Effect Of Mandibular Reconstruction With Titanium Plate In Squamous Cell Carcinoma

Md. Asaduzzaman[1], Ashik Abdullah Imon[*2], Md. Wares Uddin[3], Wahidujjaman[4], Ruman Banik[5], Mahmudul Hasan[6], Mohidul Islam[7], Tamanna Khandker Tonny[8]

[1]Associate Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: asaduzzamanomfs@bsmmu.edu.bd, orcid id:0000-0003-1101-7898

[2]Assistant Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: imonomfs@bsmmu.edu.bd, orcid id:0000-0002-7793-1159*

[3]Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex - BSMMU), Dhaka, Bangladesh, Email: wares.bsmmu63@gmail.com, orcid id:0009-0007-4366-2329

[4]Assistant Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: jaman.dentist@gmail.com, orcid id:0009-0004-6385-8212

[5]Assistant Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: ruman_banik@bsmmu.edu.bd, orcid id:0000-0003-4597-5998

[6]Assistant Professor, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: mhasanomfs@bsmmu.edu.bd, orcid id:0009-0009-9732-1532

[7]Medical Officer, Department of Oral & Maxillofacial Surgery, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: mohidul.bsmmu@yahoo.com, orcid id:0009-0002-7326-7315

[8]Medical Officer, Department of Paediatric dentistry, Bangladesh Medical University (Ex-BSMMU), Dhaka, Bangladesh, Email: tamanna48ddc@gmail.com, orcid id:0009-0000-5502-5393

**Corresponding*

Email ID: imonomfs@bsmmu.edu.bd

KEYWORDS

Oral squamous cell carcinoma, mandibular reconstruction, titanium plate, post-operative complications, long-term stability.

ABSTRACT

Background: Oral squamous cell carcinoma (OSCC) frequently necessitates mandibular resection, posing significant challenges for functional and aesthetic reconstruction. Titanium plates are increasingly utilized in resource-limited settings due to their accessibility, strength, and biocompatibility**.**

Aim of the study: This study aimed to evaluate the clinical outcomes of mandibular reconstruction using titanium plates in OSCC patients, focusing on operative time, post-operative healing, and long-term stability.

Methods: A prospective clinical study was conducted on 40 OSCC patients undergoing mandibular resection and reconstruction with titanium plates at Bangabandhu Sheikh Mujib Medical University. Data on demographics, operative time, post-operative complications, and long-term outcomes were collected and analyzed using SPSS v26**.0.**

Result: The cohort had a mean age of 56.3 ± 12.3 years, with 68% male predominance. The average operative time was 5.87 ± 0.63 hours. Post-operative complications included infection (7.5%), hematoma (5%), plate fracture (2.5%), and implant failure (2.5%), while 82.5% of patients exhibited no complications. Long-term issues included joint stiffness (12.5%) and chronic pain (10%), with 75% of patients showing no abnormalities.

Conclusion: Titanium plate-based mandibular reconstruction in OSCC patients demonstrated favorable outcomes with minimal complications, offering a viable

alternative in settings where microvascular free flaps are not feasible.

