Symmetrical Midfacial Growth After Pediatric Mandibular Reconstruction With Free Fibula Flap

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Background: Free fibula is the workhorse flap for mandibular reconstruction and is increasingly being used in pediatric patients. However, craniomaxillofacial growth and development involve interdependent processes, and it remains unknown whether mandibular reconstruction with free fibula allows symmetric growth of the midface.

Purpose: The study evaluated midfacial symmetry after pediatric mandibular defect reconstruction.

Study Design, Setting, Sample: This retrospective cohort study included pediatric patients aged ≤14 years who underwent mandibular reconstruction with free fibula flap. Postoperative computed tomography data were obtained at predefined follow-up time points. Midfacial symmetry was evaluated based on 3-dimensional (3D) cephalometry.

Predictor variable: The predictor variable was the side of the midface (affected or healthy side relative to the mandibular defect).

Main Outcome Variables: The primary outcome variable was postoperative midfacial symmetry (at 1 week, 6 months, 1 year, 2 years, and >3 years, or after the age of 18 years), assessed in horizontal, vertical, and anteroposterior dimensions using 3D cephalometry. Another outcome variable was patient satisfaction based on a self-evaluation using visual analog scoring.

Covariates: Sex, age, diagnosis, and type of denture restoration.

Analyses: Paired t tests were performed to assess the relationship between the predictor and outcome variables, with the significance level of $P < .05$.

Results: A total of 13 patients were included in this study (9 males and 4 females; mean age: 12.23 ± 2.39 years). The average distance from upper first molar point (U6) to the horizontal plane on the affected side became greater than on the healthy side (difference: 0.7 ± 0.5 mm to 1.6 ± 1.4 mm, $P < .05$), while the average distance from pterygomaxillary fissure to coronal plane on affected side became shorter than that on the healthy side (difference: 0.6 ± 0.6 mm to 1.2 ± 1.1 mm, $P < .05$) from

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1 year after the surgery. There were no statistically significant differences in the remaining measurements between the 2 sides ($P > .05$). All the patients were satisfied with their postoperative facial symmetry.

Conclusions and Relevance: There were no severe midface deformities after pediatric mandibular reconstruction with free fibula flap. Meanwhile, pediatric mandibular reconstruction and proper occlusion could promote midfacial growth and symmetry.

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Mandibular defects in pediatric patients can cause severe functional and cosmetic deformities, as well as disruption of the normal occlusion. It is generally accepted that normal occlusal and functional stimulation are essential for cranio-maxillofacial development.[1,2] Mandibular defects in pediatric patients not only cause deformities of the upper third of the face, but may also affect the growth and development of the midface.

Free fibula is the workhorse flap for mandibular reconstruction, and is increasingly being used in pediatric patients.[3-7] Recently, we demonstrated that mandibular reconstruction with the fibula facilitates growth in pediatric patients by restoring the continuity of mandible and maintaining the occlusal relationship of the remaining teeth.[8] However, it remains unknown whether this also leads to the symmetric growth of the midface. Previous study demonstrated that pediatric mandibular reconstruction using osteocutaneous flaps and dental rehabilitation could promote craniomaxillofacial growth and facial symmetry.[1,7,9-11] Currently, there is a lack of 3-dimensional (3D) cephalometric evaluations of the effects of mandibular reconstruction on midface growth in pediatric patients.

The purpose of this study was to quantitatively analyze midfacial symmetry after pediatric mandibular defect reconstruction with free fibula flap. We hypothesized that there would be no severe midface deformities after pediatric mandibular reconstruction with free fibula flap. In particular, the study aimed to estimate midfacial symmetry and patient satisfaction.

Patients and Methods

STUDY DESIGN AND SAMPLE

Based on the research objective, we designed and conducted a retrospective cohort study. The study population comprised pediatric patients who presented for mandibular reconstruction with vascularized free fibula flap. The procedures were performed by a single surgical team at the Department of Oral and Maxillofacial Surgery, Peking University School and Hospital of Stomatology between May 1999 and March 2020, were reviewed. The inclusion criteria were:

1) age at surgery ≤14 years;
2) sequential computed tomography (CT) data at each postoperative follow-up point (1 week, 6 months, 1 year, 2 years, and >3 years) or CT data after the age of 18 years;
3) no local recurrence after surgery;
4) no systemic disease affecting bone metabolism; and
5) no orthodontic or orthognathic surgery treatment performed during the follow-up period.

This study followed the ethical principles of Declaration of Helsinki and was approved by the regional ethical review board of the Peking University School and Hospital of Stomatology (approval number: PKUSSIRB-201734038).

