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Immediate Re-establishment of Mandibular Continuity after Tumor Surgery Using Reconstruction Plates

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ABSTRACT

These days tumor surgery of maxillofacial region demands not just a radical removal of a tumor with primary or secondary reconstruction. Furthermore, the patient requires the full function and dental rehabilitation. To be a normal member of the society is sometimes more important for the patient than the success of radical tumorectomy and the possibility of the recurrences. Fifty-two cases (52 patients) of mandibular reconstruction using reconstruction A/O plate following composite resection of tumor masses at National Cancer Institute (NCI), Cairo University, between 1991 and 1998 were reviewed. The age of the patients was between 26-63 years. Cases were followed for 1 to 6 years and were classified into 4 groups according to location of reconstruction.

Group A: Anterior mandible crossing midline (12 cases).

Group B: Body segment of the mandible (14 cases).

Group C: Body, ramus and condyle (20 cases).

Group D: Whole mandible except both condyles (6 cases).

The incidence of revision or removal of plate because of untoward complications was used as an objective measure of outcome and was calculated. The other measures are: Postoperative infection, wound dehiscence and plate exposure, tempromandibular joint pain or limited mouth opening, unsatisfactory facial contour and separation between the screw and the plate.

The study concluded that reconstruction plates satisfy essential requirements of bone surgery in terms of functional stability, universal applicability and that reconstruction can provide a significant reduction of morbidity in patients with osseous defects of the mandible.

INTRODUCTION

Loss of mandibular continuity can result in altered and restricted movements that will lead to cosmetic and functional deficits which include speech and deglutition [1,2]. The immediate reconstruction of mandibular defects after resection affecting continuity permits stress-stable positioning of the mandibular stumps and hence retention of the position of the soft tissues and the contour of the lower face. The concomitant function of the mandibular joints is also retained. Also, immediate reconstruction is very essential to overcome the problem that will arise and decrease the possibility of facial disfigurement and overcome the psychological effect. Rapid rehabilitation is the expected benefit of using a bridging bone plate after composite resection for oral malignancy involving the lateral mandible. The internal fixation ranges from simple Kirschner wire or braided stainless steel wire to more elaborate bone plate. These should be used only as temporary spacer as they will often loosen or fracture over time [3,4,5]. A bridging plate covered by a healthy myocutaneous flap is a reliable and effective method of primary reconstruction in high risk patients with advanced cancer and uncertain long-term survival. Plates permit restoration of speech, mastication, swallowing and facial contour. Titanium plates do not interfere with planned radiotherapy. Secondary bone reconstruction is made easier with a well adapted bone plate which provides fixation and a durable contour [6].

In previous decades, delayed reconstruction of mandibular defects was favored over primary reconstruction secondary to the belief that primary reconstruction could potentially mask tumor recurrence. In addition, success rates following primary reconstruction were not very high. This was noted by Lawson et al., [7] who, reported a success rate of 90% for delayed reconstruction versus 46% for primary reconstruction.

When a segmental defect of the mandible is reconstructed primarily by a vascularised bone graft, there is an increased complication rate and prolonged hospitalization. This is probably related to a longer operative period with greater blood loss and the need for delayed feeding by percutaneous gastrostomy or nasogastric tube [8,9].

Assacl [10] stated that the bone graft failure can occur even when rigid internal fixation is used. He used gap bridging plates without bone graft as means of providing maintenance of form while consequent therapy is completed. This method, first used by Spiessl et al., [11] and saved as a part of the core of education, investigation and clinical practice since that time by Association of Internal Fixation Maxillo Facial Section.

Alloplasts have been widely used in mandibular reconstruction in the form of metallic wires and plates, organic materials (calcium aluminate, calcium apatite, calcium sulfate) and synthetic material [1] (methylmethacrylate, proplast, Teflon). Of these, mandibular reconstruction plates constructed of stainless steel (A/O plates), vitallium and titanium (Titorp plates) are used most often mandibular. Mandibular reconstruction plates have the advantage of no donor site morbidity, expediency, ease of contour and ability to reconstruct the condyle [8]. Major complications include plate extrusion, loosening of screws and plate fracture. Additional soft-tissue coverage may be frequently required in the form of a myocutaneous flap [12,13,14].

