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Reasons for Removal of Mandibular Reconstruction Plates

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Background: Mandibular reconstruction plates (MRPs), used alone or alongside bone reconstruction, are now the standard approach for treating mandibular continuity defects. Advancements in plate design and materials have improved the success

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Ethics approval and consent were granted by the University's Human Research Ethics Committee (clearance number M250646), and written informed consent was obtained from all patients.
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rate of mandibular reconstruction. Nonetheless, plate-related complications remain prevalent and may, in some cases, result in significant morbidity for patients.

Objective: To determine complications associated with MRPs and analyse parameters related to the complications.

Methods: A descriptive cross-sectional retrospective study was undertaken over a 5-year period (from January 2018 to December 2022) on patients who had complications after segmental resection and reconstruction with MRPs. Complications were analysed according to age, sex, location of defect, defect size, and whether the patient underwent a bone graft procedure or not. Univariate binary logistic regression was used to determine the predictors of complications. The level of significance was set at $P \leq 0.05$.

Results: A total of 100 patients were enrolled in the study. Benign and malignant tumors accounted for 76 and 18 cases, respectively. The prebent technique was used in 96 patients. LCL (63%), LC (18%), and HCL (14%) were the most observed defects. Dehiscence (n = 38), infection (n = 21), and plate fracture (n = 9) were the most common complications. Smoking ($P = 0.005$) and smoking and alcohol ($P = 0.008$) were significantly associated with the presence of infection. Six of the 9 patients with plate fracture had no bone graft. Plate length was significantly higher in participants with plate failure ($P = 0.032$).

Conclusions: Risk stratification for plate-related complications should consider factors such as plate length, defect type, soft tissue adequacy, and smoking and tobacco use. Patients with anterolateral defects and longer reconstruction plates are at higher risk for complications.

Key Words: Dehiscence, infection, mandibular reconstruction, plate fracture, reconstruction plates, risk factors

Mandibular continuity defects commonly arise from a variety of conditions, including benign and malignant tumors, osteomyelitis, trauma, osteoradionecrosis, and, more recently, medication-related osteonecrosis of the jaw.[1] These defects can significantly affect a patient's facial anatomy, speech, nutrition, self-esteem, and overall quality of life.[2] The primary goals of mandibular reconstruction are to restore both function—including occlusion, speech, breathing, mastication, and swallowing—and facial esthetics.[1]

Since the early 1980s, the standard approach to managing mandibular discontinuity has involved the use of rigid reconstruction plates, either with immediate or delayed osseous reconstruction.[3] Advances in osteosynthesis have enhanced the reliability of this method, particularly through the use of titanium reconstruction plates, which offer superior biocompatibility, and locking screw systems that improve biomechanical stability.[3] These developments have enabled modern plates to provide secure anchorage and rigid fixation.

However, the use of mandibular reconstruction plates (MRPs) is not without risk. Postoperative complications such as plate exposure, plate fracture, screw loosening or fracture, and infection remain prevalent. These issues frequently necessitate the removal or replacement of the reconstruction plate.

Despite the large volume of MRPs placed in our unit, no study has been undertaken to evaluate the outcomes of MRPs, in particular, the factors associated with their complications. This study was undertaken to identify the indications for MRP placement, as well as the risk factors contributing to their removal. The findings are expected to yield critical insights that may inform strategies to reduce the incidence of plate-related complications and improve overall outcomes.

METHODS

Study Design

To address the research question, the investigators designed and implemented a cross-sectional retrospective study of patients who had MRP-related complications and subsequently had to have the plates removed/replaced. These patients were treated at the department of Oral and Maxillofacial Surgery at Wits Oral Health Centre [Chris Hani Baragwanath Academic Hospital (CHBAH) and Charlotte Maxeke Academic Hospital (CMJAH)], University of the Witwatersrand in Johannesburg, over a period of 5 years, from January 2018 to December 2022. The study was approved by the institution's Human Research Ethics Committee (clearance number M250646). All patients who had reconstruction plates placed for mandibular segmental defects and subsequently had to be removed or replaced due to complications were included in the study. Patients with incomplete records were excluded from the study. Sampling technique was that of a convenience sampling, where patients' records were sequentially collected according to the inclusion criteria over a 5-year period. The primary predictor was MRPs. The primary outcome variable was complications, which included plate exposure, fracture, screw loosening, and infections.