THREE-DIMENSIONAL CEPHALOMETRY

Spiral CT data for each postoperative follow-up point were imported in DICOM format into the ProPlan CMF 3.0 (Materialise, Leuven, Belgium). Multiplanar sagittal, coronal, axial, and 3D reconstruction images were obtained, along with the special 3D cephalometric module. The landmarks were defined using multiple planar reconstruction (Table 1).

After importing the spiral CT data, a 3D virtual skull model was created. The maxilla was segmented from the skull in preparation for 3D cephalometry. Points OrL, OrR, PoL, and PoR were defined, and the Frankfort Horizontal (FH) plane was created based on points MOr (the midpoint between OrL and OrR), PoL, and PoR. Standard head positioning was achieved using the FH plane (Fig 1). Three reference planes were defined using nasion (N): the horizontal plane (HP) passed through point N and was parallel to the FH plane; the midsagittal plane (MSP) intersected points N and S, and was perpendicular to FH plane; and the coronal plane (CP), passing through point N perpendicular to both HP and MSP (Fig 2). The remaining points listed in Table 1 were then defined (Fig 3A-D), and 3D cephalometric measurements were performed

Table 1. DEFINITIONS OF SKELETAL LANDMARKS

Landmarks	Abbreviation	Definition
Sella	S	The center of the hypophyseal fossa
Nasion	N	The median point of the frontonasal suture
Porion	Po (L, R)	The most superior point of the external acoustic meatus
Orbitale	Or (L, R)	The lowest point on the orbital margin
Frontozygomatic suture	Fm (L, R)	The most lateral and most superior point on each frontozygomatic suture on the lateral orbital edge
Zygion	Zy (L, R)	The most lateral point on the contour of each zygomatic arch
Zygomaxillary suture	Zm (L, R)	The most lateral and most inferior point of the zygomaxillary suture
Pterygomaxillary fissure	Pt (L, R)	The posterosuperior point on the margin of the pterygomaxillary fissure
Upper first molar	U6 (L, R)	The tip of the mesiobuccal cusp of the maxillary first molar

Abbreviations: L, left; R, right.

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based on the definitions presented in Table 2. Midfacial symmetry was evaluated from the horizontal, vertical, and anteroposterior aspects. All measurements were independently recorded by 2 experienced investigators who were not involved in the surgery, and their average was calculated.

Satisfaction with the facial symmetry outcomes was scored by the patients using visual analog scoring, and categorized as fully satisfied (8 to 10), fairly satisfied (4 to 7), and not satisfied (0 to 3). An investigator who was not involved in the surgery administered the survey.

