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RESEARCH ARTICLE

Evaluation on the use of plate positioning guide (PPG) on the placement accuracy of post-hemimandibulectomy plate reconstruction

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ABSTRACT

Improper placement of the reconstruction plate can lead to postoperative complications. Placing reconstruction plates that have arch for operation is made easier with the plate positioning guide (PPG) as a transfer method of reconstruction plate. This study aimed to assess the impact of PPG on the placement accuracy of reconstruction plate as determined by the symmetrical breadth of the mandibular arch and the consistent placement of reconstruction plate following hemimandibulectomy. According to the inclusion criteria, this was a retrospective cross-sectional study with 12 participants (n = 12) after hemimandibulectomy. Subjects were divided into PPG (n = 6) and Non-PPG (n = 6) groups. Measurement of the difference in the width of the mandibular arch and the height of the placement of the reconstruction plate between the reconstructed and non-resected sides in three positions (anterior, posterior, and angulus) was conducted using submentovertex radiographs and orthopantomogram (OPG) through the RadiAnt DICOM Viewer software. The placement accuracy of the reconstruction plates was analyzed using a one-sample t-test with p-value 0.05. The results showed that the placement accuracy of the reconstruction plate in the PPG group were accurate (p = 0.590), and the Non-PPG group was inaccurate (p = 0.000); with the independent sample test. There was a significant difference between the two groups (p = 0.000). Plate positioning guide provides better symmetry of the mandibular arch width post-hemimandibulectomy.

Keywords: accuracy of reconstruction plate placement; hemimandibulectomy; plate positioning guide (PPG)

INTRODUCTION

Hemimandibulectomy is a treatment to take part of the mandibular bone, which includes all the condyloid process, coronoid process, ramus, and part of the mandibular body on one side of the jaw, which can result in impaired aesthetic function and physiological function.[1,2,3,4,5] The use of commercial titanium (stock plates) is needed in mandibular reconstruction measures.[6,7]

Incorrect placement of reconstructive plates can lead to complications, such as dehiscence with or without intraoral and extraoral plate exposure, screw loss, plate fractures, and infection, as well as 50% of instances of osteomyelitis and orocutaneous fistulas.[8,9] The prebending method can make a reconstruction plate according to the shape of the anatomical arch of the mandible, which makes the placement of the reconstruction plate on the mandibular bone during surgery accord with the position during prebending, thus making it necessary to apply the transfer method of the reconstruction plate.[10,11,12]

During mandibular reconstructive resection, the plate placement guide (PPG) is a device that can use to transport reconstruction plates.[10,12] PPG makes use of a 3D mandibular anatomical model and a bent reconstruction plate, which serves as a guide for placing the reconstruction plate and screws on the remaining mandibular bone in the position determined before surgery.[11] The advantage of PPG is that it is easy to use and has high accuracy, thereby making work more accessible and shortening operation time.[10,12] PPG is placed by first positioning the PPG in a preset position, followed by setting the bent reconstructive plate on top of the PPG following the groove, and finally fixing the PPG with screws to the mandibular bone.[10,12]

In terms of mandibular segmental reconstruction, previous studies reported the results of the accuracy of placing the reconstruction plate and shortening the operating time as well as the ability to position the condyle head in its position.[10,11,13,14,15,16] Fariña et al used the prebending fariña's splint transfer method in a study of the use of non-vascular grafts in 11 cases of mandibular segmental reconstruction and three instances of hemimandibulectomy reconstruction.[12] Wilde et al compared ten patients of mandibular segmental reconstruction using the prebending transfer method with the name transfer key with the standard method (without critical transfer) in an in vitro study. The results were statistically insignificant between the two groups.[17] Wilde et al. also conducted the same analysis with 42 cases, and showed that using the critical transfer method provided better clinical accuracy, effectiveness, and accuracy in the fixation of the prebending plate.[18]

To our knowledge, no research has been done on hemimandibulectomy reconstruction using the PPG transfer technique. Hence, this research aimed to evaluate the influence of PPG on the precision of reconstruction plate order as assessed by the symmetrical breadth of mandibular arch and similarity in reconstruction plate position.