Papaxian [11] reported that the qualities plate would permit: 1- Easy application with minimal additional room time. 2- Provision of a solid arch with which the maxilla can articulate. 3- No compromise of cancer curability. 4- Closure of soft tissue defect and bone gap. 5- Minimal cosmetic deformity. 6- Satisfactory function.

Alloplastic implants may be combined with autogenous bone, either cortical or cancellous. Implants are in the form of trays made of vitallium, titanium, or Dacron. This method can only be used for secondary reconstruction. Successful reconstruction is reported in 80% to 90% of patients with traumatic defects, compared to 50% of patients with resection for carcinoma. Major disadvantages include extrusion and difficulty with postoperative radiotherapy [8,15].

MATERIAL AND METHODS

Fifty two cases (52 patients) of mandibular reconstruction using A/O stainless steel plates following composite resection of tumor masses at National Cancer Institute (NCI) (Cairo University) between 1991 and 1998 were reviewed. The age of the patients was between 26 and 63 years. Cases were followed for up to 1-6 years. Cases where a primary bone graft had been undertaken were not included. Only pure defect bridging were included in the evaluation. Some patients were placed in intermaxillary fixation if dentition was present. Suitable plate in each group was reshaped and fixed in place with at least 3-5 screws. The plates were then covered by local soft tissue flaps.

Cases were grouped into 4 groups, according to location of reconstruction:

Group A: Anterior mandible crossing midline (12 cases).
Group B: Body segment of the mandible (14 cases).
Group C: Body, ramus and condyle (20 cases).
Group D: Whole mandible except both condyles (6 cases).

The incidence of revision or removal of plate, because of untoward complications, was used as an objective measure of outcome and was calculated. Thes other measures are:

- Postoperative infection.
- Wound dehiscence and plate exposure.
- Tempromandibular joint pain and limited mouth opening (30 mm) occlosal change.
- Unsatisfactory facial contour.
- Separation between the screw and the plate.

Twenty nine patients of the cases had undergone malignant tumor ablative surgery and radiotherapy. Radiation effects were independent factor for evaluation the result in this study. Radiotherapy was carried out for 29 patients out of 52 patients included in this study. These 29 patients were 4 in group A, 7 in group B, 14 in group C and 4 in group D.

RESULTS

Postoperative infection, plate exposure, T.M.J pain, mouth opening, swallowing difficulty, un-satisfactory facial contour and the separation between the screw and plate were used as objective measure. The dada was collected in table (1).

Table (1): Complication following mandibular reconstruction with AO plate.

	A	B	C	D	Total
No. of patients	12	14	20	6	52
Postoperative infection	4	2	6	2	14
Plate exposure	0	4	2	0	6
T.M.J pain	2	-	4	-	6
Mouth opening	-	-	1	-	1
Swallowing difficulty	-	-	-	-	-
Un-satisfactory facial contour	-	-	7	-	7
The separation between the screw and plate	1	-	1	3	5

Revision or plate removal occurred in 11.5% (6 out of 52 cases) with incidence of 16.6% in group A, 28.5% in group B, 20% in group C and 0% in group D (Table 2). Reconstruction of body of mandible in groups B and C resulted in more complications than other any other part of the mandible.

Table (2): Incidence of plate removal.

Group	Plate removal	%
A	2	16.6
B	4	28.5
C	4	20
D	-	0

Postoperative infection rate was 26.9% with no significant differences between each group (Fig. 1). Skin dehiscence and plate exposure occurred in 11.5% (6 of 52 cases) (Fig. 2). The incidence of plate exposure was higher in group B (28.5% of 14 cases) the difference was significant compared to other groups. Unsatisfactory facial contour was 13.4%. This unsatisfactory contour was observed in only group C. Separation between screws plate (Fig. 3) occurred in 9.5% of total cases with significant different in group D (50% of 6 cases) compared with results obtained from other groups. Most of the patients were satisfied with their facial contour (Fig. 4).