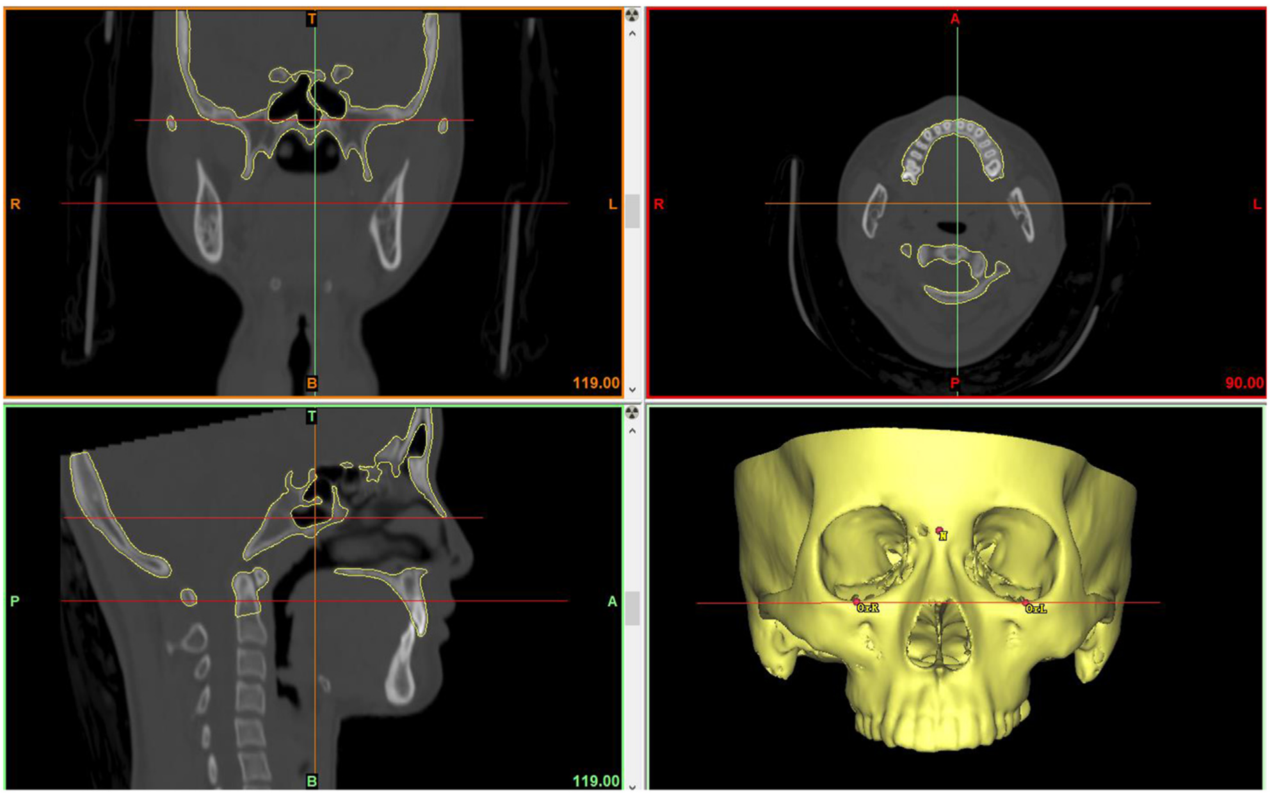

FIGURE 1. Determination of the points and reference planes for standard head positioning.

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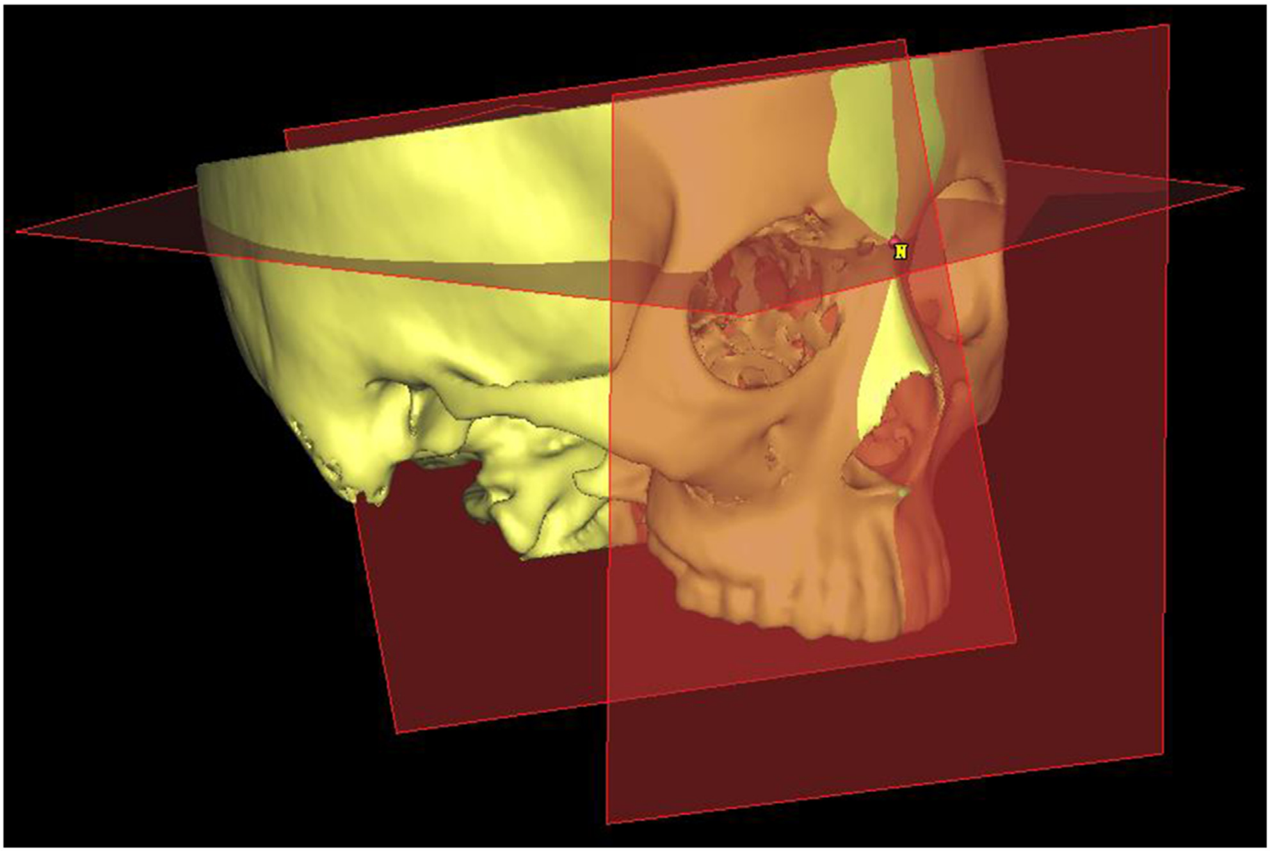

FIGURE 2. Determination of the 3 reference planes.