INTRODUCTION

Oral squamous cell carcinoma (OSCC) is recognized as the sixth most common malignancy globally, accounting for a significant burden of head and neck cancers [1]. In Bangladesh, OSCC ranks as the third most prevalent malignancy, often presenting at an advanced stage that necessitates extensive surgical intervention, including resection of the mandible [2]. A study by Ahmed et al., published in the Journal of Oral Pathology and Medicine in 2008, showed squamous cell carcinoma constituted approximately 73% of all oral cancers in Bangladesh [3]. The mandible, being a vital component of the maxillofacial skeleton, plays a critical role in mastication, speech, and aesthetics. Therefore, the functional and cosmetic consequences following segmental or hemimandibulectomy are profound, often demanding prompt and effective reconstruction [4]. Mandibular reconstruction aims to restore form and function while minimizing postoperative complications. The ideal reconstruction approach involves the use of vascularized bone grafts such as the fibula, scapula, or iliac crest free flaps, which provide both bony and soft tissue components and are associated with superior long-term outcomes [5,6]. However, microvascular free flap reconstruction may not always be feasible due to patient-related factors such as advanced age, systemic comorbidities, poor nutritional status, or financial constraints—challenges frequently encountered in resource-limited settings like Bangladesh [7,8]. In such scenarios, titanium reconstruction plates offer a viable alternative for immediate mandibular continuity restoration. These plates help to maintain jaw alignment, allow early oral rehabilitation, and significantly improve patients' self-esteem and quality of life [9]. The use of rigid reconstruction plates in mandibular surgery has been a standard technique since 1980s, and their design has continued to evolve [10]. Contemporary titanium plates, especially those incorporating locking screw mechanisms, offer enhanced biomechanical strength, reduced micromovement at the bone–plate interface, and improved stability in load-bearing conditions [11]. Despite these advantages, plate-based mandibular reconstruction is not devoid of complications. Common issues include infection, plate exposure through mucosa or skin, screw loosening, plate fracture, and wound dehiscence [12]. These complications can be exacerbated by poor soft tissue coverage, radiation therapy, and inadequate oral hygiene. Furthermore, in the oncologic setting, achieving oncological safety margins while preserving or reconstructing the mandible remains a delicate balance [13]. Therefore, proper case selection, meticulous surgical technique, and optimal plate design are essential for minimizing risks and improving surgical outcomes. With advancements in plate manufacturing technologies, including patient-specific plate design, computer-aided surgical planning, and 3D printing, the functional and aesthetic outcomes of mandibular reconstruction using titanium plates have markedly improved [14]. Regardless, the selection of this approach must be guided by a comprehensive assessment of the patient's general health, tumor characteristics, and the socioeconomic context. In this regard, evaluating the effectiveness of mandibular reconstruction using titanium plates, particularly in low-resource environments, remains a pertinent area of investigations [15]. This study conducted to evaluate the effectiveness of titanium plates in mandibular reconstruction for oral squamous cell carcinoma by assessing lesser operative time, post-operative healing, and long-term stability.

METHODOLOGY & MATERIALS

This study was a prospective clinical study conducted in the Department of Oral & Maxillofacial Surgery at Bangabandhu Sheikh Mujib Medical University (BSMMU). The study was conducted for 1 year from July 2023 to June 2024. A total of 40 patients fulfilling the selection criteria and diagnosed with Oral Squamous Cell Carcinoma (OSCC) requiring mandibular resection and reconstruction was included. Patients who were medically fit for general anesthesia and surgery. Patients who were willing to comply with study procedures and follow-up schedule. Exclusion Criteria were Patients with significant comorbidities contraindicating surgery, patients with a history of previous mandibular surgery or reconstruction and patients with history of previous radiotherapy and chemotherapy.

Ethical Consideration

Prior to the start of the study, ethical clearance was obtained from the Institutional Review Board (IRB) of BSMMU. Permission for conducting the study was also be sought from the Department of Oral & Maxillofacial Surgery. The aims and objectives of the study, as well as the procedures involved, potential risks, and benefits, was explained to all participants in an easily understandable local language. Written informed consent was obtained from all participants. Patients were assured of confidentiality and informed of their right to withdraw from the study at any point without any consequences. There were minimal physical, psychological, social, or legal risks during the clinical examination and surgical procedure. All measures were taken to safeguard patient privacy and data confidentiality.

Surgical Procedure

All operations were conducted under general anesthesia. After appropriate skin preparation and draping, local infiltration was performed using 1% lidocaine at the marked surgical site. If indicated based on the condition of the neck lymph nodes, neck dissection was performed initially. Following neck dissection, the mandible was exposed and resection markings were made. A titanium reconstruction plate was adapted to the mandible and cut to the desired length. Pre-plating was done using 9 mm titanium reconstruction screws. Occlusion was checked following plate fixation, and the plate was then removed. Mandibular resection was performed using a micromotor, after which the titanium reconstruction plate was re-fixed to the mandible. The surgical site was thoroughly irrigated with normal saline, and wound closure was done in layers using Vicryl for deep tissue and Prolene for skin closure. A surgical drain was placed in situ, and pressure dressing was applied. Post-operative follow-up was conducted at 3,6 and 9 months to evaluate outcomes.

Data Collection

Data collection was conducted using a pre-tested, structured questionnaire form. This form documented patient demographics, operation time, post-operative and long-term complications. Each participant was assigned a unique identification number to maintain confidentiality throughout the data collection and analysis process. A short interview (approximately 15–30 minutes) was also conducted with each participant to gather relevant information for the study.