Data Collection

Quantitative data were collected from patients' clinical and radiographic records, including preoperative radiographs and CT scans documenting the initial lesion, as well as postoperative imaging. Histopathological data were retrieved from the National Health Laboratory Service (NHLS) database. This included the initial diagnosis, the diagnosis following surgical resection, and a description of resection margins—classified as positive or negative—as well as any evidence of recurrence.

Planning included acquisition of preoperative computed tomography (CT) in slices 0.5 to 0.7 mm thick of the entire maxilla and mandible for simulation and mirroring for prebent cases. These data were saved in Digital Imaging Communication in Medicine (DICOM) format and imported into Mimics Segmentation Software (Materialize). A model of the ideal mandible was prepared with PA 2200 Nylon plaster composite on a EOSINT P SLS Laser 3D printer (Z-Corp). A 2.6 mm reconstruction plate (Biomet Microfixation) was prebent on the model before the operation. After resection, the prebent reconstruction plate was secured to the extant mandible with bicortical screws, which ensured that the distance to the upper incisor in the midline was as planned. The plates were covered by a soft tissue flap, either a free soft tissue or local flap. Figure 1 shows preoperative clinical radiographic images, model, and planning and reconstruction plate insertion after tumor resection in a patient who had ameloblastoma in the mandible.

For non-prebent cases, the plates were bent immediately after the segmental mandibulectomy by freehand.

The length of the defects was measured in centimetres (cm), which was obtained from the CT scans. The defects were classified according to the hemimandible condyle lateral (HCL) classification as described by Jewer et al.[4] Central defects including both canines are designated "C," and lateral segments that exclude the condyle are designated "L." When the condyle

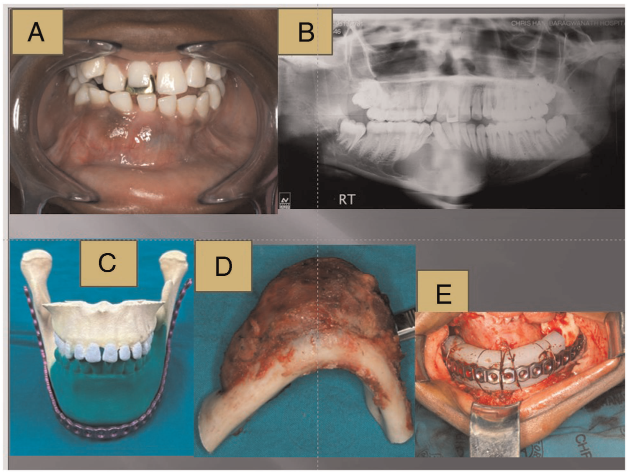

FIGURE 1. Patient with conventional ameloblastoma who had segmental mandibulectomy. (A) Preoperative panoramic radiographic showing multilocular radiolucent lesion in the mandible. (B). Clinical image showing tumor labial and buccal expansion. (C) Stereolithographic model for bending a 2.6 mm reconstruction plate. Resection margin shown in green. (D) Gross specimen of the resected mandibular tumor. (E) Reconstruction plate secured to the extant mandible with bicortical screws. In this case, a silicone spacer is secured on the lingual side of the plate with wires.

is resected together with the lateral mandible, the defect is designated "H," or hemi mandibular. Defects with multiple types are represented with a combination of the corresponding letter (eg, type-LCL for bilateral lateral defects including canines but not condyles). Eight permutations of these capital letters—C, L, H, LC (lateral defects including both canines), HC (lateral and condyle including both canines), LCL, HCL (condyle lateral, central, and contralateral lateral), and HCH (entire mandible)—are encountered for mandibular defects.

The results were captured in Microsoft Excel.