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STUDY VARIABLES

The primary predictor variable was the side of midface (affected or healthy side relative to the mandibular defect). The other study variables included age, sex, and types of denture restoration.

The primary outcome variable was postoperative midfacial symmetry, which was assessed in horizontal, vertical, and anteroposterior dimensions through 3D cephalometry.

Another outcome variable was patient satisfaction, self-evaluated using visual analog scoring.

STATISTICAL ANALYSIS

Paired-sample Student's *t* test was used to compare 3D cephalometric measurements between the affected and healthy sides. The consistency in 3D measurement between the 2 investigators was assessed by calculating the intraclass correlation coefficient. IBM SPSS Statistics 21.0 (IBM Corp, Armonk, NY, USA) was used for statistical analyses. $P < .05$ was considered statistically significant.

Results

PATIENT DEMOGRAPHICS

The study included 13 pediatric patients (9 males and 4 females; mean age: 12.23 ± 2.39 years, median age: 14 years, age range: 8 to 14 years; Table 3). Eight patients had sequential CT data for each postoperative follow-up point, and 8 were followed up to ages >18 years using the CT data. All fibula flaps were successfully integrated.

HORIZONTAL SYMMETRY

The horizontal measurements, which reflect the growth and development of the midfacial width, showed no statistically significant differences between the affected and healthy sides relative to the MSP during follow-up ($P < .05$). This indicates that the midface remained horizontally symmetrical, and its width was equal on either side (Table 4).

VERTICAL SYMMETRY

Vertical measurements, which reflect the growth and development of midfacial height, showed that