Quality Assurance

To ensure data quality and procedural consistency, each patient was clinically examined under the direct supervision of the principal investigator. Data collected for each participant was reviewed and verified by the principal investigator. High standards of hygiene and safety were maintained using only disposable and sterilized instruments during the procedure. These measures ensured the validity and reliability of the study outcomes.

Data Analysis

Data analysis was conducted using SPSS software version 26.0 (SPSS Inc., Chicago, IL). Descriptive statistics were used to summarize the characteristics of the participants. Categorical variables were expressed as frequencies and percentages, while continuous variables were reported as means with standard deviations.

RESULT

Consequently, follow-up was given in 3, 6, 9 months interval and final results was described as below. The age of the study population ranged from 30 to 70 years, with the highest proportion (50%) aged between 60 and 70 years. The mean age was 56.3 ± 12.3 years. In terms of sex distribution, 68% (n=27) of the patients were male, while 32% (n=13) were female (Table 1). The mean operation time was approximately 5 hours and 52 minutes, with a standard deviation of 38 minutes, which corresponds to 5.87 ± 0.63 hours in decimal form (Table 2). Regarding post-operative healing complications, the most frequently observed complication was infection in 7.5% of patients (n=3), followed by hematoma (5%), plate fracture (2.5%), and implant failure (2.5%). Notably, 82.5% of patients (n=33) experienced no abnormal findings (NAD) (Figure 1). For long-term stability complications, joint stiffness was reported in 12.5% of cases (n=5), and chronic pain was observed in 10% (n=4). A small proportion required reoperation (2.5%, n=1), whereas 75% of patients (n=30) had no detectable abnormalities (NAD) during long-term follow-up (Figure 2).

Table 1: Demographic characteristics of the study population (n=40)

Age Group (years)	Frequency (n)	Percentage (%)
30–39	1	2.50
40–49	5	12.50
50–59	14	35.00
60–70	20	50.00
Mean ± SD	56.3 ± 12.3	

Gender		
Male	27	68.00
Female	13	32.00

Table 2: Operation Time among participants (n=40)

Variable	Hours	Minutes	Mean±SD
Operation Time	5	52	5.87±0.63

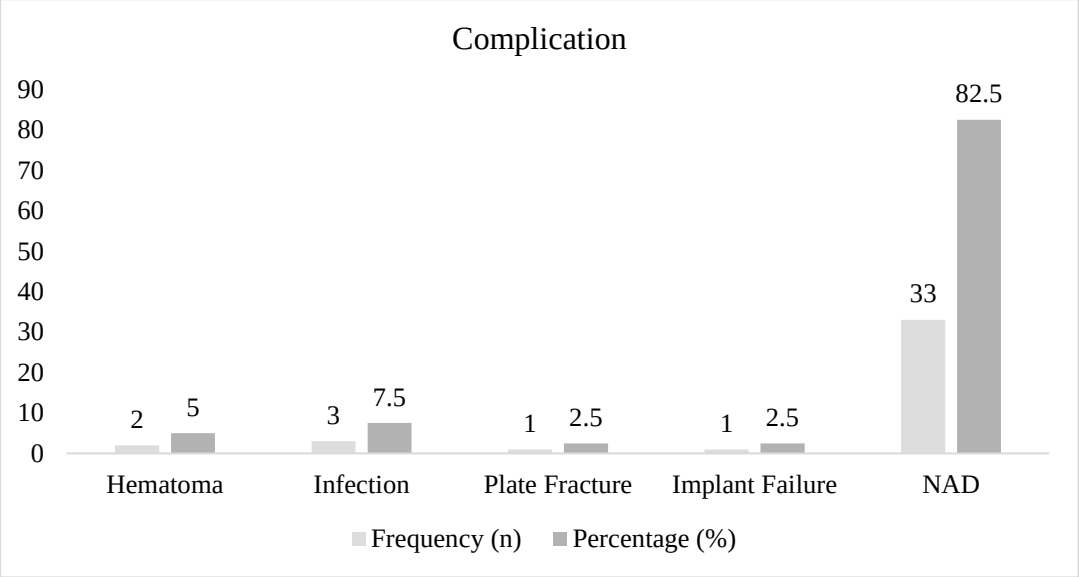

Figure 1: Post-Operative healing complications of the study population (n=40)