Data Analysis

The data were captured and tabulated in Microsoft Excel worksheets (Microsoft Office 365; Microsoft Corporation). Statistical analysis was performed using IBM SPSS version 27,0. Descriptive statistics of frequency, percentage, median and interquartile range, mean, and SD were used to summarize the participants' profiles. Fisher exact test of association was used to determine the association between complications and participants' characteristics, such as demographics, chronic diseases, diagnosis, and size of the defect. Mann-Whitney *U* test was used to determine the significant difference between the presence and absence of complications, age, length of plate, and time to removal. Kruskal-Wallis test was used to determine the significance between the presence or absence of complications and number of chronic diseases. Univariate binary logistic regression was used to determine the predictors of complications. The level of significance was set at 0.05.

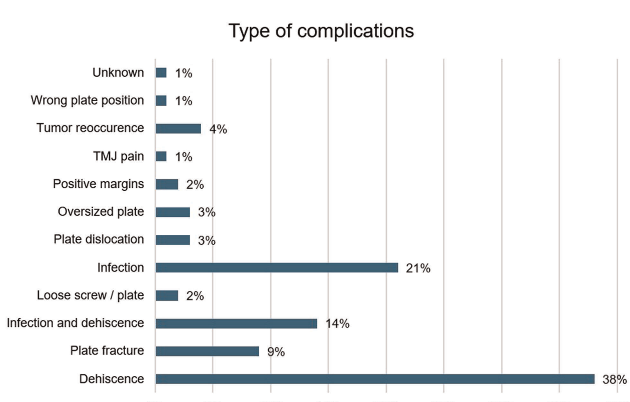

FIGURE 2. Postoperative complications and reasons for plate removal.

RESULTS

Demographic Characteristics of the Participants

Data were extracted from records of 100 patients who had complications associated with mandibular reconstruction plates. Several parameters of plate-related complications were analyzed. The mean age of the participants was 35.06 ± 13.24 years, and the majority (58%) were males. Supplemental Table 1 (Supplemental Digital Content 1, http://links.lww.com/SCS/I495) outlines baseline clinical and biographic data of the participants.

The prebent technique was used in 96 patients, and the mean length of plate was 19 ± 3.27 cm. Based on the classification by Jewer et al,[4] LCL (63%), LC (18%), and HCL (14%) were the most observed defects.

Disease Processes Resulting in Mandibular Continuity Defects

The patients had various diagnoses, including malignant tumor presence, benign odontogenic tumor and cysts, mandibular fractures, and infection. Benign tumors accounted for 76 cases (76%), malignant tumors accounted for 18 cases (18%), mandibular fractures for 3 cases (3%), and osteomyelitis for 3 cases (3%). Ameloblastoma (n = 51) and squamous cell carcinoma (n = 14) were the most common benign and malignant tumor,s respectively.

Postoperative Complications Leading to Removal and or Replacement

As shown in Figure 2, dehiscence/plate exposure (n = 38), infection (n = 35,) and plate fracture (n = 9) were the most common postoperative complications resulting in removal of mandibular reconstruction plates. The mean time frame between placement and removal of reconstruction plates was 2.09 ± 1.37 years (75% IQR: 3). Age did not seem to predispose to plate-related postoperative complications. Ameloblastoma and squamous cell carcinoma were the most diagnoses with plate-related postoperative complications at 51% and 14%, respectively (Figure 3).

Relationship Between Complications and Risk Factors

Infection

A history of smoking ($P = 0.005$) and smoking and alcohol ($P = 0.008$) were significantly associated with the presence of infection. No demographic characteristics showed a significant association with the presence or absence of infection. Equally, the presence of any comorbidity was not associated with occurrence of infection-related complications postoperatively. The results of the association tests are presented in Supplemental Table 2 (Supplemental Digital Content 2, http://links.lww.com/SCS/I496).