Other complications such as T.M.J. pain was present in 11.5% of cases and unsatisfactory mouth opening was present in 1.9%. While swallowing difficulty occurred only during early period after reconstruction and disappeared after 1 week to 10 days postoperatively. Mouth opening, greater than 30 mm, (Fig. 5) was obtained in all cases except only one case in group C.

Clinical examination and assessments of the patients who underwent reconstructive surgery were satisfied with their facial contour and would recommend the same procedure to other patients except 7 patients in group C (13.4% of all patients in this study) were not satisfied with their facial appearance.

DISCUSSION

These days tumor surgery of maxillofacial region demands not just a radical removal of a tumor with primary or secondary reconstruction. Furthermore, the patient requires the full function and dental rehabilitation. To be a normal member of the society is sometimes more important for the patient than the success of radical tumorectomy and the possibility of the recurrences. There are some problems that occur from creating mandibular defects.

Quinn et al. **[16]** reported that the mandible plays a major role in airway protection and support of the tongue, lower dentition and the muscles of the floor of the mouth permitting mastication, articulation, deglutition and respiration. It also defines the contour of the lower third of the face. Interruption of mandibular continuity, therefore, produces both a cosmetic and functional deformity. The resulting dysfunction after loss of part of the mandible varies from minimal to major. Loss of mandibular continuity results in deviation of the mandible toward the resected side due to the unopposed pull of the remaining muscles of mastication and soft tissue contracture and scar formation.

In the last 20 years, surgical possibilities have increased by means of cross section controlled tumor lesion and immediate bridging of the defect by plate **[17]**.

The goal of reconstruction is to restore form, function and strength the gap bridging. Plate alone can not accomplish these goals. Hence, it can only be considered a temporary method of stabilization and must be followed by definitive reconstruction of the patient who is cured of his or her tumor. Clearly, surgical reconstruction or the reestablishment of the continuity of the mandible is ideally the first step in reconstruction however, this is still not possible in some patients **[12]**.

Fig. (1): Postoperative infection.

Fig. (2): Skin dehiscence and plate exposure.

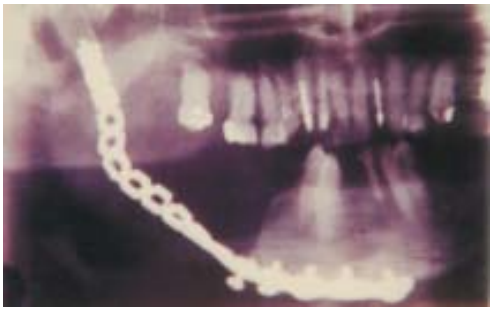

Fig. (3): Separation between screws plate.

Fig. (4): Satisfactory facial contour.

Fig. (5): Mouth opening greater than 30 mm.

Terzr et al. **[18]** mentioned that Alloplastic implant can not be used for reconstruction in cases where: 1- The surgeon wishes to wait for a disease free period before reconstructing. 2- The margins of the surgery are not free of disease. 3- Patient's other treatment may compromise the consideration (radiation therapy, chemotherapy, etc.) 4- Patient's health status may not allow further surgery. 5- Patient may decline more surgery.

The timing of mandibular reconstruction continues to be debated. In previous decades, delayed reconstruction of mandibular defects was favored over primary reconstruction secondary to the belief that primary reconstruction could potentially mask tumor recurrence. In addition, success rates following primary reconstruction were not very high. This was noted by Lawson et al. **[7]** who, reported a success rate of 90% for delayed reconstruction versus 46% for primary reconstruction. In addition, oral contamination of primary reconstruction resulted in unacceptably high complication rates from infection. Further support for this belief was evidenced by Komisar **[19]** who noted that patients undergoing primary reconstruction experienced longer and more frequent hospitalizations due to multiple staged procedures or complications secondary to reconstruction. He also reported that patients undergoing immediate reconstruction with a free nonvascularized bone graft had similar results as unreconstructed patients with regard to swallowing and mastication, but did have improved cosmetics. He concluded that there was no functional benefit obtained with immediate restoration of mandibular continuity. Quinn et al. **[16]** considered that primary reconstruction offers the theoretical advantage of rapid return of form and function in a single operation procedure. Secondary reconstruction via an external approach prevents salivary contamination and avoids infection, resulting in higher success rates.

