

Mandibular Reconstruction with Autogenous Bone Graft vs. Reconstruction Plate: How Treatment Modalities Affect Clinical Outcomes and Quality of Life

Mohammad Adhitya Latief¹, Benny Sjariefsyah Latief^{1*}, Rev R Arian Reza Marwan¹

1. Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Universitas Indonesia.

Abstract

Treatment of jaw tumors usually involves enucleation, curettage, or resection, to remove the pathology. Vascularized bone graft is known as the gold standard for large defects which ensures adequate healing reconstruction plate can be used to reconstruct mandibular continuity defects which provides a cheaper and simpler alternative with no need of dual team surgery. However, differences of quality of life and clinical outcomes in patients treated with either approach is not well studied.

This study aims to compare quality of life and clinical outcomes between different reconstruction method of mandibular defects.

The included literatures were searched on three databases, PubMed, ScienceDirect, and EBSCOhost, without any restriction according to PRISMA guidelines. Four studies were included as eligible study for further analysis in terms of pathological condition, surgery and graft used, and outcomes.

There is no significant difference of quality of life between reconstruction groups, but significant difference were observed on the complication rate between groups. This study showed that quality of life alone should not be a sole consideration for deciding which modalities to choose to reconstruct mandibular defects.

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Keywords: Mandibular reconstruction, autogenous bone graft, reconstruction plate, quality of life.

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Introduction

Treatment of jaw tumors usually involves enucleation, curettage, or resection, to remove the pathology. The treatment choice usually varies between pathological conditions, but aggressive tumors are usually treated with resection, to remove the infiltrated cells and prevent further recurrence of the pathology.¹⁻³ In ameloblastoma, a type of benign and locally aggressive tumor, radical treatment by resection showed significantly lower recurrence rate compared to conservative treatments.^{4,5} However, those treatments usually leave large defects on the jaw, requiring reconstruction to restore the functional and aesthetic function of the jaw.⁶

Several methods of reconstructions are currently available, with varying success and complication rate. Vascularized bone graft is known as the gold standard for large defects which ensures adequate healing.^{7,8} Other than that, nonvascularized bone graft is also an option for reconstruction of mandibular defect after resection.⁹ On the other hand, reconstruction plate can be used to reconstruct mandibular continuity defects which provides a cheaper and simpler alternative with no need of dual team surgery.¹⁰ However, differences of quality of life and clinical outcomes in patients treated with either approach is not well studied. This study aims to compare quality of life and clinical outcomes between different reconstruction method of mandibular defects.

Materials and methods

Protocol and Registrations

This study is a systematic literature review conducted based on the "Cochrane Handbook for Systematic Reviews of Interventions" guidelines. The results of this

*Corresponding author:

Benny Sjariefsyah Latief,
Department of Oral and Maxillofacial Surgery,
Faculty of Dentistry, Universitas Indonesia,
Jalan Salemba Raya 4, Jakarta Pusat, Jakarta 10430,
Indonesia
E-mail: bennylatiefomfs@gmail.com

study are reported according to the “Preferred Re-reporting Project Guidelines for Systematic Review and Meta-analysis” (PRISMA) statement.

Eligibility Criteria

Studies were critically reviewed based on the inclusion criteria of the predetermined Population, Intervention, Control, Outcome, and Study design (PICOS) strategy. Patients of any age representing both genders and diagnosed with a benign or malignant tumor in the mandibular region without nonrelated confounding condition and treated with resection of the mandible, including mandibulectomy, hemimandibulectomy, and en bloc resection are included in this review. The intervention investigated in this study was reconstruction with any autogenous vascularized or nonvascularized bone graft, including costal graft, free fibula flap, etc. Comparison were made to reconstruct mandibular defect by using reconstruction plate. Outcomes, including OHRQOL, QOL, recurrence rate, morbidity rate, complication rate was recorded as the primary outcome, with additional cost and surgery time as the secondary outcome. Prospective, retrospective, and ambiperspective studies, including RCTs, cohort studies, case reports, case series, and cross sectional studies were included in this study with no publication year restriction.