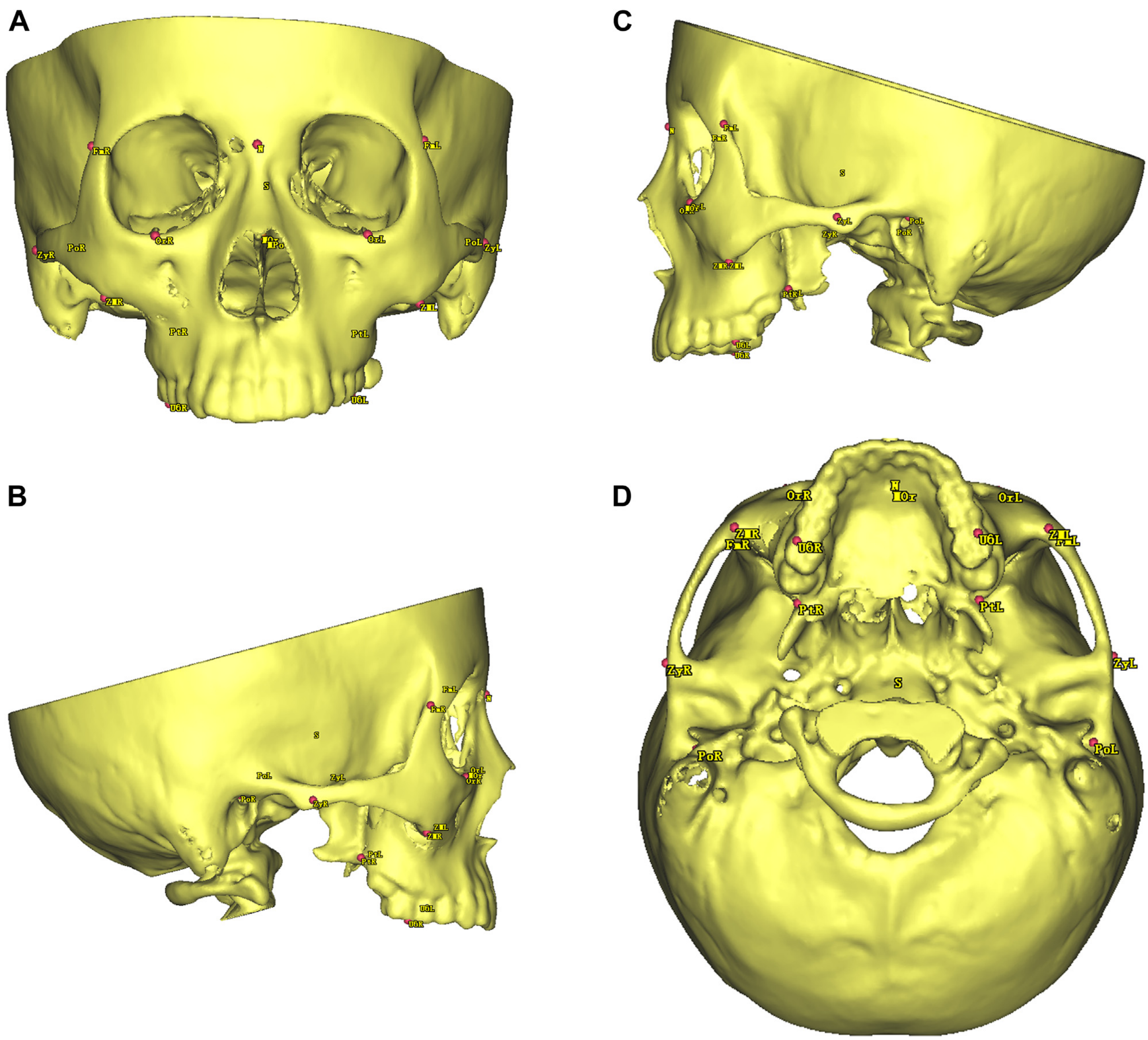

FIGURE 3. Measurement points. (*A*) Anterior view; (*B*) right lateral view; (*C*) left lateral view; and (*D*) base of skull view.

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there were no statistically significant differences in the Pt-HP distance between the 2 sides ($P > .05$). However, the distance between U6 and HP on the affected side gradually increased from the first year after surgery compared to the healthy side ($P < .05$) (Table 5). This indicates that the maxillary molars on the affected side became longer because of the absence of opposable teeth, and that the midfacial height on the affected side was slightly greater than that on the healthy side.

ANTEROPOSTERIOR SYMMETRY

Anteroposterior measurements are an indicator of the maxillary length. The distance between Pt and CP on the affected side was smaller than that on the healthy side 1 year after the surgery (Table 6). This indicates that the maxillary length was slightly reduced on the affected side compared to the healthy side.

MIDFACIAL SYMMETRY AT ADULTHOOD

Measurements taken during adulthood showed that the mean distance between U6 and HP was greater on the affected side ($P < .05$), while the mean distance between Pt and CP was shorter on the affected side than on the healthy side ($P < .05$). There were no statistically significant differences in the remaining measurements between the 2 sides (Table 7). This indicates that the midfacial height of the affected side is slightly

Table 2. DEFINITIONS OF THE MEASUREMENTS

Representation of Measurements	Definition
Or (L, R)-MSP	Distance between Or point and MSP plane
Fm (L, R)-MSP	Distance between Fm point and point MSP point, indicating the upper face width
Zy (L, R)-MSP	Distance between Zy point and MSP plane, indicating the middle face width
Zm (L, R)-MSP	Distance between Zm point and MSP plane, indicating the maxillary width
Pt (L, R)-HP	Distance between the Pt point and HP plane
U6 (L, R)-HP	Distance between U6 point and HP plane
Pt (L, R)-CP	Distance between Pt point and CP plane

Abbreviations: CP, coronal plane; Fm, frontozygomatic suture; HP, horizontal plane; L, Left; MSP, midsagittal plane; Or, Orbitale; Pt, pterygomaxillary fissure; R, Right; U6, upper first molar; Zm, zygomaxillary suture; Zy, Zygion.

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greater, while the maxillary length was slightly smaller, compared to the healthy side.

SELF-EVALUATION SCORES FOR FACIAL SYMMETRY

The self-evaluated facial symmetry scores showed that 12 of the patients were fully satisfied with their appearance, while the remaining patient reported acceptable facial symmetry (Table 1, Fig 4).

CONSISTENCY OF MEASUREMENTS

The measurements between the 2 investigators had <10% disagreements. The intraclass correlation coefficient (0.91, >0.9) showed a high degree of consistency and reliability between the investigators.

Discussion

This study quantitatively analyzed midfacial symmetry after mandibular defect reconstruction with free fibula flap in pediatric patients. We hypothesized that there would be no severe midface deformities after pediatric mandibular reconstruction with free fibula flap. The study specifically aimed to estimate midfacial symmetry and patient satisfaction. The results showed that there were no severe midface deformities in pediatric patients who underwent mandibular reconstruction with free fibula flap.

The present study used spiral CT and 3D cephalometric measurements to evaluate midfacial symmetry after mandibular reconstruction with free fibula flap in pediatric patients. We demonstrated a lack of severe midfacial asymmetries after mandibular reconstruction with free fibula flap in pediatric patients. The midfacial width remained mostly symmetrical on both sides, but the midfacial height was slightly greater and the maxillary length was slightly reduced on the affected side compared to the healthy side. These findings indicate that pediatric mandibular reconstruction with free fibula flap has important clinical implications for midfacial growth.