MATERIALS AND METHODS

Dr. Sardjito Hospital Yogyakarta is a member of the Research Ethics Commission team of the Faculty of Medicine, Public Health, and Nursing at Universitas Gadjah Mada (Ref. No. KE/FK/0944/EC/2020). This study was a retrospective cross-sectional investigation on 12 participants recruited at Dr. Sardjito's hospital, using sequential sampling methods. Subjects who fulfilled the inclusion and exclusion requirements were split into two groups: the PPG group (n = 6) who had reconstruction while utilizing PPG to transfer the placement of bent reconstruction plates, and the Non-PPG group (n = 6) who underwent reconstruction without PPG. The exclusion criteria in this study were: patients who could not get in touch; patients who refused or did not attend the examination; and patients who had fractured in the reconstruction plate or lost screws in the reconstruction plate resulting in a change in position. The inclusion criteria in this study were: patients with benign tumors aged over 18 years who had undergone hemimandibulectomy reconstruction without bone graft in the period of 2014-2019 at the oral surgery polyclinic Dr. Sardjito Hospital; patients with the use of a 3D mandibular model for prebending; patients with the resection border crossing the region of the first molars and did not cross the midline; and patient who did not experience recurrences.

PPG uses various methods a 3D mandibular anatomical model and a bent reconstruction plate. The replacement plate was crooked in such a way as to follow the shape and contour of the mandible. The dish's wavy edge used the template's top limit. At the same time, the border of the mandible served as its bottom boundary after developing the PPG design in line with the reconstruction plate. In this study, acrylic, rubber base, and shellac were used (Figure 1) for the manufacture of PPG.

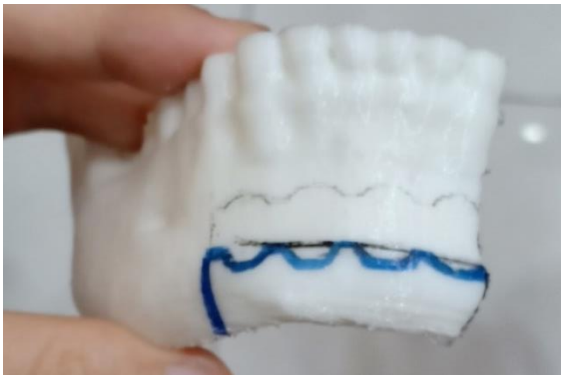
The accuracy of the reconstruction plate placement was determined by measuring the breadth of the mandibular arch and comparing the positioning of the reconstruction plate on the reconstructed and non-resected sides. Measurements was conducted using submentovertex and OPG rontgent photos in RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit) Windows 10 system by a radiologist of Prof. RSGM. Soedomo UGM and a resident of the oral and maxillofacial surgery of UGM who previously had Cohen's Kappa test.

Measurement of the mandibular arch width was conducted using submentovertex X-rays by: (1) creating a perpendicular median line from the point of recognition in the mandibular arch that separated the non-resected side of the mandible from the one that had been attached to the reconstruction plate; (2) measuring the side of the mandible that was not resected anteriorly (midpoint of the mandible region of the canine) to the median line in units of centimeters (cm) with code symbol X1; (3) taking measurements

on the side of the reconstruction plate (midpoint of the reconstruction plate for the canine region) to the median line with the symbol code X1'; (4) if the resection boundary did not cross the canine, the initial measurement point was at the most anterior point of the resection boundary and the measurement point X1 would follow the opposite point X1'; (5) taking measurements on the posterior side of the unresected mandible (midpoint of the mandible in the first molar region) and the unresected angular region (gonion point) in the same manner as the symbol codes X2 and X3, followed by measurements on the side of the reconstruction plate with the symbol code X2' and X3' (Figure 2).