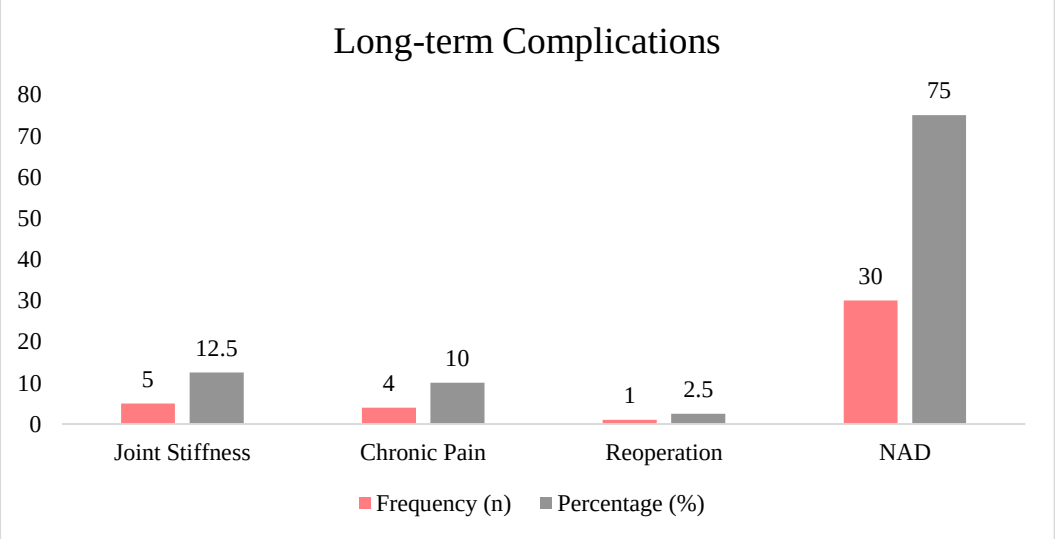

Figure 2: Long-Term stability complications (outcome) among patients (n=40)

DISCUSSION

Squamous cell carcinoma (SCC) of the oral cavity is a prevalent malignancy that often necessitates aggressive surgical intervention, including mandibular resection. Such procedures, while life-saving, can significantly impact a patient's facial aesthetics, oral functionality, and overall quality of life. Mandibular reconstruction aims to restore both structural integrity and functional outcomes, with titanium plates emerging as a widely accepted

solution due to their strength, biocompatibility, and resistance to corrosion. Titanium plates facilitate stable fixation and offer immediate support for soft tissue healing, making them ideal in complex oncological cases. This study evaluated the clinical outcomes and complications associated with mandibular reconstruction using titanium plates in patients diagnosed with OSCC. The demographic profile of our study population (n=40) revealed a mean age of 56.3 ± 12.3 years, with a male predominance (68%). This is consistent with findings by Zrnc et al., who reported a similar mean age of 54.5 years in patients undergoing mandibular reconstruction, with an age range of 31–71 years [16]. The gender distribution aligns with global trends, as males are generally at higher risk for oral SCC due to greater exposure to risk factors such as tobacco and alcohol [17]. The mean operation time in our study was approximately 5 hours and 52 minutes (5.87 ± 0.63 hours), reflecting the complexity and meticulous nature of mandibular reconstruction surgeries. Salvatori et al. reported comparable results, with an average operative time of 270 minutes (range 180–390 minutes), underscoring the extensive time investment needed for effective reconstruction and complication prevention [18]. Post-operative complications in our study were relatively minimal. Infection occurred in 7.5% of cases, hematoma in 5%, plate fracture in 2.5%, and implant failure in 2.5%, while 82.5% of patients experienced no abnormalities. These results are encouraging and suggest a favorable short-term healing profile. In comparison, other studies have reported surgical site infections (SSIs) in 10–45% of cases, which can lead to wound dehiscence, delayed healing, and systemic infections, significantly affecting post-operative outcomes [19]. Regarding long-term complications, 12.5% of patients experienced joint stiffness, 10% reported chronic pain, and 2.5% required reoperation. The majority (75%) did not exhibit any long-term complications. These findings are consistent with the study by Radwan et al., who reported similar rates of long-term stability issues following titanium plate reconstruction [20]. Furthermore, a systematic review by Vosselman et al. highlighted that plate extrusion occurred in 20% of soft-tissue reconstructions compared to 10% in osseous reconstructions, with revision surgeries needed in 32% and 14% of cases, respectively [21]. This comparison reinforces the efficacy of titanium plates, particularly when used with adequate bony support. Our plate fracture rate of 2.5% is notably lower than the 16% reported in a 10-year follow-up study, which also found stress shielding (9%), infections (8%), and plate exposure (4%) as additional concerns [22]. The lower complication rates in our cohort may be due to smaller follow-up time, advancements in surgical techniques, stringent patient selection, and meticulous post-operative care protocols implemented during the study period.