Mandibular defects can lead to facial deformities; disordered occlusion; and chewing, swallowing, and language dysfunction. In pediatric patients, the disruption of normal cranio-maxillofacial relationships and the balance of muscles during the growth period may cause abnormal development of the midface, mandible, and the skull base, leading to severe facial deformity and dysfunction.[1] It has previously been suggested that normal development of the cranio-maxillofacial skeleton requires a harmonious relationship among the cranial base, midface, and mandible.[2] Disruption of a single cranio-maxillofacial subunit may affect the development of the adjacent subunit. Mandibular reconstruction using the free fibula flap in pediatric patients restores the continuity of mandible, reconstructs the temporomandibular joint, and reestablishes the normal occlusion. This allows normal cranio-maxillofacial growth and alleviates the negative effect of mandibular defects on midfacial growth.[3,4,7,12,13] During adulthood, osteointegrated implants can be used to restore the dentition and function. In a recent study of 6 pediatric patients with secondary mandibular reconstructions, Hu et al[14] reported disruption of the dynamic balance of the masseter muscle after partial resection of the mandible, and that without primary reconstruction, occlusal disorder, mandibular skew, and severe facial deformity could affect the growth of the entire cranio-maxillofacial complex. Some patients also required bimaxillary orthognathic surgery during second-stage reconstruction, indicating that unrepaired mandibular defects in pediatric patients could affect maxillary growth and development. Crosby et al[3] reported that mandibular defect reconstruction with the free fibula flap prevented any negative effects on midfacial growth and development. This is because the fibula grows with the mandible to restore the occlusal and masticatory functions. Some early studies have also reported this phenomenon.[1,10] Castellon et al[15] believed that maxillary growth and development could be affected if a mandibular defect was

Table 3. PATIENTS DEMOGRAPHICS

Patient Number	Sex	Age at the Time of Surgery (y)	Age at Last Follow-Up (y)	Etiology	Denture Type	Mandibular Defect Type	Self-Evaluation Score
1	F	14	19	Ameloblastoma	Movable denture	BRC	9
2	M	13	18	Ameloblastoma	None	CRB	9
3	M	14	19	Osteoblastoma	None	RBS^H	8
4	F	10	16	Osteosarcoma	None	CRB	10
5	M	8	12	Ossifying fibroma	None	BRC	9
6	M	12	16	Ameloblastoma	None	CRB	8
7	M	8	11	Ossifying fibroma	None	CRB	8
8	F	10	13	Ossifying fibroma	Movable denture	BS^H	8
9	M	14	19	Ossifying fibroma	None	BRC	8
10	F	14	21	Osteosarcoma	None	BRC	8
11	M	14	21	Odontogenic myxoma	None	BRC	7
12	M	14	28	Ameloblastoma	Implant denture	CRB	9
13	M	14	32	Ameloblastoma	None	BRC	9
Summary	F: 4	Mean ± SD:	Mean ± SD:	Ameloblastoma: 5	Movable denture: 2	Condyle resected: 11	Mean ± SD:
	M: 9	12.23 ± 2.39	18.84 ± 5.96	Ossifying fibroma: 4	Implant denture:1	Condyle preserved: 2	8.46 ± 0.78
				Osteoblastoma:1	None: 10		
				Osteosarcoma:2			
				Odontogenic myxoma: 1			

Mandibular defects were classified based on Urken's classification: S^H: symphysis, B: body, R: ramus, C: condyle.
Abbreviations: BRC, mandibular body, left ramus, left condyle; CRB, right condyle, right ramus, mandibular body; F, female; M, male; SD, standard deviation.

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incorrectly repaired. A recent study by Slijepcevic suggested that dental rehabilitation at the time of pediatric fibula reconstruction or during the perioperative period may prevent long-term craniofacial abnormalities.[11] Regardless of the technique used, if the mandible is anatomically reconstructed and stable occlusal relationships are achieved, the effects on maxillary growth and development can be avoided.