Further analysis using binary logistic regression showed that the odds of having an infection as a complication following

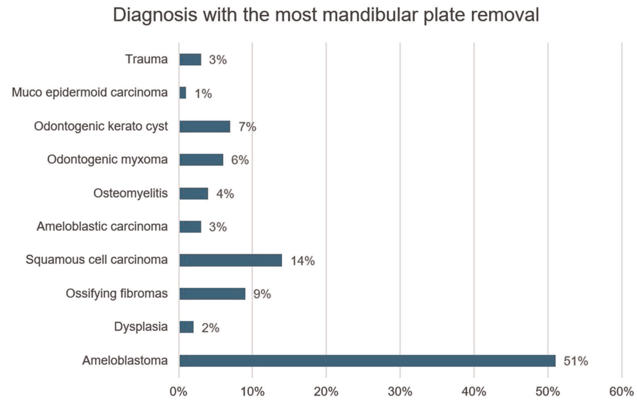

FIGURE 3. Diagnoses with the most mandibular reconstruction plate removal.

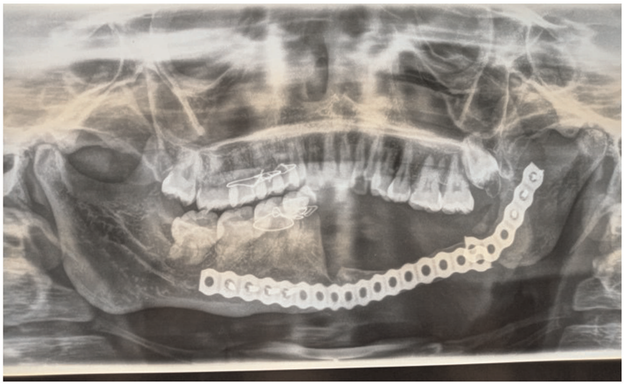

FIGURE 5. Postoperative panoramic radiograph showing fractured reconstruction plate in the left angle region.

plate reconstruction increased by 3.8 in smokers than non-smokers [B = 3.78 (1.54–9.29), $P = 0.004$]. Also, participants who smoked and drank alcohol had an increased odds of 3.68 to present with an infection complication [B = 3.68 (1.45–9.35), $P = 0.006$; Supplemental Table 3, Supplemental Digital Content 3, http://links.lww.com/SCS/I497].

Dehiscence/Plate Exposure

Dehiscence complications showed a significant relationship with sex ($P = 0.015$) and diagnosis ($P < 0.001$). A clinical picture of a patient with an anterolateral defect with plate exposure is shown in Figure 4.

Further analysis using binary logistic regression showed that women are 3 times more likely to present with a dehiscence complication than men [B = 2.95 (1.28–6.79), $P = 0.011$]. However, logistic regression showed that diagnosis did not significantly predict dehiscence as a complication (Supplemental Table 4, Supplemental Digital Content 4, http://links.lww.com/SCS/I498).

Fracture

There was no significant relationship between plate fracture and the participant's characteristics ($P > 0.05$). Plate length was significantly higher in participants with plate failure ($P = 0.032$). Therefore, plate length was a significant predictor of plate failure complications. A unit increase in the plate length increases the odds of presenting with a plate fracture complication by 28% Although there was no significant association between non-grafting and plate fracture, it was noted that 6 of the 9 patients with plate fracture were not grafted. Figure 5 depicts a panoramic radiograph of a patients with a fractured MRP on the left side.

FIGURE 4. Example of plate exposure in a patient with anterolateral defect.

Others

Other complications leading to plate removal and or replacement included screw loosening (n = 5), plate dislocation (n = 3) and plate malpositioning (n = 1) and tumor recurrence (n = 4).

DISCUSSION

We designed this study to evaluate clinical outcomes of mandibular reconstruction plates in patients with segmental mandibular defects over a 5-year period at WOHC. The specific aims of the present study were to determine the risk factors associated with reconstruction plate failures. Indications for MRP were also assessed together with the influence of factors such as age, sex, location for the defect, defect size, comorbidities, length of the plate, and use of bone graft in the reconstruction on the survival of MRPs.