Measurement of the similarity in the placement of the reconstruction plate using an OPG X-ray was conducted by the following procedures: (1) making the median and horizontal oblique line angles perpendicular to the median line as a guide to determine the accuracy of placing the reconstruction plate; (2) measuring the first point on the unresected edge of the inferior anterior margo of the mandible (perpendicular to the maxillary canine region) to the horizontal line in units of cm with code Y1; (3) measuring the reconstructed mandible at the very bottom of the reconstruction plate to the horizontal line (perpendicular to the maxillary canine region) plus 1 cm with the code symbol Y1'; (4) if the resection boundary did not cross the canine, the initial measurement point was at the most anterior point of the resection boundary and the measurement of the Y1 point would follow the opposite Y1' point; (5) taking measurements on the posterior side (perpendicular to molar region 1 maxilla) in the same way as the code symbol Y2 and followed by the measurement on the part resected with

(A)



(B)

(C)

(D)

Figure 1. The process of making PPG. (A) Prebending reconstruction plate; (B) PPG designs; (C) Acryl used to make PPG; (D) PPG from shellac material

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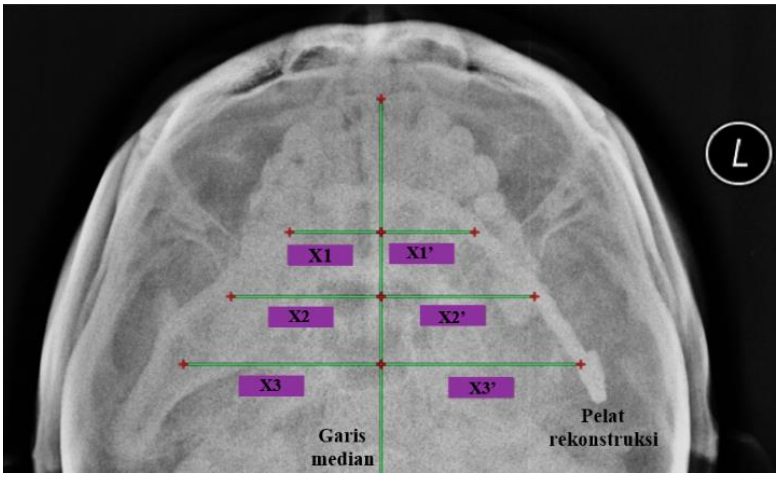

Figure 2. Illustration of symmetrical measurement of mandibular arch width with rontgen submentovertex photograph

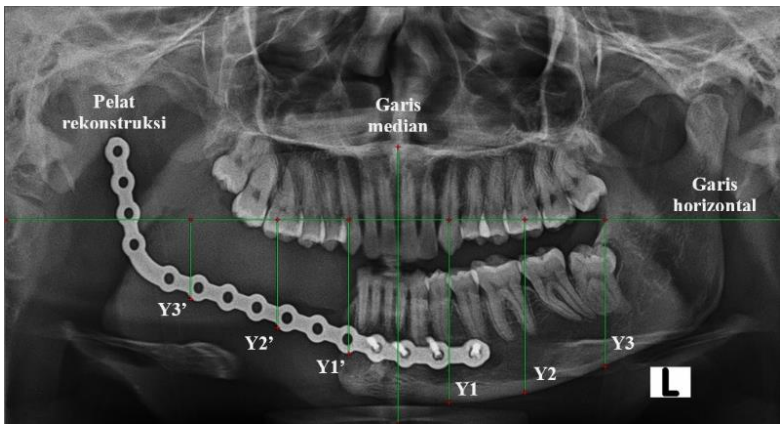

Figure 3. Illustration of the similarity measurement in the placement of the reconstruction plate using OPG X-rays