Search Strategy

The included literatures were searched on three databases, PubMed, ScienceDirect, and EBSCOhost, without any restriction. Keywords used to identify eligible studies were “jaw neoplasms” OR “jaw cysts” AND “Mandibular Reconstruction” OR “Reconstructive Surgical Procedures” AND “Health Related Quality Of Life” OR “Oral Health Related Quality Of Life” OR “Treatment Outcome” OR “Recurrence” OR “Surgery Time”. The search strategy protocol is uploaded to PROSPERO, presented at Table 1.

Data Extraction

Data extraction were performed by extracting (1) author data, (2) year of publication, (3) patients characteristics such as age, sex, (4) the pathological condition, (5) surgical management, (6) type of bone graft used, and (7) OHRQOL, QOL, (8) recurrence rate, (9) morbidity rate, (10) complication rate, (11) cost, and (12) surgery time for analysis.

Study Quality Assessment

The studies was assessed for their quality assessment using the National Institutes

of Health (NIH) Study Quality Assessment Tools.¹¹ There were 8-14 questions to analyze the internal quality of the studies, which were specified according to the design. The assessment includes research questions, study population, target population and case representation, randomization, blinding, and other questions. All questions were answered with 'yes' if the criterion was fulfilled and with 'no' if the criterion was not fulfilled. Other answers include 'cannot determine,' 'not applicable,' and 'not reported.' The assessment gave each study a grade of good, fair or poor. If domains were answered yes, the studies overall assessment would be good. Studies with no answer scored as fair quality, while studies with more than 4 no answer were graded as poor.

Database	Search Strategy
Science Direct	(jaw neoplasms) OR (Jaw Cysts) AND (Mandibular Reconstruction) OR (Reconstructive Surgical Procedures) AND ((((((Health Related Quality Of Life) OR (Life Quality))) OR (OHRQOL)) OR (Oral Health Related Quality Of Life)) OR (Treatment Outcome)) OR (recurrence)) OR (surgery time)
PubMed	(jaw neoplasms[MeSH Terms]) OR (Jaw Cysts[MeSH Terms]) AND (Mandibular Reconstruction[MeSH Terms]) OR (Reconstructive Surgical Procedures[MeSH Terms]) AND ((((((Health Related Quality Of Life[MeSH Terms]) OR (Life Quality[MeSH Terms])) OR (OHRQOL)) OR (Oral Health Related Quality Of Life)) OR (Treatment Outcome[MeSH Terms])) OR (recurrence)) OR (surgery time)
EBSCOhost	(jaw neoplasms) OR (Jaw Cysts) AND (Mandibular Reconstruction) OR (Reconstructive Surgical Procedures) AND ((((((Health Related Quality Of Life) OR (Life Quality)) OR (OHRQOL)) OR (Oral Health Related Quality Of Life)) OR (Treatment Outcome)) OR (recurrence)) OR (surgery time)

Table 1. The search strategy protocol is uploaded to PROSPERO.

Results

Study Selection

One thousand and eight records were identified from three electronic databases. Three authors (A.R.M, M.A.L.) reviewed 923 titles and abstracts for relevant studies, after removing 85 duplicates. A number of 807 reports were excluded after title and abstract review. Then, the remaining 116 reports was retrieved and evaluated, with 112 excluded texts and four articles fit the inclusion requirements. The selection process is reported on Figure 2 based on PRISMA 2020 study selection flow. The extracted data, i.e. designs, patient characteristics, and outcomes of each studies, are recapitulated on Table 2.

Study Characteristics

Four included studies with a total of 371 patients have different designs with different variables. The studies published by Gemert et al., Davudov et al., and Groot et al. were conducted as cross-sectional studies. All groups studied and compared FFF to plate reconstruction only. However, Davudov et al. included no reconstructed patients and Groot et al. studied QOL in digitally planned FFF reconstruction and conducted a multi-center study. Ritschl et al. studied complications after reconstruction with FFF or plate only.

