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Risk of plate removal in free flap reconstruction of the mandible

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ABSTRACT

Objectives: To evaluate the factors associated with need for removal of fixation plates in mandibular free flap reconstruction.
Methods: This retrospective cohort analysis reviews patients undergoing mandibular free flap reconstruction at a tertiary care center from 2005 to 2016. Patients requiring removal of fixation plates were identified through electronic medical records. Factors including demographics, adjuvant therapy, surgical site infection (SSI) and fistula rates were compared. Removal rates based on flap type were determined.
Results: Between 2004 and 2016, 307 patients underwent osteocutaneous mandibular free flap reconstruction. 83 required removal of their fixation plates (27%). Age, tobacco use, and BMI were similar between patients requiring removal versus not requiring removal. Primary indications for removal were plate exposure (n = 41), and/or chronic drainage (n = 31), infection (n = 25), and pain (n = 17). Patients undergoing removal were significantly more likely to have had adjuvant radiation therapy (OR 2.09, CI 1.82–3.81), surgical site infection (OR 13.9, CI 5.15–43.2), and post-operative fistula (OR 13.0, 6.85–24.8). 35% of all fibula flaps (n = 52), 21% of osteocutaneous radial forearm (n = 21), and 11% of osteocutaneous scapular flaps (n = 6) required removal. 90% of patients (n = 75) had resolution of their symptoms following hardware removal.
Conclusion: Surgical site infection and fistula are strongly associated with the need for plate removal. Fibular free flaps carry the highest rate of plate removal. Plate removal leads to resolution of plate-associated symptoms in a majority of cases.

Introduction

Osteocutaneous free flap surgery is the gold standard for mandibular reconstruction following major head and neck oncologic resections [1]. While a variety of flaps exist for reconstruction of the mandible, osteocutaneous free flap reconstruction is most commonly employed given the need for bony reconstruction for both functional and aesthetic purposes [2]. The three most commonly used osteocutaneous flaps are the osteocutaneous radial forearm flap (OCRFF), the fibular flap, and the osteocutaneous scapular flap (OCSF). Surgical outcomes are comparable amongst these types of reconstructions [3].

In experienced hands, these procedures typically have high success rates and low rates of serious complications, regardless of the type of flap employed [4,5]. While rare, complications occurring early in the post-operative course can be devastating [6]. Later complications such as plate exposure occur more commonly, with reported rates in the literature ranging from 10% to 15%. Surgical site infection has been shown to be an independent risk factor for development of plate exposure [7–9]. While problematic, plate exposure does not always necessitate plate removal. In some cases, further coverage with negative pressure dressings or additional local flaps allow for adequate closure over the exposed hardware [10]. In other cases, plate exposure may require removal for definitive treatment.

While factors associated with plate exposure have been identified, there is less data regarding the incidence of plate removal following mandibular reconstruction from oncologic defects. Notably, the potential association of post-operative fistula formation and the need for plate removal has never been characterized. Fistula formation is a problem unique to head and neck reconstruction, and this complication has the potential to expose the reconstruction hardware to saliva and oral flora for prolonged periods until wound closure is achieved. The goal of this study was to determine whether risk factors such as post-operative fistula are associated with the need for removal of fixation plates in mandibular free flap reconstruction. Based on the experience at our institution, we hypothesized that adjuvant therapy and post-operative fistula formation would be independently associated with the need for plate removal.

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Methods

Following approval from the local institutional review board, all cases of free flap reconstruction for surgical defects in the head and neck were retrospectively reviewed. All instances of mandibular reconstruction were identified and reviewed in depth. Patients were included if they had undergone osteocutaneous free flap reconstruction with plate fixation following mandibular resection for benign or malignant neoplasia or osteoradionecrosis. Patients who required removal of their fixation hardware at any point following reconstruction were identified, and additional details were extracted from the medical records of these patients.

Demographic information including age, race, gender, and body mass index (BMI) were obtained. Factors such as tobacco and alcohol use, utilization of adjuvant therapy, and free flap reconstruction type were reviewed for each case. The type of flap utilized in each case was determined by the resecting surgeon preoperatively based on factors such as body habitus, tumor size, tumor location, and degree of invasion into surrounding structures. At this institution, fibula flaps are chosen for patients requiring large amounts bony reconstruction and lesser need for soft tissue coverage, whereas both OCRFF and OCSF are used when there is greater need for soft tissue coverage. Scapular flaps are typically reserved only for larger defects, as the requirement for changes in patient positioning for flap harvesting can increase operative time. Post-operative complications, including surgical site infection and fistula formation, were also recorded. Surgical site infection (SSI) was diagnosed by the treating surgeon in all cases and was defined as treatment with antibiotics with one or more of the following: (1) fever greater than or equal to 101.3 °F, (2) blanching erythema over the surgical site, or (3) purulent drainage from the incision and/or closed suction drain system. Post-operative fistula was differentiated from SSI by the presence of frank saliva in closed suction drains or obvious breakdown of the flap inset with communication into the neck.