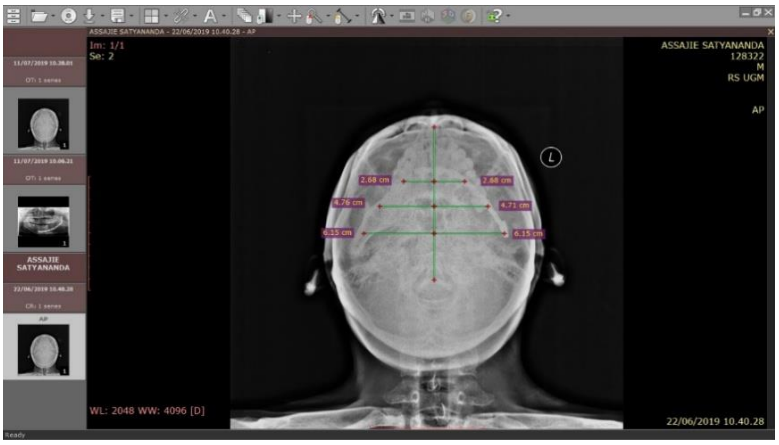

Figure 4. The measurement results of the symmetrical mandibular arch width using submentovertex X-rays were determined using RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit). (A) Anterior position (Caninus); (B) Posterior position (first Molar); (C) Angulus position.

the symbol code Y2'; (6) taking measurements at the linea oblique angle point (perpendicular) in the same way as the symbol Y3 and followed by measurements on the part that was resected with the code symbol Y3' (Figure 3).

A one-sample t-test was conducted to analyze the data to determine the placement accuracy of the reconstruction plate, the symmetrical width of the mandibular arch, and the similarity in the height of the reconstruction plate's post with p value 0.05. If there was no difference ($p > 0.05$), the results were deemed accurate or symmetrical and had the same size. The PPG and Non-PPG groups were contrasted using an independent sample test. Normality and homogeneity tests on all measurements of the two groups were conducted using the Shapiro-Wilk and Levene's trial, and the results showed that the information was equally distributed and homogeneous. The confidence level of this study was 95% ($p = 0.05$), and data processing was concluded with IBM SPSS version 23 software on a Windows 8 system.

It was possible to achieve mandibular arch width symmetry from the comparison of measurements of the non-resected mandibular arch width with the curved width of the reconstruction plate to the median line using submentovertex X-rays on RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit). Measurements were made at three positions, namely anterior (Caninus), posterior (first Molar), and angle (Figure 4).

RESULTS

The research subjects amounted to 12 patients, who were divided into two groups with a balanced number ($n = 6$). The characteristics of the age, gender, diagnosis, defect-wide classification, operating time interval to study time, and type of PPG used are presented in Table 1.

The results of measuring the difference in the average curvature of the placement of the reconstruction plate based on the position, and determining the level of symmetry, were analyzed using a one-sample t-test. The results of the one-sample test were said to be symmetrical when there was no difference ($p > 0.05$). The balanced comparison between the PPG and Non-PPG groups in the test was conducted using the independent sample test, and it was disclosed that there was a difference of $p < 0.05$. Statistically, the anterior position in the PPG group showed symmetrical results ($p = 0.267$), and the Non-PPG group was not balanced ($p = 0.018$). The posterior part in the PPG and Non-PPG groups was proportional ($p > 0.05$), but between the two groups, there was no significant difference ($p > 0.05$). The position of the angulus in the PPG group showed symmetrical results ($p = 0.583$) but the non-PPG asymmetrical ($p = 0.001$). In addition, between the two groups, there was a significant difference with a value of $p = 0.001$ (Table 2).

Observations of each subject on the symmetrical arch width of the placement of the mandibular reconstruction plate after hemimandibulectomy in the PPG group were 83.3%. In contrast, in the Non-PPG group, the level of symmetry was lower and only found in 50% of subjects (Table 3).

Measurements were made via OPG photos with RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit) at three positions, namely anterior (Caninus), posterior (first Molar), and angulus (angle of the linea oblique) (Figure 5). One centimeter was added to the space between the bottom edge of the reconstruction plate and the horizontal line of the diagonal line to compare it to the distance between the margo mandibular edge that was impossible to fix and the horizontal line of the oblique line angle perpendicular to the median line.

The difference measurement in the average height of the placement of reconstruction plate based on the position and the level of height similarity for each part were analyzed using a one-sample test. The data were considered the same if the results were not different ($p > 0.05$). The comparison between the PPG and Non-PPG groups was conducted using the independent sample test, $p < 0.05$. Statistically, the anterior position in the PPG group showed the same height ($p = 0.109$), and the Non-PPG group did not

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have the same height (p = 0.018). The posterior position in the PPG and Non-PPG groups was not in the same height (p < 0.05), and there was no significant difference between the two groups (p > 0.05). The angulus positions in the PPG and Non-PPG groups were not in the same height (p < 0.05), but between the two groups, there was a significant difference with a value of p = 0.003 (Table 4). In the PPG group, each subject's similarity in the height placement of mandibular reconstruction plate height placementfollowing hemimandibulectomy was as high as 100%. In contrast, in the Non-PPG group, the level of similarity of subjects was lower with 83.3% of subjects (Table 5).