We found in this study that the most common indications for MRPs were benign odontogenic tumor, and most of the plates were prebent. The mean age of the participants was 35.06 ± 13.24 years, and the majority (58%) were males. The study found that the mean length of plate which was used was 19 ± 3.27 cm. Dehiscence/plate exposure, infection, and plate fracture were the most contributory factors to plate removal. Increased plate length, smoking and alcohol and LCL defects were significantly associated with increased risk of postoperative plate complications requiring removal of MRPs. There was no relationship between the survival rate of the reconstruction plate and the sex of the patient. The mean time between placement and removal of reconstruction plates was 2.09 ± 1.37 years.

From the present study, empirical evidence suggests that age is not associated with postoperative plate-related complications. Similar findings were reported by Arias-Gallo et al,[5] Okura et al,[6] and Guerrier et al.[7] On the contrary, Maurer et al[8] reported that the risk of MRP complications increased with increasing age. There is a plausible rationale for the general association between increasing age and postoperative complications, as advancing age is typically accompanied by a decline in immune function and a higher burden of comorbidities, both of which can impair wound healing. However, contrary to this well-established trend, our study revealed an opposite pattern. This can be attributed to the relatively young demographic of our sample, the majority of whom had preoperative diagnoses of benign odontogenic tumors. We found no significant association between preoperative diagnoses (indications) and plate-related complications. In contrast, Mariani et al[9] and Okura et al[6] reported that patients with malignancy had more plate-related complications than those with benign conditions, especially those who had preoperative radiotherapy. Radiotherapy damages small vessels, thus reducing the smooth muscle density and progressively thickens the subendothelial components of the vessel wall and leads to progressive occlusion and fibrosis of the vessels, resulting in poor tissue perfusion and healing around the plates.[10–14] Nicholson et al,[14] however, reported that neither preoperative nor postoperative radiotherapy was associated with an increase in plate exposure. The lack of association between radiation treatment and plate-related complications is possibly related to the low number of patients with malignancy in our study.

The most common complication of plate reconstruction observed in the present study was plate exposure. Similar findings were reported by Yu-Wei Chiu et al.[15] The incidence of plate exposure ranges from 3.7% to 75%. Patients at the WOHC, usually presents with long-standing pathology, resulting in large expansile and destructive lesions. These large lesions often have soft tissue breakthrough. Resection of these tumors lead to larger defects (evidenced by the mean plate length of 19 ± 3.27 cm in our study), longer reconstruction plates and compromised soft tissue coverage which are inherently associated with increased postoperative complications.[16,17] For these cases, simultaneous soft tissue grafting over the surfaces of the plates must be considered even in situations of delayed osseous reconstruction. Under contouring of the plate may also help to mitigate problems associated with insufficient soft tissues. One of the most important factors of reconstruction with a mandibular plate is to fill the dead space around the plate with tissue from the transferred flap or available soft tissue[18]

Mariani et al[9] identified postoperative radiotherapy and defects located in the central region of the mandible as significant factors contributing to plate-related complications. Similarly, Chiu et al[15] reported a higher incidence of plate failure in patients with anterolateral defects (types C, LC, and LCL), particularly among those who had received preoperative radiotherapy. In our study, most complications occurred in the anterior segments (LCL and LC), followed by HCL defects. These findings align with existing literature, which consistently demonstrates a greater susceptibility to complications in the anterior mandibular region.[9,14,19] This increased vulnerability is attributed to the complex, convex contour of the chin area, which influences both jaw movement and force distribution. The use of model-based, prebent plates following resection—rather than conventionally bent freehand plates—has been shown to improve mandibular contour, ensure optimal plate positioning, and reduce the overall incidence of plate-related complications. Other benefits include reduced operating time and exposure to anesthetic.