Limitations of the study:

- Long-term complications were assessed up to 9 months post-operatively; extended follow-up could reveal additional outcomes.
- The absence of a control group (e.g., free flap reconstructions) limits direct comparison with other reconstruction modalities.
- Limited access to advanced imaging or patient-specific plates may have influenced surgical planning and outcomes.

CONCLUSION

Titanium plate reconstruction offers an effective options for mandibular continuity restoration in OSCC patients, particularly in resource-constrained environments. The procedure demonstrated a low incidence of both immediate and long-term complications, supporting its continued use when microvascular reconstruction is not feasible. For optimal outcomes, meticulous surgical technique, proper patient selection, and rigorous post-operative care are essential. Future multi-center studies with larger cohorts and extended follow-up are recommended to further validate the long-term efficacy and cost-effectiveness of titanium plate reconstruction in diverse clinical settings.

Funding: Awarded by BSMMU Research Grant.
Conflict of interest: No conflict of interest.

Ethical approval: The study was approved by the Institutional Review Board (IRB)

REFERENCES

1. Dhanuthai K, Rojanawatsirivej S, Thosaporn W, Kintarak S, Subarnbhesaj A, Darling M, Kryshtalskyj E, Chiang CP, Shin HI, Choi SY, Lee SS, Aminishakib P. Oral cancer: A multicenter study. Med Oral Patol

Oral Cir Bucal. 2018 Jan 1;23(1):e23-e29. doi: 10.4317/medoral.21999. PMID: 29274153; PMCID: PMC5822535.