The placement accuracy of the reconstruction plate is the symmetrical width of the mandibular arch as seen from the width of the mandibular arch and the similarity in the post of the mandible reconstruction plate by comparing the resected and non-resected mandibles after hemimandibulectomy. It is an evaluation of

Table 1. Characteristics of research subjects

Variable	PPG group			Non-PPG group		
	Mean ± SD	n	%	Mean ± SD	n	%
Age (years)	29.00 ± 8.17			39.33 ± 8.43		
Gender :						
Man		6	100		4	66-7
Women					2	33.3
Diagnosis:						
Ameloblastoma		5	83.3		5	83.3
Odontogenic keratocyst		1	16.7			
Ossifying fibroma					1	16.7
Classification of defects (Brown, 2016):						
IC class		5	83.3		2	33.3
IIC class		1	16.7		4	66.7
Operation time interval to study time (months)	24.00 ± 7.58			48.83 ± 21.47		
PPG type:						
Acrylic		3	50			
Rubber base		2	33.3			
Shellac		1	16.7			

Table 2. The results of the difference in the measurement of the reconstruction plate placement consist of the width of the mandibular arch seen from the anterior, posterior, and angulus points

Mandibula width (Measuring Position)	PPG (n = 6)		Code	Non-PPG (n = 6)		Code	PPG vs. Non-PPG
	mean ± SD (cm)	p^1		mean ± SD (cm)	p^1		p^2
Anterior (Caninus)	0.245 ± 0.284	0.267	S	0.592 ± 0.347	0.018	NS	0.088
Posterior (First Molar)	0.312 ± 0.211	0.057	S	0.503 ± 0.426	0.068	S	0.346
Angulus (Angulus Angle)	0.137 ± 0.153	0.583	S	1.019 ± 0.351	0.001	NS	0.001*

Mean = Calculated was the mean difference in the mandibular arch width from the difference between the reconstructed and the non-reconstructed sides. p^1 base on one sample test with a test value = 0.1 cm, p^2 relevance base on the independent sample test, p-value = 0.05, * = significan, S = symmetric, NS = not symmetric.

how vast the mandibular arch was from the measurement of the anterior position (Caninus), the posterior part (first Molar), and the angulus position (angle of the angle). We measured the height of the reconstruction plate installation from the measurement of the anterior part (Caninus), the posterior position (first Molar), and the angulus position (oblique line angle).

The symmetry of the width of the arch and the height of the placement of the reconstruction plate of the mandible were analyzed using a one-sample test, and it was considered as symmetrical when they had an exact size and if the results were not different ($p > 0.05$). The accuracy of the mandibular reconstruction plate placement was obtained from the symmetrical width of the mandibular arch and the similarity in the post of the reconstruction plate and it was analyzed using a one-sample test. The comparison between the PPG group and the Non-PPG group was tested using the independent sample test with a p of < 0.05. It worked accurately if the results were not different ($p > 0.05$).

PPG groups (100%) complied with each subject's assessment of accuracy, as seen from the fact that the mandibular reconstructive plate installation came after the hemimandibulectomy. The data revealed that the height placement of PPG group's reconstruction plate and mandibular arch width produced symmetrical outcomes and were the same height ($p > 0.05$), although they were not balanced. However, the Non-PPG group ($p < 0.05$) did not have the same size as shown through a significant difference between the two groups ($p < 0.05$). The placement accuracy of the reconstruction plate was obtained in the PPG group ($p = 0.590$), while the Non-PPG group did not provide accurate result ($p = 0.000$). The difference between the two groups gave a significant value of $p = 0.000$ (Table 6). At the same time, the Non-PPG group had lower result with 66.7% (Table 7).