Outcomes Reported

Health Related Quality of Life were measured by Gemert et al., Davudov et al., and Groot et al, using the European Organization for Research and Treatment of Cancer questionnaires (EORTC QLQ-C30 version 3.0 and EORTC QLQ-H&N35). The EORTC QLQ-C30 included 30 questions to assess quality of life, while EORTC QLQ-H&N35 included 35. The result of both assessment varied between studies. Gemert et al. reported significant correlations between type of reconstruction with functional outcomes as measured using EORTC QLQ-C30 and "feeling ill" as measured using EORTC QLQ-H&N35. On the other hand, Davudov et al. in their study revealed significant difference between reconstruction with free fibula flap vs. reconstruction plate vs. no reconstruction on speech problems (11.1 vs. 16.3 vs. 6.7; $p=0.04$), dry mouth (21.5 vs. 47.5 vs. 28.2; $p=0.03$), and feeling ill (8.3 vs. 20.8 vs. 8.5; $p=0.04$). Groot et al., in their study, reported different score between patients receiving reconstruction with digitally planned FFF vs. bone graft vs. reconstruction plate, in weight loss (0.0 vs. 60.0 vs. 100.0; $p=0.000$) and weight gain (16.7 vs. 100.0 vs. 100.0; $p=0.001$).

Other recorded outcomes in this study includes mixing ability index to measure mastication, maximum mouth opening, bite force, and complication rate, namely fistula, dehiscence, intraoral bone exposure, cutaneous perforation, screw loosening, and plate fracture. Groot et al. reported significant difference of mixing ability index between patients reconstructed with digitally planned FFF vs. bone graft vs. reconstruction plate (20.7 vs. 29.5 vs. 30.1; $p=0.007$). Moreover, different outcomes were measured between conventional FFF vs. CAD/CAM FFF vs. iliac crest flap (DCIA) vs.

intraop bent reconstruction plate vs. prebent reconstruction plate, in terms of cutaneous perforation (29,7% vs. 7,5% vs. 6,3% vs. 3,8% vs. 4,2%; $p=0.004$) and screw loosening (29,7% vs. 7,5% vs. 6,3% vs. 3,8% vs. 4,2%; $p=0.004$).

Quality Assessment

The quality assessment are presented on table 3. All studies conducted were evaluated using the 14 question Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies. All studies were rated as fair quality, based on our criteria.

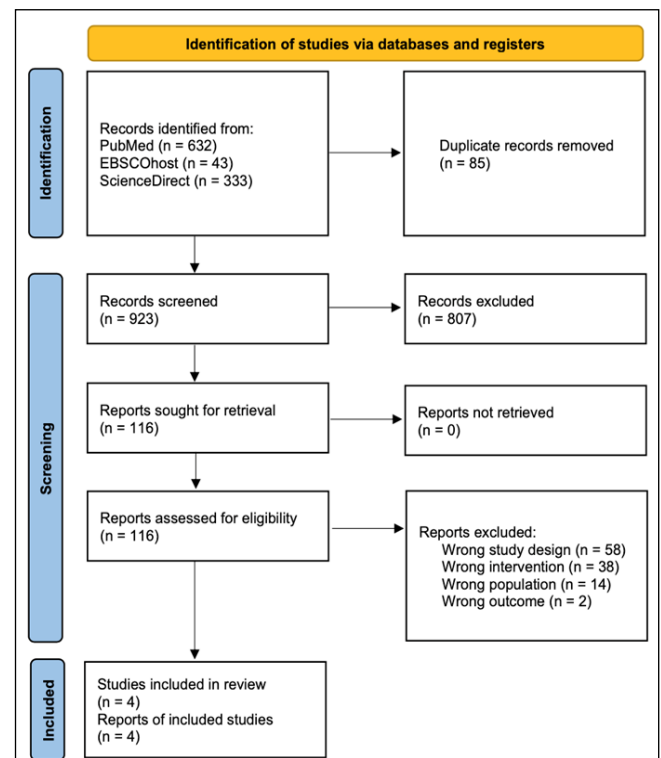


Figure 2. The selection process on PRISMA 2020 study selection flow.

Studies	Tool	Answered as "No"	Summary Quality
Davudov, 2019 ¹⁴	Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	3/14	Fair
Ritschl, 2020 ¹³	Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	1/14	Fair
Gemert, 2015 ¹²	Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	3/14	Fair
Groot, 2019 ¹⁵	Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies	4/14	Fair
Quality was rated as good (0 Answered as "No"), Fair (1-4 Answered as "No"), and Poor (>4 Answered as "No")			

Table 2. Patient characteristics, and outcomes of each studies.