2. NATHIE DM. The rate of submandibular gland involvement in patients who underwent neck dissections for oral cavity squamous cell carcinoma at Chris Hani Baragwanath Academic Hospital (Doctoral dissertation, Faculty of Health Sciences, University of the Witwatersrand).
3. Lalli A, Tilakaratne WM, Ariyawardana A, Fitchett C, Leigh IM, Hagi-Pavli E, Cruchley AT, Parkinson EK, Teh MT, Fortune F, Waseem A. An altered keratinocyte phenotype in oral submucous fibrosis: correlation of keratin K17 expression with disease severity. Journal of oral pathology & medicine. 2008 Apr;37(4):211-20.
4. Anesi A, Palumbo C, Ferretti M, Salvatori R, Cavani F, Chiarini L. PRELIMINARY FINDINGS OF A POTENZIATED PIEZOSURGERGICAL DEVICE AT THE RABBIT SKULL. InBook of abstract 22° Congress of European Association for Cranio-Maxillofacial Surgery (EACMFS) 2014.
5. Schmeizeisen R, Schön R. Microvascular reanastomozed allogenous iliac crest transplants for the reconstruction of bony defects of the mandible in miniature pigs. International journal of oral and maxillofacial surgery. 1998 Oct 1;27(5):377-85.
6. Anthony JP, Rawnsley JD, Benhaim P, Ritter EF, Sadowsky SH, Singer MI. Donor leg morbidity and function after fibula free flap mandible reconstruction. Plastic and reconstructive surgery. 1995 Jul 1;96(1):146-52.
7. Boyd JB. Use of reconstruction plates in conjunction with soft-tissue free flaps for oromandibular reconstruction. Clinics in plastic surgery. 1994 Jan 1;21(1):69-77.
8. Head C, Alam D, Sercarz JA, Lee JT, Rawnsley JD, Berke GS, Blackwell KE. Microvascular flap reconstruction of the mandible: a comparison of bone grafts and bridging plates for restoration of mandibular continuity. Otolaryngology—Head and Neck Surgery. 2003 Jul;129(1):48-54.
9. Maurer P, Eckert AW, Kriwalsky MS, Schubert J. Scope and limitations of methods of mandibular reconstruction: a long-term follow-up. British Journal of Oral and Maxillofacial Surgery. 2010 Mar 1;48(2):100-4.
10. Peacock ZS, Afshar S, Lukas SJ, Kaban LB. Customized repair of fractured mandibular reconstruction plates. Journal of Oral and Maxillofacial Surgery. 2012 Oct 1;70(10):e563-73.
11. Knott PD, Suh JD, Nabili V, Sercarz JA, Head C, Abemayor E, Blackwell KE. Evaluation of hardware-related complications in vascularized bone grafts with locking mandibular reconstruction plate fixation. Archives of Otolaryngology–Head & Neck Surgery. 2007 Dec 1;133(12):1302-6.
12. Probst FA, Mast G, Ermer M, Gutwald R, Schmelzeisen R, Pautke C, Otto S, Schiel S, Ehrenfeld M, Cornelius CP, Metzger MC. MatrixMANDIBLE preformed reconstruction plates—a two-year two-institution experience in 71 patients. Journal of Oral and Maxillofacial Surgery. 2012 Nov 1;70(11):e657-66.
13. Morrison EJ, Matros E. Modern Oncologic Maxillary Reconstruction. Plastic and Reconstructive Surgery. 2024 Sep 1;154(3):601e-18e.
14. Goodson A. The use of personalised 3D-printed cranio-maxillofacial implants in future healthcare, with a focus on reconstruction of mandibular continuity defects. University of South Wales (United Kingdom); 2023.
15. Pruitt SL, Shim MJ, Mullen PD, Vernon SW, Amick III BC. Association of area socioeconomic status and breast, cervical, and colorectal cancer screening: a systematic review. Cancer epidemiology, biomarkers & prevention. 2009 Oct 1;18(10):2579-99.
16. Zrnc TA, Tomic J, Tomazic PV, Hassanzadeh H, Feichtinger M, Zemann W, Metzler P, Pau M. Complex mandibular reconstruction for head and neck squamous cell carcinoma—the ongoing challenge in reconstruction and rehabilitation. Cancers. 2020 Oct 30;12(11):3198.
17. Eloranta R, Vilén ST, Keinänen A, Salo T, Qannam A, Bello IO, Snäll J. Oral squamous cell carcinoma: Effect of tobacco and alcohol on cancer location. Tobacco Induced Diseases. 2024 Jun 18;22:10-8332.
18. Salvatori P, Motto E, Paradisi S, Zani A, Podrecca S, Molinari R. Oromandibular reconstruction using titanium plate and pectoralis major myocutaneous flap. Acta otorhinolaryngologica italica. 2007 Oct;27(5):227.
19. Yao CM, Ziai H, Tsang G, Copeland A, Brown D, Irish JC, Gilbert RW, Goldstein DP, Gullane PJ, de Almeida JR. Surgical site infections following oral cavity cancer resection and reconstruction is a risk factor for plate exposure. Journal of Otolaryngology-Head & Neck Surgery. 2017 Jan;46(1):30.
20. Radwan D, Mobarak F. Plate-related complications after mandibular reconstruction: observational study osteotomy. Egyptian Journal of Oral and Maxillofacial Surgery. 2018 Jan 1;9(1):22-7.

21. Bauer E, Mazul A, Zenga J, Graboyes EM, Jackson R, Puram SV, Doering M, Pipkorn P. Complications after soft tissue with plate vs bony mandibular reconstruction: a systematic review and meta-analysis. Otolaryngology–Head and Neck Surgery. 2021 Mar;164(3):501-11.
22. Jia MY, Jiang JJ, Chu XY, Yuan RT, Wang K, Bu LX. Clinical application of titanium plate reconstruction of mandibular defect: 10 years of follow up. Zhonghua kou Qiang yi xue za zhi= Zhonghua Kouqiang Yixue Zazhi= Chinese Journal of Stomatology. 2016 Jul 1;51(7):401-4.