DISCUSSION

The minimum research subjects in this study led to some challenging issues, since some subjects declined to participate in this study. In addition, the use of PPG for hemimandibulectomy reconstruction in Dr. Sardjito Yogyakarta's oral surgery polyclinic only began in 2018, and thus the

Table 3. The results of the curve width symmetrical test placement of the reconstruction plate between the PPG and Non-PPG groups after hemimandibulectomy for each subject

Group	Subject	Width of mandibula		Code	Symmetrical (%)
		mean ± SD (cm)	p		
PPG (n = 6)	1	0.243 ± 0.238	0.406	S	83.3%
	2	0.230 ± 0.265	0.485	S	
	3	0.017 ± 0.029	0.038	NS	
	4	0.280 ± 0.176	0.218	S	
	5	0.410 ± 0.339	0.254	S	
	6	0.207 ± 0.153	0.351	S	
Non-PPG (n = 6)	1	0.767 ± 0.686	0.234	S	50%
	2	0.740 ± 0.580	0.196	S	
	3	1.097 ± 0.375	0.044	NS	
	4	0.453 ± 0.360	0.231	S	
	5	0.523 ± 0.137	0.033	NS	
	6	0.647 ± 0.182	0.035	NS	

mean = Calculated was the mean difference in the mandibular arch width from the difference between the reconstructed and the non-reconstructed sides. p based on one sample test with a test value = 0.1 cm, p-value = 0.05, S = symmetric, NS = not symmetric.

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Figure 5. Calculations made were utilizing the OPG rontgen image to determine the height of the reconstruction plate placement with the RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit). (A) Anterior position (Caninus); (B) Posterior position (first Molar); (C) Angulus position (linea oblique angle).

Table 4. The test results for the placement of the mandibular reconstruction plate from the anterior, posterior, and angulus measurement points

Mandibula Width (Measuring Position)	PPG (n = 6)		Code	Non-PPG (n = 6)		Code	PPG vs. Non-PPG
	mean ± SD (cm)	p[1]		mean ± SD (cm)	p[1]		p[2]
Anterior (Caninus)	0.273 ± 0.218	0.109	S	0.517 ± 0.295	0.018	NS	0.135
Posterior (First Molar)	0.378 ± 0.205	0.021	NS	0.757 ± 0.511	0.025	NS	0.123
Angulus (Angulus Angle)	0.337 ± 0.225	0.049	NS	1.283 ± 0.542	0.003	NS	0.003*

mean= The difference between the side undergoing reconstruction and the side not undergoing reconstruction is used to compute the average difference in the height of the reconstruction plate. p[1] significance based on one sample test with a test value = 0.001, p[2] relevance based on the independent sample test, p-value = 0.05, * = significan, S = equal high, NS = not the same high.

number of patients was very limited. As a result, the research power dropped from 99.3% to 80.2%.

This preliminary study is the first to evaluate the placement accuracy of reconstruction plate against the use of PPG after hemimandibulectomy, since previous studies have only assessed segmental mandibular reconstruction. The reports of Farina et al, in two cases compared the reconstruction plate's location and the condyle head before and after surgery was finished. Wang et al, in one instance, and Funayama et al in two cases of mandibular segmental excision and bilateral and unilateral abnormalities included the symphysis, corpus, and angulus. The assessment merely finished visually using OGP photos, and accuracy became available in the placement of the reconstruction plate, but there was no change in the position of the condyle head.[10,11,14] Another study by Berrone et al examined 4 cases of mandibular segmental reconstruction using fibular-free grafts with bilateral and unilateral defects involving the corpus and symphysis, requiring a transfer method for the evaluation focused on placement of the reconstruction plate, aesthetics, and functional movement. The assessment was performed visually on the CT scan results before and after surgery. It worked out accurately in the post of the reconstructive plate, there was no change in the mandibular edge, and contour of the lower third of the face, and the condyles head remained in position.[13] In this study, the reconstruction did not evaluate condyle motion. Still, it focused on determining the placement accuracy of the reconstruction plate by