Discussion

Mandibular reconstruction is essential to restore aesthetic and functional aspects of the

jaw, allowing patients to be better psychologically, as it minimizes the deformity, and physiologically, as it aids in speaking and mastication. However, the question of which reconstruction method to choose and which one is better than the other is still up for debate. This study aims to compare quality of life and clinical outcomes of patients receiving mandibular reconstruction with either bone graft or reconstruction plate.

In this study, 3 included studies compared the quality of life and clinical outcomes of patients after mandibular resection. The quality of life was measured by Gemert et al., Davudov et al., and Groot et al. using either EORTC QLQ-C30 version 3.0 and/or EORTC QLQ-H&N35 from the European Organisation for Research and Treatment of Cancer. The two questionnaire is aimed to assess quality of life in cancer patients by asking 30 or 35 questioned survey to patients. However, variable result were presented by each of the included studies.

Gemert et al. assessed the quality of life of patients with either benign or malignant tumor treated with segmental resection and reconstructed by using either FFF or reconstruction plate. Based on the analysis of EORTC QLQ- C30 version 3.0 and recorded variables, there is a difference and significant correlation of functional scale assessment and type of mandibular reconstruction. The team also found a difference and significant correlation of "feeling ill" point in the EORTC QLQ- H&N35 questionnaire, based on type of mandibular reconstruction. However, no significant difference were found in other topic on the quistionaire.

Another study by Davudov et al. assessed the quality of life of patients with either sarcoma or carcinoma and were treated with continuity resection and reconstructed by using either FFF or reconstruction plate or no reconstruction. Their investigation revealed no significant difference in all subsections of EORTC QLQ- C30 version 3.0 questionnaire, namely functional scale, symptom scale, and global health scale, between type of reconstructions. On the analysis of the EORTC QLQ- H&N35 results, the authors found a significant difference of speech problems, dry mouth, and feeling ill ($p < 0.05$). However, although they did not present the post hoc analysis between groups, they conclude that the significant differences were a result of analysis between no reconstruction and reconstruction group, implying there is no

difference of quality of life between reconstruction type.

Groot et al. in their study analyse the difference of quality of life of patients using the EORTC QLQ- H&N35, between patients receiving reconstruction with digitally planned FFF vs. bone graft vs. reconstruction plate. The recorded significant difference between reconstruction group in their study were weight loss (0.0 vs. 60.0 vs. 100.0; $p = 0.000$) and weight gain (16.7 vs. 100.0 vs. 100.0; $p = 0.001$). Other than that, the authors also presented significant difference of mixing ability index, to assess mastication, between reconstruction group. Although significant difference were favoured to the digital planning group, this study is one of the most biased based on our analysis (Table 3). Due to small sample size of the study, this study should also be considered as a pilot study.

Ritshcl et al. in their study presented complication rate between conventional FFF vs. CAD/CAM FFF vs. iliac crest flap (DCIA) vs. intraop bent reconstruction plate vs. prebent reconstruction plate. The study showed difference in cutaneous perforation (29,7% vs. 7,5% vs. 6,3% vs. 3,8% vs. 4,2%; $p = 0.004$), and screw loosening (29,7% vs. 7,5% vs. 6,3% vs. 3,8% vs. 4,2%; $p = 0.004$). However, no significant difference were observed in rate of fistula, dehiscence, intraoral bone exposure, and plate fracture. Lilies et al in their study also suggest that mandibular reconstruction using plate is only for temporary procedure, it is necessary to consider the use of either vascukarized or non vascularized grafts.

Based on the included studies, we concluded that there is no significant difference of quality of life between reconstruction groups, but significant difference were observed on the complication rate between groups. This study showed that quality of life alone should not be a sole consideration for deciding which modalities to choose to reconstruct mandibular defects.

Conclusions

Based on our included studies, there is no significant difference of quality of life in patients treated with resection between reconstruction group. However, complication rate differs between groups and should be assessed with a more in depth manner.

Declaration of Interest

The authors report no conflict of interest.