In this study, revision or plate removal occurred with incidence of 11.5%. There are certainly reports **[20,21]** on unsatisfactory results with A/O reconstruction plate, these were results in addition to the results of this study summarized in table (3). It can nevertheless be concluded that better results than that obtained in this study. These results can be proceeded and improved with attention to correct indications and careful operative procedures. The present study indicated that the incidence of failure (11.5%) was generally due to progressive micro motion and or exposure of the plate to external environment. Radiographic findings showed a radiolucency surrounding a screw indicating a separation between the plate and screw.

Table (3): Loss rates after A/O reconstruction plates.

	Cases	Plate loss	%
Rudolf et al. **[7]**	12	0	0
Gullance and Holmes **[22]**	28	1	4
Klotch and Prein **[23]**	60	8	13
Klotch and Prein **[23]** (including cancer patients)	(42)	(8)	(19)
Birt et al. **[24]**	20	2	10
Present study	52	10	11.5

Although some surgeons **[23,24,25]** recommended covering the plate with local flaps others illustrated the importance of using distance flap to over the problem of the plate exposure and avoid closure of surgical field under tension **[10,14,26,27]**. Exposure of the plate through the skin was reported in six of these patients. Exposure of the plate may be caused by inadequate closure, inadequate soft tissue for coverage, or the location of the plate. Bending of A/O plates, in some cases especially in group C, was not done properly due to difficulty of adjustment and contouring of the plate before complete removal of resected part, this method may increase the risk of exposure and failure of the plate. Andrew **[12]** described surgical procedure as reconstruction plates are usually shaped before the mandibular resection and applied afterwards. By bending these plates and placing drill holes in the proximal and distal mandible segments before mandibulotomy, the surgeon can more confidently establish the proper relationships of the remaining mandibular segments after removal of the involved bone. As repeatedly stated in the literatures **[28,29]** it is advisable to aim at reshaping the entire width of the mandibular arch with reconstruction plate. It is better to keep the dimension of the reconstruction smaller than the basic mandibular defect. In this way, there is relief of tension on soft tissue during wound closure. This reduces the risk of wound dehiscence or later perforation.

If attached mucosa and/or skin are resected as part of extirpative procedure the problem is

compounded. This may result in closure with tension with resulting plate exposure either in the oral cavity or extra oral area. To minimize this problem, the present study recommended bending the plate to adapt to medial aspect of the mandible and this bending procedure can be also accomplished before resection to preserve mandibular position. Klatch and Prein [23] recommended always using a pectoralis major myocutaneous flap or other regional flap to apply coverage which in our study no flap was used to cover the plate and we depend up on only the local tissue to cover the plate and adaptation of the plate to medial aspect of the mandible. This was also confirmed by some other authors [29,30] that a secure soft tissue coverage of the reconstruction plate is important. Here suturing to surface skin or muscosa play a role and fixation of the soft tissue deep to the plate is also important which is possible with the continuous series of holes in A/O plates.

Early infection and wound dehiscence was reported by some authors [1,2,30] as the most common complication of the immediate mandibular reconstruction using reconstruction plate. This study demonstrated that the proportion of inflammation complication through infection (26.9%) and skin dehiscence with plate exposure (11.5%) also confirmed that inflammatory complication can heal without plate loss. Treatment includes maintaining good hygiene in the site of exposure because exposure leads to contamination around exposure. Postoperative infection was treated by conservative treatment in the form of antibiotic administration with continuous cleaning.

Overall all look to the result of this study showed that no significant indication that location of reconstruction play an important role inflammation complication. It is generally recommended that exposed plate should be removed only when it gets loose while exposed stable plate can be by successfully treated by control of infection followed by coverage with local flaps. The present study indicates that the skin dehiscence is not due to the presence of plate but due to either improper indication for reconstruction or surgical technique for reconstruction. Some authors [3,23,24,31] reported that inflammatory complications can heal without plate loss.

Although the results obtained here demonstrated the portion of inflammation complications through infection (26.9%) and skin dehiscence with plate exposure (11.5%) seems to be high, some literature reports, [11,30,31] on variety of experiences with alloplastic material reconstruction of mandibular defects. However, the results of the present study were not completely satisfactory because the proportion of inflammatory complications through infection and dehiscence with plate loss seems to be too high. The literature reports on a variety of experiences with Alloplastic material reconstruetion of mandibular defects [32]. With the titanium implants of Bowerman [31] there were 37% losses and 56% losses [12]. It may be possible that the soft tissues cannot be fixed so well to the smooth plate as to the later developed continuously perforated plates. Terz et al. [8] showed over 35% failures with reconstruction with wire mesh. Xenoist [33] gave a loss rate of 21.1% for plastic-coated metal plates (this figure includes cases with primary bone grafts). Better results have been obtained with newer systems. In 1985, Weiser et al. [34] reported on good results with osteoplates according to Reutber and Hausamen [25] combined with interposed palaces, there were only 8 losses in 92 plates. In 1983, Mandpe et al. [27], reported on the successful application of Vitallium mandibular reconstruction plates according to Lubr [29] in 16 cases, without plate loss. Less favorable results were reported by Platz et al. [21] 60 Vitallium plates and by Papel et al. [35] for osteoplates.

Mouth opening greater than 30mm was obtained in all cases except only one case in group C, it may be due to radiation effect that this patient was subjected to high dose of radiation. While some authors [3,23,37] reported that mouth opening was less than 30 mm in 29.3% and added that this result was not related to significantly to the variables studied. There is limited range of motion when attempting lateral and protrusive movements of the jaw with a return to midline on opening or closing secondary to the remaining contralateral muscles of mastication. In addition, malocclusion and problems with pro prioception occur [16]. Placement of mandibular reconstruction plates does not contraindicate the use of post-operative radiation therapy. In 1991, Gullane [22] reported an analysis of 64 cases evaluating the interface radiation dose using both stainless steel and titanium plates with a parallel beam radiation technique. He noted that the radiation dose at the plate-

bone interface increased only 15% at the 6-mV level with the excess tissue dose scatter extending only 1.1 mm to the surrounding soft tissue.

Clinical examination and assessments of the patients who underwent reconstructive surgery were satisfied with their facial contour and would recommend the same procedure to other patients except 7 patients in group C (13.4% of all patients in this study) were not satisfied with their facial appearance, this may be due to difficulty of adjusting the plate before resection. Other studies **[1,30]** reported that 29.2% were not satisfied by their facial contour.

Conclusion:

Mandibular reconstruction has always been one of the most challenging and demanding operation in all of plastic surgery. It is unrealistic to discuss functional impairment without reference to the physics and social factors affecting patients with mandibular resection. Distortion in self-image, inability to communicate and altered firmly and vocational role require the reconstruction of physics systems to handle these new demands. So, immediate reconstruction is very essential to overcome problem that will arise and decrease the possibility of facial disfigurement and overcome the psychological effect.

With the reconstruction plates mandibular function can be established by restoring the form, stiffness and load-bearing capacity of the mandible. Also, mandibular movement can be restored even by replacing mandibular condyle. Clinical observation in this study demonstrated good function of the joint replacement with no adverse effect on the contralateral joint. This study provided information on the minimum number of screws necessary for stable fixation.

Under contouring of the reconstruction plate proved to be of importance in the bridging defect under irradiated soft tissue.

The study concluded that reconstruction plate satisfies essential requirements of bone surgery in terms of functional stability, universal applicability and that reconstruction, can provide a significant reduction of morbidity in patients with osseous defects of the mandible.

Despite short comings of A/O reconstruction when used alone, the oncologic patient is the best candidate for the use of this because the shortened mean survival time of these patients and its use is simple and atraumatic.

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