Table 5. The results of the height test placement of the mandibular reconstruction plate between the PPG and Non-PPG groups after hemimandibulectomy for each subject

Group	Subject	Platen Placement Height mean ± SD (cm)	p	Code	High similarity (%)
PPG (n = 6)	1	0.307 ± 0.085	0.052	S	100%
	2	0.237 ± 0.198	0.354	S	
	3	0.293 ± 0.316	0.401	S	
	4	0.377 ± 0.314	0.266	S	
	5	0.307 ± 0.085	0.052	S	
	6	0.457 ± 0.266	0.146	S	
Non-PPG (n = 6)	1	0.730 ± 0.598	0.210	S	83.3%
	2	0.663 ± 0.426	0.147	S	
	3	1.093 ± 0.240	0.019	NS	
	4	1.477 ± 0.827	0.102	S	
	5	0.517 ± 0.311	0.146	S	
	6	0.633 ± 0.408	0.152	S	

mean= The difference between the side undergoing reconstruction and the unreconstructed side was used to compute the average difference in plate location during reconstruction. p based on one sample test with a test value = 0.1 cm, p-value = 0.05, S = the same height, NS = not the same size.

Table 6. The accuracy test results for placement of the reconstruction plate based on the symmetrical width of the mandibular arch and the height of the post of the reconstruction plate of the mandible following hemimandibulectomy in the PPG and Non-PPG groups

Mandibula Measurement	PPG (n = 6)		Code	Non-PPG (n = 6)		Code	PPG vs Non-PPG
	mean ± SD (cm)	p^1		mean ± SD (cm)	p^1		p^2
Arch width	0.231 ± 0.222	0.205	S	0.704 ± 0.423	0.001	NS	0.000*
Plate height	0.329 ± 0.208	0.556	S*	0.852 ± 0.545	0.000	NS*	0.001*
Width + Height	0.280 ± 0.218	0.590	A	0.778 ± 0.487	0.000	NA	0.000*

mean= The difference between the side undergoing reconstruction and the side not undergoing reconstruction was used to compute the average difference in plate placement. p^1 based on one sample test with a test value = 0.1 cm, p^2 based on the independent sample test, p-value = 0.05, * = significan, S = symmetrical, NS = not balanced, S* = equal height, NS* = not the same height, A = accurate, NA = not accurate.

assessing it through measurements on OPG and submentovertex photos using RadiAnt DICOM Viewer software version 5.5.0.23265 (64-bit), thus providing more objective information.

The experiment used OPG pictures to evaluate how comparable the height placement of the reconstruction plate following hemimandibulectomy. In contrast, Azuma et al used OPG photos to see the symmetrical angle of the mandible after segmental reconstruction. They compared the prebending 3D model group with the conventional method, and obtained significantly more symmetrical results in the prebending group.[19]

The reconstruction plate in this study was placed under contour with more medial placement, entering as deep as the thickness so that the outer surface of the reconstruction plate was in a position parallel to the remaining mandibular bone, as was done by Fariña et al and Wang et al.[10,11] The measurement procedure for the mandible used three measurement points using OPG and

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Table 7. The test results for the accuracy of placement of the mandibular reconstruction plate between the PPG and Non-PPG groups after hemimandibulectomy for each subject

Group	Subject	Reconstruction plate width and height mean ± SD (cm)	p	Code	Accuracy (%)
PPG (n = 6)	1	0.275 ± 0.164	0.723	A	100%
	2	0.233 ± 0.209	0.470	A	
	3	0.155 ± 0.252	0.217	A	
	4	0.328 ± 0.234	0.778	A	
	5	0.358 ± 0.228	0.558	A	
	6	0.332 ± 0.237	0.757	A	
Non-PPG (n = 6)	1	0.748 ± 0.576	0.115	A	66.7%
	2	0.702 ± 0.456	0.083	A	
	3	1.095 ± 0.282	0.001	NA	
	4	0.965 ± 0.799	0.097	A	
	5	0.520 ± 0.215	0.054	A	
	6	0.640 ± 0.283	0.032	TA	

mean= the difference between the side undergoing reconstruction and the side not undergoing reconstruction was used to compute the average difference in plate placement. p based on one sample test with test value = 0.1 cm, p-value = 0.05, A = accurate, NA = inaccurate.

submentovertex images, namely the anterior point (Caninus region), the posterior point (first Molar region), and the angulus point. The measurement points were determined based on the curvature of the mandible.[1] These measurement points were slightly different from the study by Wilde, who compared the reconstruction plate transfer method in 42 patients with segmental mandibular reconstruction with unilateral or bilateral defects involving the angulus and coronoid process using 6-point measurements on pre-and postoperative CT scans. The measurement points were carried out on the condyles (2 points), mandibular notch, mandibular lingula, coronoid process, and mandibular angle, obtaining better accuracy on the transfer method compared to the standard procedure, and there was no change in the position of the condyle head.[18]

This study showed that the mandibular arch in the PPG group was symmetrical, and that there was a significant difference between the two groups. One issue in the PPG group showed asymmetrical results, particularly the one using shellac material. It was probably because the shellac material was prone to changes due to hot temperatures, which might lead to distortion and make it unstable as compared to acrylic.[20,21]

The height placement of the reconstruction plate in the PPG group showed that it had the same size, and the two groups showed a significant difference. The use of PPG can assist the height placement of the reconstruction plate. Because of the occlusal surface tracing of the tooth, the residual mandibular structure and the plate's indentation, the reconstruction plate was positioned on the mandibular bone in PPG at the exact location as prebending on the 3-dimensional anatomical model of the mandible.[10,11]

The symmetrically curved breadth and the similarity in the positioning of the reconstruction plate demonstrate the research accuracy. They have achieved expected accuracy in individuals across all PPG groups. In contrast, there was a significant difference in the accuracy of the non-PPG group had, as seen from the comparison between the groups. PPG in this study provided better accuracy, although some inaccurate placement might still occur, which was attributed to several factors, including the 3D model of the mandible that

was not the same as the patient's actual mandible, the operator's difficulty in positioning PPG on the remaining side of the mandible, and the selected materials for use. The difference in the mandibular 3D model used to manufacture PPG can serve as the reason for the thickness of the patient's MSCT piece of more than 1.0 mm and the inaccuracy of the prototype machine used to print the model. Some materials used to manufacture PPG can change their shape and dimensions due to sterilization, especially heating.[17,18]

Liang et al reported seven cases of mandibular segmental reconstruction with defects involving the ramus, corpus, and symphysis, using the computer-aided design computer-aided manufacture (CAM/CAD) reconstruction plate transfer method. It resulted in inaccuracy in placing the reconstruction plate, making plate placement easy, restoring the occlusal relation, and stabilizing the position of the condyle.[15] This study, however, did not not use CAD / CAM techniques, but statistically, it could produce the accuracy of placing the reconstruction plate using PPG. This study used PPG made of acrylic, shellac, and rubber base, with transfer guidance using the remaining mandibular structure and the reconstruction plate indentation structure. This method was practical and was cost-efficient. PPG can be produced manually using dental materials. This transfer method can be an alternative in determining the placement of reconstruction plates in areas where CAD/CAM systems are unavailable.

In this study, there was no benchmark for symmetrical criteria in the shape of the mandible. In addition, there was no record of the placement of the reconstruction plate before surgery, the determination of measurement points that need to be improved (deviation can still occur at other issues), and there was no analysis of the condyle. This condition can affect the symmetry of the mandible. According to Moraes et al, faces that are completely symmetrical right and left do not exist. Still, asymmetrical conditions need to be made as small as possible, so further research is necessary to find symmetric reference values.[22]

CONCLUSION

The research and data analysis on six subjects in the PPG group and six issues with Non-PPG after hemimandibulectomy reconstruction, revealed that PPG individuals had a similar reconstruction of plate order, and there was a huge difference between the two groups. Thus, it is conclusive that the use of a plate positioning guide (PPG) on the transfer of the reconstruction plate could provide better accuracy in the entire PPG group for the placement of post hemimandibulectomy reconstruction plate based on the symmetrical width of the mandibular arches and the similarity in height for the order of the reconstruction plate.

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