We found that a history of smoking and smoking and alcohol were significantly associated with the presence of infection, which accounted for 21% of the complications. Similar findings were reported by Maurer et al,[8] who found an increased risk of postoperative complications with an increased intake of alcohol (P = 0.04) and smoking (P = 0.045). Guerrier et al,[7] however, reported that smoking was not an independent risk factor for postoperative plate-related complications. The role of smoking and alcohol consumption in the development of these complications is not necessarily direct but is likely mediated through their systemic effects on host immunity, disease response, and wound healing. Empirical evidence supporting a definitive link remains equivocal and inconclusive. Nevertheless, it remains essential to adequately counsel and prepare patients—particularly those who smoke or consume alcohol—about the increased risk of complications associated with reconstruction plate procedures.

In the present study, no statistically significant association was found between the use of bone grafting and the occurrence of plate fractures. However, it is noteworthy that a higher incidence of plate fractures was observed among patients who did not receive bone grafts. Although this finding did not reach statistical significance, it may suggest a potential trend worth further exploration. The role of bone grafting in conjunction with reconstruction plates for the management of mandibular discontinuity defects remains a subject of ongoing debate. While some studies, such as that by Head et al,[13] have reported no significant correlation between bone grafting and plate fracture rates, others have indicated an increased risk of plate failure in cases where bone grafts were not utilized.[20,21]

These conflicting findings highlight the need for further prospective studies to clarify the potential protective role of bone grafts in improving structural stability and reducing mechanical stress on reconstruction plates

From the findings of this study, we conclude that despite the increased success rates of MRPs as a result of prebent plates on computer-aided printing models, postoperative plate-related complications such as plate exposure, infection, and plate fracture remain a problem. Closer attention must be paid to patients with anterolateral defects and longer reconstruction plates (> 19 cm). Risk stratification must include plate length, defect type, adequacy of soft tissue, radiotherapy, smoking, and tobacco use. Regular postoperative reviews—especially within the first 2 to 3 years—must become critical component of postoperative surveillance, enabling early detection of dehiscence, infection, or hardware failure.

Future prospective randomized controlled studies with larger patient cohorts and extended follow-up periods are recommended to strengthen the findings of this study. These studies should also incorporate data on clinician seniority, patient comorbidities, use of soft tissue flaps and bone grafting, as well as other factors that may influence the survival of mandibular reconstruction plates.

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Septal-Costal Cartilage Complex: A Novel Surgical Technique to Correct Septal Caudal Deviation in Unilateral Cleft Lip Nasal Deformity

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Abstract: The present study aimed to introduce a novel surgical technique of constructing a septal-costal cartilage complex to correct septal caudal deviation of patients with unilateral cleft lip nasal deformities (UCLND). The caudal end of the septal extension graft (SEG) was split based on preoperative 3D reconstruction of cranial CT to form 2 segments that straddle the septal cartilage and were firmly sutured to the anterior nasal spine. Subsequently, 2 thin septal extension grafts were inserted with SEG bilaterally to form a septal-costal cartilage complex. The study enrolled 40 patients with UCLND from January 2017 to December 2024 and collected clinical photos and the Nasal Obstruction Evaluation Scale (NOSE) scores preoperatively and postoperatively at 6 months to evaluate nasal morphology and function. Correction of septal caudal deviation were achieved in all patients. Postoperative nasal morphology, including nasofacial angle ($P<0.001$), nasal labial angle ($P=0.007$), deviation angle of columella ($P<0.001$), and the ratio of nostril (both $P<0.001$), showed significant improvements, and NOSE also showed significant differences ($P=0.035$). The authors concluded that this surgical technique with the septal-costal cartilage complex provided a strong support structure and effectively corrected septal caudal deviation.

Key Words: Cleft lip, costal cartilage, nasal septum, rhinoplasty

Postoperative complications in patients with unilateral cleft lip, including abnormal intrinsic nasal development, recurrence of pre-existing deformities, and scar formation, can contribute to the development of secondary nasal deformities. Common clinical deformities include asymmetry in nostril shape, deviation of the columellar and caudal septal toward the noncleft side, flattening of the alar rim contour, displacement of the alar base on the cleft side, etc.[1–3] Notably, columellar de-

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All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (approval number: 2024(376)) and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.
Written informed consent for publication of their clinical details and clinical images was obtained from the patient. A copy of the consent form is available for review by the Editor of this journal.
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