Author, Year	Study Design	Study Group	Population Characteristic	Pathological Conditions	Surgery and Graft Used	Outcomes Recorded	Result
Gemert, 2015 ¹²	Cross-sectional	Free Fibula Flap vs. Reconstruction Plate (n=37)	Age (Mean) FFF: 58.8 Plate: 69.3 F:M Ratio FFF: 5:4 Plate: 12:7	Benign and Malignant Tumors of Jaw	Segmental Resection, Free Fibula Flap	EORTC QLQ-C30 version 3.0	$r^2 = 0.155(p=0.023)$
						Functional Scale and and Type of Reconstruction	
						Symptom Scale and Type of Reconstruction	
						Global Health Scale and Type of Reconstruction	
						EORTC QLQ-H&N35	
						Pain	
						Swallowing	
						Senses problems	
						Speech problems	
						Trouble with social eating	
						Trouble with social contact	
						Less sexuality	
						Teeth	
						Opening mouth	
						Dry mouth	
						Sticky saliva	
						Coughing	
						Felt ill	
						Pain killers	
						Nutritional supplements	
						Feeding tube	
						Weight loss	
						Weight gain	
Ritschl, 2020 ¹³	Cohort-retrospective	Free Fibula Flap (A: Conventional and B: CAD/CAM) vs. Iliac Crest Flap (C: DCIA) vs. Reconstruction Plate (D: Intraop Bent vs. E: Prebent) n=(199)	Age (Median) FFF Conventional: 60,0 (27-76) FFF CAD/CAM: 56.0 (18-76) DCIA: 53.5 (24-71) Plate Intraop Bent: 69.3 (62.5 (43-86) Plate Prebent: 66.0 (14-93) F:M Ratio FFF Conventional: 22:41 FFF CAD/CAM: 8:18 DCIA: 11:13 Plate Intraop Bent: 16:21 Plate Prebent: 15:25	Benign and Malignant Tumors of Jaw	Continuity Resection, FFF or DCIA	A:B:C:D:E	$r^2 = 0.282 (p=0.007)$
						Fistula	
						Dehiscence	
						Intraoral bone exposure	
						Cutaneous perforation	
						Screw loosening	
						Plate fracture	
Davudov, 2019 ¹⁴	Cross-sectional	A: Free Fibula Flap vs. B: Reconstruction Plate vs. C: No Reconstruction (n=120)	Age (Mean) 50,4 F:M Ratio FFF: 22:17 Plate: 18:23 No Recon: 19:21	Carcinoma or Sarcoma	Continuity Resection, FFF	EORTC QLQ-C30 version 3.0	(A vs. B vs. C)
						Functional Scale and and Type of Reconstruction	
						Symptom Scale and Type of Reconstruction	
						Global Health Scale and Type of Reconstruction	
						EORTC QLQ-H&N35	
						Pain	
						Swallowing	
						Senses problems	
						Speech problems	
						Trouble with social eating	

						Trouble with social contact	ns
						Less sexuality	ns
						Teeth	ns
						Opening mouth	ns
						Dry mouth	21.5 vs. 47.5 vs. 28.2 (p=0.03)
						Sticky saliva	ns
						Coughing	ns
						Felt ill	8.3 vs. 20.8 vs. 8.5 (p=0.04)
						Pain killers	ns
						Nutritional supplements	ns
						Feeding tube	
						Weight loss	ns
						Weight gain	ns
Groot, 2019 ¹⁵	Cross-sectional	A: Digitally planned FFF vs. B: Bone Graft vs. C: Reconstruction Plate (n=15)	Age (Mean) A: 58.3 B: 53.6 C: 69.8 F:M Ratio A: 2:4 B: 2:3 C: 2:2	SSC and Other Carcinoma	Segmental Resection, FFF, DCIA	Mixing Ability Index (Mastication)	(A vs. B vs. C) 20.7 vs. 29.5 vs. 30.1 (p=0.007)
						Maximum Mouth Opening	ns
						Bite force	ns
						EORTC QLQ-H&N35	
						Pain	ns
						Swallowing	ns
						Senses problems	ns
						Speech problems	ns
						Trouble with social eating	ns
						Trouble with social contact	ns
						Less sexuality	ns
						Teeth	ns
						Opening mouth	ns
						Dry mouth	ns
						Sticky saliva	ns
						Coughing	ns
						Felt ill	ns
						Pain killers	ns
						Nutritional supplements	ns
						Feeding tube	
						Weight loss	0.0 vs. 60.0 vs. 100.0 (p=0.000)
						Weight gain	16.7 vs. 100.0 vs. 100.0 (p=0.001)

Table 3. Patient characteristics, and outcomes of each studies.

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