Following surgery, each patient received 24 h of peri-operative antibiotics for infection prophylaxis. When diagnosed, SSI was treated with 7–10 days of antibiotics aimed at treating oral flora. Post-operative fistula was treated similarly, with initiation of antibiotic therapy to prevent infection at time of diagnosis and continuation of strict NPO diet to facilitate spontaneous closure if possible. Additional treatment for fistulas included targeted opening of the cervical incision with wet-to-dry packing to allow for controlled drainage of the fistula. Reoperation with further flap coverage was only performed in cases refractory to the conservative management described above.

For each patient requiring plate removal, additional details including the indication for plate removal were identified. Indications for plate removal included the following: (1) non-healing wound with or without plate exposure, (2) chronic soft tissue infection related to presence of the plate (3) chronic mandibular pain without other identifiable sources (4) and plate exposure without evidence of infection. Physical exam findings such as plate exposure, the presence of granulation tissue, or chronic drainage were recorded for each patient that underwent removal. The time from initial free flap reconstruction and plate placement to plate removal was recorded in each instance. All plates used at this institution are locking, reconstruction bars and the majority are 2.0 mm in thickness, with the exception of a single surgeon who used varying plate sizes. This surgeon compromised < 10% of flaps evaluated in this study.

Statistical analysis was conducted using Stata/SE version 15.0 (College Station, TX). For all variables analyzed, statistical significance was defined as $p < 0.05$. Univariate testing was performed using chi-squared analysis for categorical values and analysis of variance (ANOVA) for continuous variables. Student's *t*-test was used for comparison of means. Odds ratios for removal were calculated between these groups when this was feasible. Multivariate regression was performed using the variables SSI, fistula formation, adjuvant therapy, neoadjuvant therapy, and flap type. Beta-coefficients were calculated in multivariate analysis to determine the extent to which each variable contributed to need for removal. Rates of plate removal based on free flap type were additionally determined, and the removal rates were compared using ANOVA testing.

Table 1
Patient characteristics with univariate analysis comparing removal vs non-removal cohorts.

Variable	Removal N = 83	Non-removal N = 224	Odds ratio (CI)	*p*
Age, mean years (range)	60 (31–88)	64 (14–92)		0.97
BMI, mean (range)	26 (14–51)	25 (18–40)		1.00
Gender, n Male (%)	49 (59)	149 (67)	1.41 (0.81–2.43)	0.19
Tobacco, n (%)	59 (71)	154 (69)	0.99 (0.44–1.86)	0.99
Never	22 (27)	65 (27)		
Current	31 (37)	75 (37)		
Prior	28 (34)	79 (34)		
Alcohol, n (%)	34 (41)	123 (55)	0.55 (0.32–0.95)	0.02
Never	49 (59)	98 (44)		
Current	18 (22)	82 (37)		
Prior	16 (19)	41 (18)		
Adjuvant therapy, n (%)	37 (45)	118 (53)	1.94 (1.07–3.60)	0.02
Radiation	15 (18)	37 (18)	2.09 (1.12–3.81)	0.01
Chemotherapy	1 (1)	15 (7)	0.59 (0.06–2.94)	0.5
Chemoradiation	22 (27)	77 (37)	1.09 (0.63–1.88)	0.74
Radiation dose, mean Gy	58.4	59.6		0.54
Neoadjuvant therapy, n (%)	24 (29)	33 (16)	1.88 (0.98–3.52)	0.04
Surgical site infection, n (%)	28 (34)	54 (24)	13.9 (5.15–43.2)	< 0.005
Fistula, n (%)	24 (29)	6 (3)	13.0 (6.85–24.8)	< 0.005

Results

During the period ranging from 2005 to 2016, 792 free flaps were performed at our institution. 307 (39%) of these cases were mandibular osteocutaneous free flaps. 83 of these flaps (27%) required removal of the plates. Baseline characteristics are detailed in Table 1. There were no significant differences between patients whose plates were removed versus those whose plates were not removed in terms of age, gender, pre-operative BMI, or tobacco use. Current or prior alcohol users were found to be less likely to require plate removal on univariate analysis (OR 0.55, CI 0.32–0.95, p = 0.02).

Adjuvant therapy was more common in the non-removal group compared to the removal group (53% versus 45%); however, the overall utilization of adjuvant therapy did show a slight but significant association with plate removal on univariate analysis (OR 1.95, CI 1.07–3.60). Neoadjuvant therapy trended towards association with plate removal (p = 0.04), although this was not significant on univariate analysis (OR 1.88, CI 0.98–3.52). Rates of utilization of adjuvant and neoadjuvant therapies are summarized in Table 1. When stratified by type of adjuvant therapy received, only radiation showed a statistically significant association with plate removal. Cumulative radiation dosage was able to be determined in 31 patients (84%) who received radiation in the plate removal cohort and 101 patients (89%) who received radiation in the non-removal cohort. The difference in mean radiation dosage was not significant (58.4 Gy vs. 59.6 Gy, $p = 0.54$). Post-operative surgical site infection (34% versus 24%) and fistula (29% versus 3%) were more likely to have occurred in the removal cohort than in the non-removal cohort ($p < 0.005$). Both post-