Few studies have evaluated midfacial growth after mandibular resections. Frontal and lateral cephalometric images have previously been used to measure cranio-maxillofacial growth and development.[16] However, the complex anatomy of the cranio-maxillofacial region causes distortion and anatomical overlap on cephalometric images. Spiral CT, cone-beam CT, and other 3D imaging modalities provide greater information, allow digital measurements, and are not associated with amplification distortion or overlap interferences. These advantages are particularly useful in symmetry analysis.[17] Based on their improved repeatability,[18-20] 3D cephalometric measurements are increasingly being used in orthodontics, orthognathic surgery, and the study of cranio-maxillofacial morphology and growth.[21]

In the vertical dimension, the distances from U6 to HP and from Pt to HP represent the midfacial height. The Pt-HP distance showed no statistically significant differences between the 2 sides, while the distance between U6 and HP gradually increased on the affected side from 1 year after the surgery compared to the healthy side. The average difference between the 2 sides was 0.7 mm during the first year after surgery, 1.4 mm at 3 years after surgery, and 1.6 mm during adulthood ($P < .05$). This indicates that mandibular reconstruction with free fibula flap in pediatric patients results in a slightly greater midfacial height on the affected side than on the healthy side. In the present study, only 3 of the 13 patients received dentures, including 2 patients who started using removable dentures 1 year after the surgery, and 1 patient who

Table 4. HORIZONTAL SYMMETRY AFTER SURGERY (MM, MEAN ± SD)

Time	Measurement	Affected Side	Healthy Side	Difference	*P* Value
1 wk	Or - MSP	30.5 ± 2.2	30.8 ± 2.3	0.3 ± 0.8	.330
	Fm - MSP	50.3 ± 2.0	50.0 ± 1.7	−0.3 ± 1.2	.466
	Zy - MSP	65.0 ± 2.8	63.9 ± 2.4	−1.1 ± 2.1	.202
	Zm - MSP	48.0 ± 2.7	47.6 ± 2.2	−0.4 ± 1.0	.322
6 mo	Or - MSP	30.9 ± 2.3	31.4 ± 2.3	0.5 ± 0.8	.127
	Fm - MSP	50.4 ± 2.0	50.5 ± 1.7	0.03 ± 1.2	.957
	Zy - MSP	65.2 ± 2.7	64.4 ± 2.5	−0.8 ± 2.0	.296
	Zm - MSP	48.3 ± 2.6	48.1 ± 2.1	−0.2 ± 0.9	.559
1 yr	Or - MSP	31.6 ± 2.3	31.9 ± 2.3	0.3 ± 0.9	.364
	Fm - MSP	50.7 ± 2.0	50.8 ± 1.7	0.08 ± 1.2	.870
	Zy - MSP	65.5 ± 2.7	64.8 ± 2.6	−0.6 ± 1.9	.383
	Zm - MSP	48.7 ± 2.6	48.3 ± 2.1	−0.4 ± 0.9	.242
2 yr	Or - MSP	32.1 ± 2.3	32.4 ± 2.3	0.3 ± 0.8	.312
	Fm - MSP	51.0 ± 2.1	51.3 ± 1.6	0.3 ± 1.3	.546
	Zy - MSP	66.0 ± 2.7	65.5 ± 2.8	−0.5 ± 1.8	.452
	Zm - MSP	48.9 ± 2.5	48.9 ± 2.2	−0.01 ± 0.5	.949
>3 yr	Or - MSP	32.7 ± 2.1	33.1 ± 2.1	0.4 ± 0.6	.090
	Fm - MSP	51.5 ± 2.0	51.9 ± 1.9	0.4 ± 1.2	.411
	Zy - MSP	66.5 ± 2.6	66.5 ± 3.5	0.01 ± 2.1	.987
	Zm - MSP	49.3 ± 2.8	49.5 ± 2.2	0.2 ± 0.9	.574

Abbreviation: MSP, midsagittal plane.

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received implant-supported dentures 3 years after the surgery. Therefore, we speculate that the difference in the midfacial height may be due to the long-term absence of mandibular teeth on the affected side, resulting in overeruption of the maxillary molars.

In the anteroposterior dimension, the mean distance from Pt to CP on the affected side became smaller than that on the healthy side from 1 year after the surgery, with a mean difference of 0.6 mm. This difference increased to 1.2 mm during adulthood ($P < .05$). This indicates the underdevelopment of maxillary length on the affected side, and may be related to the abnormal occlusion and insufficient occlusal stimulation on the affected side.

Our findings demonstrated the role of denture restoration in promoting symmetric craniomaxillofacial growth. To maintain the intermaxillary distance and occlusal function, dentures should be delivered early after mandibular reconstruction with free fibula flap in pediatric patients. Normally, implant denture

Table 5. VERTICAL SYMMETRY AFTER SURGERY (MM, MEAN ± SD)

Time	Measurement	Affected Side	Healthy Side	Difference	*P* Value
1 wk	Pt - HP	50.8 ± 4.3	51.3 ± 4.2	0.5 ± 0.6	.072
	U6 - HP	69.7 ± 5.2	69.5 ± 5.3	−0.2 ± 0.5	.351
6 mo	Pt - HP	52.5 ± 5.2	53.0 ± 5.3	0.5 ± 0.8	.173
	U6 - HP	72.3 ± 5.8	71.9 ± 5.6	−0.4 ± 1.0	.273
1 yr	Pt - HP	53.8 ± 6.1	54.4 ± 6.3	0.6 ± 0.8	.059
	U6 - HP	74.5 ± 6.7	73.8 ± 6.8	−0.7 ± 0.5	.008*
2 yr	Pt - HP	55.0 ± 6.0	55.9 ± 5.8	0.9 ± 0.6	.072
	U6 - HP	76.5 ± 6.5	75.3 ± 6.4	−1.2 ± 0.9	.006*
>3 yr	Pt - HP	55.9 ± 5.7	56.5 ± 5.5	0.6 ± 0.7	.064
	U6 - HP	78.3 ± 6.1	76.8 ± 6.2	−1.4 ± 0.8	.002*

Abbreviations: HP, horizontal plane; Pt, pterygomaxillary fissure; U6, upper first molar.

* $P < .05$.

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Table 6. ANTEROPOSTERIOR SYMMETRY AFTER SURGERY (MM, MEAN ± SD)

Time	Measurement	Affected Side	Healthy Side	Difference	*P* Value
1 wk	Pt - CP	45.2 ± 2.9	45.7 ± 3.1	0.4 ± 0.5	.057
6 mo	Pt - CP	45.6 ± 3.1	46.0 ± 3.1	0.4 ± 0.5	.051
1 yr	Pt - CP	46.3 ± 3.3	46.9 ± 3.6	0.6 ± 0.6	.021*
2 yr	Pt - CP	46.8 ± 3.7	47.5 ± 4.0	0.7 ± 0.5	.009*
>3 yr	Pt - CP	48.0 ± 4.2	49.0 ± 4.2	1.0 ± 0.9	.019*

Abbreviations: CP, coronal plane; Pt, pterygomaxillary fissure.

* $P < .05$.

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restorations are performed after the completion of mandibular growth, while removable dentures are used before adulthood. Since the mandible is still growing, the dentures must be replaced annually to maintain the intermaxillary distance, prevent the overeruption of maxillary dentition, restore the normal occlusion, and stimulate the normal development of the maxilla.

Despite a certain degree of vertical and anteroposterior asymmetry in the midface in adults, the outcomes were reported as satisfactory on self-evaluation by the patients, indicating that the asymmetries were not severe.

In the study, the midfacial width was not affected by the surgery. This may be because of the 3D growth sequence of the jaws. The length, width, and height of the jaws increase in a certain order, ie, width is the first to complete its growth, followed by length, and finally height.[22] The width of the jaw generally completes growth before puberty, while the growth in length continues during puberty, generally up to the age of 14 to 15 years in girls and 18 years in boys. Jaw height grows for the longest duration, and stops only in adulthood. In the present study, 7 of the 13 patients were nearly 14 years old at the time of surgery. Therefore, the mandibular defect and dentition loss did not affect the horizontal midfacial symmetry in these patients.

There were some limitations in this study. Although a large number of 3D measurements were included, the sample size was small. As this study was a retrospective study, not a randomized controlled study, the sex distribution was skewed. Further studies with larger samples, long-term follow-up, and in-depth analyses are needed in the future.

In summary, mandibular reconstruction with the free fibula flap in pediatric patients can be used to avoid the negative influence on midfacial growth and development. However, if dentures are not provided in a timely manner, the midfacial height on the affected side may be greater than that on the healthy side. Meanwhile, the maxillary length on the affected side may be slightly smaller than that on the healthy side. These findings suggest that pediatric mandibular reconstruction and proper occlusion could promote midfacial growth and symmetry. We recommended that pediatric patients should be provided dentures early after fibula transplantation, and that these should

Table 7. MIDFACIAL SYMMETRY DURING ADULTHOOD (MM, MEAN ± SD)

Measurement	Affected Side	Healthy Side	Difference	*P* Value
Or - MSP	35.0 ± 3.2	34.5 ± 3.4	−0.5 ± 1.0	.225
Fm - MSP	54.2 ± 2.7	53.6 ± 2.1	−0.6 ± 1.4	.252
Zy - MSP	68.4 ± 3.3	69.0 ± 4.3	0.6 ± 2.0	.411
Zm - MSP	49.9 ± 3.0	50.3 ± 2.8	0.4 ± 1.1	.356
Pt - HP	57.7 ± 5.6	57.8 ± 5.7	0.1 ± 0.6	.637
U6 - HP	81.1 ± 5.4	79.5 ± 6.0	−1.6 ± 1.4	.016*
Pt - CP	49.3 ± 4.0	50.5 ± 4.5	1.2 ± 1.1	.020*

Abbreviations: CP, coronal plane; