

## Mandibular Reconstruction with Vascularized Fibular Graft: Comparing Outcomes of Adjuvant Radiotherapy Versus No-Radiotherapy

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### ABSTRACT

**Objective:** To compare the outcomes of mandibular reconstruction with vascularized fibular graft in adjuvant and non-radiotherapy Groups.

**Study Design:** Retrospective longitudinal study.

**Place and Duration of Study:** Plastic Surgery Department, Shifa International Hospital, Islamabad Pakistan, from 2010 to 2018.

**Methodology:** The data of 92 patients from 2010-2018 was included. Outcomes regarding local wound complications, wound dehiscence, fistula, skin necrosis, plate exposure and bone union rate were compared in Radiated (IR) and Non-Radiated (NR) Groups. Orthopantomography (OPG) was done at one month, six months, and one-year follow-up and was reviewed by a Radiologist.

**Results:** Ninety-two patients were included in the study, 56(60.9%) patients in the IR-Group and 36(39.1%) patients in the NR-Group. In the IR-Group, 56(60.9%) causes were intraoral squamous cell carcinoma in 51(91.0%) cases and osteosarcoma in 5 (9.0%) cases. In NR-Group cases were ameloblastoma 15(41.6%), giant cell tumor 4(11.1%), craniofacial microsomia 4(11.1%), osteonecrosis 6(16.6%) and trauma 19(4%). Common complications were plate exposure (2.1%), wound break-down (10.8%) in the IR-Group, and, on the other hand, in the NR Group, wound breakdown noted in (3.2%) respectively ( $p=0.05$ ).

**Conclusion:** With our experience, adjuvant radiation is an important modality that increases survival rate and can be safely administered without any significant complications related to soft tissue and reconstructed bone.

**Keywords:** Fibular graft, Mandibular reconstruction, Non-union, Plate exposure, Radiotherapy.

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### INTRODUCTION

Autologous vascularized bone grafts utilizing microsurgical techniques have revolutionized mandibular reconstruction in Head and neck surgery. The Free Fibula Flap allows customized osteotomies due to excellent segmental blood supply.<sup>1</sup> The fibula is the bicortical bone with good inherent properties for future Osseo-integration.<sup>2,3</sup>

Radiation is indicated for high-risk factors like recurrence or locally advanced disease of Head and Neck cancer patients.<sup>3,4</sup> Radiotherapy is applied on the tumour bed to kill the neoplastic, but it also affects non-neo-plastic cells.<sup>5</sup> Intensity-modulated radiation therapy (IMRT) is a precision modality in addition to computer-controlled linear accelerators to deliver precise doses to the tumour and small regions around it.<sup>6</sup> With technological advancement, intensity-modulated radiotherapy (IMRT) integrates the boost concept in daily radiation sessions by increasing the dose per fraction within the boost volume.<sup>7</sup> This is the so-called

IMRT with simultaneous integrated boost (SIB).<sup>8</sup> Limited data is available on radiation effects on mandibular reconstruction in Pakistan. The present study aims to compare the outcomes of mandibular reconstruction with vascularized fibular grafts in IR and NR Groups.

### METHODOLOGY

The retrospective longitudinal study was conducted at the Department of Plastic Surgery, Shifa International Hospital, Islamabad Pakistan. Patients who underwent mandibular reconstruction with vascularized fibular graft between 2010 and 2018 were included. We took Ethical Approval from IERB (294-784-2019). Informed written Consent was taken from all patients/kin regarding their data utilization.

**Inclusion Criteria:** All patients with mandibular defects who underwent reconstruction with a Free Fibular flap, with both malignant and benign conditions were included in the study. Patients undergoing mandible reconstruction for a benign condition like benign bone tumours, trauma, osteomyelitis and congenital disease did not receive any further treatment and were designated as a Control Group (NR).

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**Exclusion Criteria:** Patients with early complications (wound dehiscence, fistula, plate exposure, partial flap failure), recurrence, defects that were reconstructed with double free flaps, patients lost to follow-up and those that received neo-adjuvant radiotherapy were excluded from the study.

All malignant cases that involved mandible or primary bone tumours were planned for adjuvant radiotherapy. Radiation was commenced at a minimum of 4 weeks from surgery. It lasted five weeks except in patients who had severe reactions to radiotherapy in whom radiation was interrupted to allow complete healing of soft tissue and subsequently completed. Early and late complications after adjuvant treatment were noted during each follow-up and were collected through photographic data and written documentation. OPG was done and reported for bone density and bone union status at the osteotomy site on sub-subsequent follow-ups, i.e., one month, sixth month & one year post-operatively, by the radiologist.

All patients with diagnosed tumours were discussed in a multidisciplinary board, and the entire treatment plan was formulated and then discussed with the patients and their families. All patients received a dose of Clexane in the morning, and a Surgical ICU bed was reserved for the post-op care for one night. Tracheostomy, tumour resections, lymph node dissection in malignant cases, and debridement of traumatic and osteomyelitis bone were done by the Maxillo-facial and Head and neck surgeons. The resected specimen and some tissue from the native region were sent for the frozen section in all malignant. The plastic Surgery team prepared the recipient vessel and measured defect size after the negative margin on the frozen section in all patients with malignancy. In trauma patients, firstly, debridement was done with Intravenous antibiotics according to culture, and later on, mandible reconstruction was done in subsequent surgery. The Free fibula flap was harvested by standard technique according to the defect intra-orally and extra-orally in all patients with malignant cases and bone only in benign defects. Contouring osteotomies and plate fixation were performed before the pedicle ligation. Ligation was performed after the recipient's vessels were identified and prepared to save time. The flap (if skin paddle) was then partially inset before micro-anastomoses with mini plates and screws. The deepest vessels within the neck cavity were anastomosed first. One arterial and two venous anastomoses were completed, and their patency was

confirmed before the inset was completed and the neck closed.

Intermaxillary fixation (IMF) was done in all cases to restrict the jaw movements so that it would not disturb bone healing. Post-operatively, patients stayed in the hospital for a minimum of 5 days. After four weeks, the patient's IMF wire was removed and replaced by dental elastic rubbers to allow limited jaw movements. Once the final histopathology report was available, the tumour board meeting was conducted for further management treatment. Simultaneously integrated boost-intensity modulated radiation therapy (SIB-IMRT) was given post-operatively in the IR Group. Follow-up OPG is done at 1<sup>st</sup>, six months and one year to look at union status and the presence of any infection or plate exposure. Dental rehabilitation is advised after one year of reconstruction of the mandible in the IR Group and was referred to an orthodontist.

In terms of complications, i.e., wound dehiscence, fistula, skin necrosis, and plate exposure, were compared in the radiated (IR) and non-radiated (NR) Groups. Bone healing time was assessed during the first six months and one year of follow-up with the help of Panoramic radiographs. Radiodensity of bone grafts was also checked on Panoramic radiographs post-operatively on 1<sup>st</sup>, 6<sup>th</sup> and one year and was rated as Good, Partial and Lucent by the radiologist.

Data analysis was done with Statistical Package for the Social Sciences (SPSS) version 24. Categorical variables were analyzed as frequency and percentage. In contrast, continuous data was presented in terms of mean and standard deviation. Pearson Chi-square and fissure exact tests were applied to measure the association between the two Groups. The *p*-value of  $\leq 0.05$  was taken as a statistically significant finding.

### RESULTS

Ninety-two patients were included in the study, 56(60.9%) patients in the IR-Group and 36(39.1%) patients in the NR-Group. In the IR-Group, 56(60.9%) cases were intraoral squamous cell carcinoma in 51(91.0%) cases and osteosarcoma in 5(9.0%) cases. In NR-Group cases were ameloblastoma (15,41.6%), giant cell tumor (4,11.1%), craniofacial microsomia (4,11.1%), osteonecrosis (6,16.6%) and trauma (7,19.4%) as shown in Table-I. The mean radiation dose was  $70 \pm 2.1$ . The mean follow-up was  $2 \pm 0.5$  years. Mean follow-up with Orthopantomogram was at  $6 \pm 0.1$  weeks and then after every six months for two years. There was no claw-toe

deformity, nor did the patient develop osteoradionecrosis after radiation in the IR Group.

**Table-I: Characteristics of the Patients (n=92)**

Study Parameters	n(%)
<b>Age</b>	
<20	10(10.8%)
20-30 years	15(16.3%)
30-40 years	21(22.8%)
40-50 years	32(34.7%)
>50 years	14(15.2%)
<b>Gender</b>	
Male	54(58.7%)
Female	38(41.3%)
<b>Aetiology</b>	
IR Group: 56(60.9%)	1.SCC: 51(91.0%)
NR Group: 36(39.1%)	2.Osteosarcoma: 5(9.0%)
	1.Ameloblastoma: 15(41.6%)
	2.Giant Cell Tumor: 4(11.1%)
	3.Craniofacial Microsomia: 4(11.1%)
	4.Trauma: 7(19.4%)
	5.Osteomyelitis: 6(16.6%)
<b>Defects</b>	
Anterior	55(59.8%)
Posterior	37(40.2%)
<b>Composition of the Flap</b>	
Osseous	41 (44.4%)
osteocutaneous	51(55.4%)
<b>Complications</b>	
IR-Group: 56(60.9%)	Wound Breakdown: 7(12.5%)
NR-Group: 36(39.1%)	Plate Exposure: 2(3.5%)
	Partial Skin Graft loss at donor site: 1(1.7%)
	Fistula Formation: 1(1.7%)
	Wound Breakdown: 3(8.3%)

On the 1<sup>st</sup> month, sixth month and one year of follow-up, NR Group showed Good radiodensity at OPG in 35 patients (97.2%). In the IR Group, in the first month, 52 bones showed good; in the sixth month, 53 showed good, 2 showed partial, and 1 showed lucent radiodensity. Later, at one year, bone grafts of 54 patients were rated good (96.4%), and 2(3.5%) were rated as partial at OPG, as shown in Table-II. Figures-1 and 2 demonstrate two cases of Mandibular reconstruction.

**DISCUSSION**

Mandibular reconstruction is a significant challenge for maxillofacial and plastic surgeons. Free vascularized tissue transfer is the gold standard in Head and Neck Reconstructive Surgeries.<sup>9,10</sup> In our study, males demonstrated a higher prevalence of smoking tobacco among males, which has been seen as a risk factor in cancer patients included in the IR Group. Benign dental tumours and Road traffic accidents were seen as the main etiological factors in the NR Group, and SCC was the common cause among the IR Group. SCC is the most prevalent form of oral cancer in Southeast Asians because of excessive betel-quinid use and different tobacco types.<sup>11,12</sup>

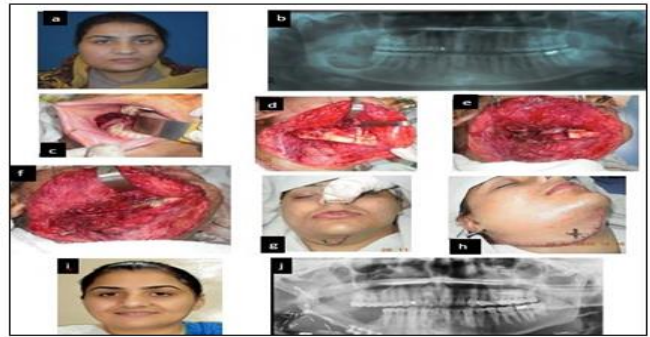


Figure-1a) Case of Young female with Ameloblastoma f right side of mandible, Figure-1b) shows pre-operative paronex radiograph, Figure-1c) is the peri-operative image of incision, Figure-1d, e) shows resection of the mandible and defect that is created after resection, Figure-1f) shows mandible reconstruction with vascularized fibula and fixation done with plates, Figure-1g, h) Closure images of the wound showing restoration of the contour, Figure-1i, j) is the two years follow up of the patient showing nice contoured face with good bone union

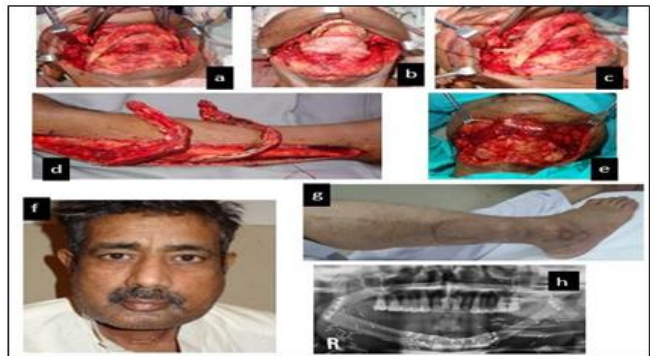


Figure-2: a,b,c), 55 years old diagnosis with SCC mandible involving body and ramus and underwent subtotal mandibulectomy, Figure-2d, e) Two site osteotomy done to reconstruct the mandible followed by fixation with the residual mandible, Figure-2 f,g): 1 year follow up showing good restoration of the face and well healed donor site, Figure-2h): Post-operative scan 1-year post radiation showing good bone union and there was good bone density

**Table-II Comparison of Radiodensity after 1 Month, 6 Months and 1-Year of Mandibular Reconstruction With Fibular Flap In Radiotherapy Group (IR) And Non-Radiotherapy (n=92)**

Radio-density of Bone Grafts	Interventional Groups		p-value
	NR(n=36)	IR(n=56)	
<b>After 1 Month</b>			
Good	33(91.6%)	52(92.8%)	1.00
Partial	2(5.5%)	3(5.3%)	
Lucent	0(0%)	1(1.7%)	
<b>After 6 Months</b>			
Good	34(94.4%)	53(94.6%)	0.710
Partial	1(2.7%)	2(3.5%)	
Lucent	0(0%)	1(1.7%)	
<b>After 1 Year</b>			
Good	35(97.2%)	54(96.4%)	0.366
Partial	1(2.7%)	2(3.5%)	
Lucent	0(0%)	0(0%)	

Our study concluded that the mandible reconstruction with free fibula was a reliable and best option, particularly for the large defects. It provided a large quantity of bone, which could easily be shaped and adapted to the residual mandible. Wei *et al.* favour fibula as the best option for anterior and large bony defects, which usually require multiple osteotomies.<sup>13</sup>

About 56 out of 96 patients with mandibular reconstruction with vascularized fibula received radiation therapy after complete healing. Our data shows that the IR Group showed complications, i.e., plate exposure (2.2%) and soft tissue complications like wound breakdown (10.9%) and in the NR Group, it was 2.2%, which is not insignificant among both Groups ( $p=0.05$ ). Previous studies reported that complications of any severity were 54% in the NR Group and 46% in IR, which further supports our study.<sup>14-15</sup>

In our study, gender is insignificantly associated with bone union ( $p>0.05$ ). Wang *et al.* reported that males are more likely to have a high frequency of bone union than females following mandibular reconstruction.<sup>16</sup> Gonzalez *et al.* reported no significant difference in bone union of different age Groups, similar to our study.<sup>17</sup>

Our study has shown that radiation given in the IR Group did not delay the healing of osteotomy sites, reduced bone height significantly or compromised the bone graft viability. Maben *et al.* suggested in their study that radiotherapy did not affect the trabecular microarchitecture and bone mass of the mandible at the osteotomy site ( $p=0.609$ ).<sup>18</sup>

In our study, there was no significant donor site morbidity, and this has been described and reported in previous studies.<sup>19</sup> Reconstruction with fibula has been very stable over time, and patients could tolerate a regular diet and also went for dental rehabilitation, improving their smile. The patient gained confidence in their appearance and had an acceptable speech.

### RECOMMENDATIONS

The Functional and esthetic outcome of mandibular reconstruction with a vascularized fibular flap has superior results in restoration of form and function compared to the other osseous flap. It provides good length, reliable skin paddle, and good bone stock for dental implantation with an approachable location, giving a two-team approach which further reduces operating time.

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### CONCLUSION

With this study, we share our experience and suggest that RTX can safely be given to HNC patients at an experienced radiation oncology centre. Complication rates among both Groups were not remarkably different and were not significantly affected by radiation therapy. In both Groups, good bony healing at the osteotomy site was noted, with no significant loss of bone height; consolidation looked similar by six months and was not affected by radiation in the IR Group, which further supported free fibula flap as the ideal donor site for mandibular reconstruction.

**Conflict of Interest:** None.

### Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

NB: & MR: Data acquisition, critical review, approval of the final version to be published.

SUR: & HUR: Study design, drafting the manuscript, data interpretation, approval of the final version to be published.

FS: & SM: Concept, data analysis, drafting the manuscript, approval of the f

inal version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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