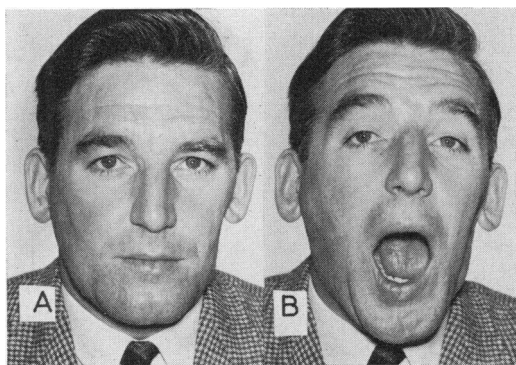


Fig 5A, postoperative view of the patient showing restoration of contour. B, full function

wiring the medial end of the graft to the mandible. Fusion of the new condyle to the inferior surface of the articular disc subsequently allowed normal jaw function, the movement occurring in the upper compartment of the temporomandibular joint (Fig 5A, B).

#### *Reconstruction Following Major Resection of Soft Tissue*

Conditions are not favourable for bone grafting following the resection of malignant lesions involving the mandible. The majority of patients are elderly and the prolongation of the operations combined with the additional surgery involved contributes to the severity of the procedure, leading to increased morbidity. The majority of patients will require the introduction of a forehead or deltopectoral flap to prevent intraoral crippling, following an adequate excision. Obviously any flap introduced into the oral cavity must have a vascular pedicle, and, even if the 2 cm pedicle technique (Wilson 1967) is used, only a nine-tenths insertion can be obtained. Consequently a complete intraoral seal cannot be guaranteed in all cases; the most minute break down often results in the bone graft becoming infected.

Many of our patients have had a previous radical dose of radiotherapy and our present treatment policy dictates a sterilizing dose to the remainder. Prior radical radiotherapy will result in an avascular bed to receive the flap, surrounded by atrophic mucosa which does not hold sutures well. There is often an associated low-grade infection which cannot be eliminated preoperatively due to the presence of necrotic tissue. The irradiated mandible is similarly avascular and sclerotic. These factors may contribute to the loss of flap or bone graft, but must not be used as an argument against the use of radiotherapy as the primary mode of treatment in many cases. The selected group of irradiation failures, which inevitably forms a high proportion of our work, should not blind us to the value of this treatment. Because of the difficulties of immediate block bone grafting numerous variations in the technique have been attempted. Small blocks of bone are more readily vascularized. Desprez & Kiehn (1959) threaded such segments of bone on a Kirschner wire, bent to shape, to restore mandibular continuity. Bone chips are even more easily vascularized and have some resistance to infection. They were employed by Yoel (1966) who held them in position by a perforated steel tray. This technique was modified by Branemark *et al.* (1970) who used a lighter titanium frame. Unfortunately the expected improvement in results was not obtained when these techniques

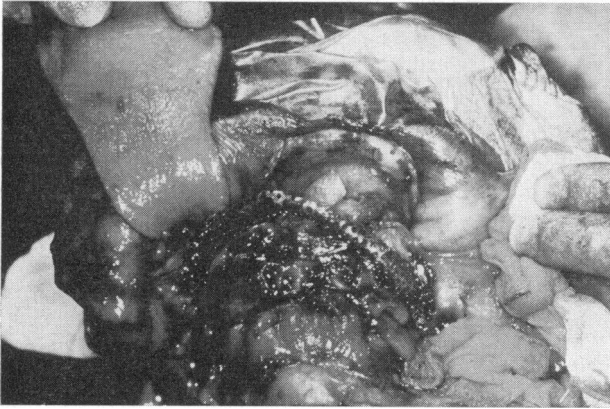


Fig 6 Reconstruction by metal tray containing bone chips

were applied to repairs of the major excisions (Fig 6).

Attempts were made to reduce the operative time and magnitude of this repair by utilizing the excised segment of mandible from which the soft tissues had been removed. The bone was sterilized by boiling (Orell 1937) autoclaving (Harding 1957), or freezing by liquid nitrogen (Weaver & Smith 1973). However, in the last paper only two of the six grafts reported survived and as far back as 1961 Gaisford *et al.* had condemned mandibular replacement following failure of three out of four grafts.

Due to hazards of immediate bone grafting, well illustrated by Millard *et al.* (1969) who reported a 30% failure, most workers now prefer not to use bone for a primary repair. Various foreign substances have been used to obtain immediate stabilization including gold, silver, ox cartilage, silicone, acrylic resins, titanium, vitalium, Teflon and chrome-cobalt. Stainless steel (Edgerton 1950) and titanium (Conroy 1969), have proved to be the most useful. Cook

(1968) has shown that 'biological union' between the metal and the ends of the bone can be achieved. The simplest form of prosthesis is a Kirschner wire driven into the inferior dental canal in the cut ends of the mandible. Such wires are commonly extruded, and postoperative pain from the irritation of the inferior dental nerve frequently occurs. However, the benefits that accrue from a simple prosthesis that requires no sophisticated equipment, and is easily inserted in a few minutes, are considerable and we have developed the twisted wire technique for these circumstances.

Alternatively a light titanium bar with reversed threaded screws at either end, as designed by Cook (1968), provides excellent stability in central arch excisions and has the benefit of having no protruding edges. Our experience with the Bowerman-Conroy (1969) prosthesis will be described in a following paper (Bowerman 1974). Whichever prosthesis is used it unfortunately involves certain risks to the flap repair. The necessity for coronoidectomy, to avoid pressure on the pedicle of the forehead flap, has previously

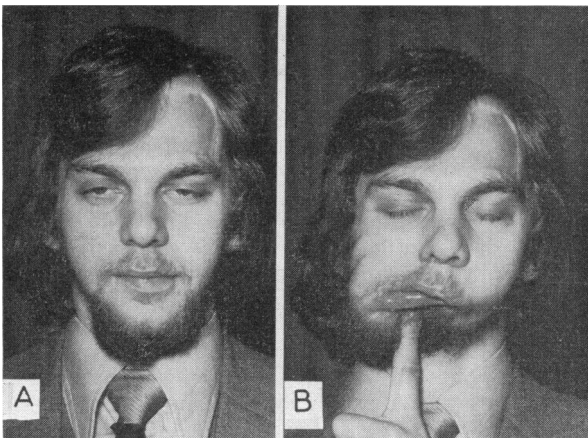


Fig 7A, postoperative appearance following two-thirds mandibulectomy with only soft tissue repair. B, demonstration of lack of mandible

been reported (Lee & Wilson 1973). Should the alternative deltopectoral flap be employed, the utmost care must be taken to avoid pressure on the base of the flap by the prosthesis (Gringrass *et al.* 1972). If a prosthesis is not used, although the cosmetic appearance is improved by the use of the deltopectoral flap, oral function is down graded by the immediate distortion of the remaining mandible by the weight of the flap. The prosthesis may ulcerate through atrophic external skin. However, this can sometimes be repaired by a second flap as long as a valvular closure of the defect is employed.

#### *Current Surgical Management*

Elderly and infirm patients have no implant inserted unless the section crosses the midline. Adequate skin replacement will provide sufficient rehabilitation and avoid the complications that are so serious in this group. In the young, following segmental resections or hemimandibulectomy, some form of metallic replacement is used. Should the prosthesis be rejected contour and function may be acceptable; if not, a bone graft is substituted. Where a central arch resection has been undertaken, or more than half the mandible removed, a prosthesis should be employed if the tissues will accept it. Long-term survival of the prosthesis has been obtained in a proportion of cases, thus avoiding the difficult two-part bone graft. If there is intraoral wound breakdown the prosthesis is removed at a minimum of three weeks to allow treatment of the associated infection. It is of great interest that when sufficient tissue is introduced by means of a pedicle skin flap further surgery is often unnecessary. The hyoid receives sufficient support from the neck flaps. By three weeks the site of the prosthesis will have thickened to produce a scar band of the correct length which provides considerable support to the chin. The patient in Fig 7 had a two-thirds mandibulectomy for a chondrosarcoma. Following the removal of his prosthesis, at seven weeks, and without further replacement, he has adequate intraoral function and, surprisingly, can eat normally. His contour is acceptable, and he has returned to society and his previous employment.

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Mr J F Towers and Mr J S P Wilson  
(St George's Hospital, London SW1)

#### Simple Reconstruction of the Mandible Following Resection

Wilson & Towers (1974) have described the desirability of reconstructing the mandible following any resection of a portion of bone. The methods that have been tried to date, and the problems that have been encountered, indicate that no entirely satisfactory prosthesis has yet been developed (Lee & Wilson 1973). The essential properties necessary in a prosthetic device to reconstruct the mandible are as follows: (1) Easily inserted. (2) Easily removed. (3) Readily adapted at time of operation. (4) Minimal bulk. (5) Well tolerated by soft tissues. (6) Sufficiently rigid to withstand muscle pull. (7) Minimal interference with bone. (8) Readily sterilized.

A simple prosthesis has therefore been developed which satisfies the above requirements. It has been used during the last three years and its insertion takes approximately ten minutes thus barely increasing operating time. It consists of four strands of 0.7 mm soft stainless steel wire twisted tightly upon themselves to form a single strut centrally, but having four loose strands at each end. A supply of these wires may be made preoperatively in varying sizes, the appropriate length being chosen at operation.

Initially the strut was inserted as shown in the uppermost specimen (Fig 1), but lately the wire has been covered with silastic tubing which can be sterilized by autoclaving, thus providing a smooth surface in contact with the tissues. Two holes are drilled in each bone fragment, using a No. 3 dental drill, and are placed quarter of an inch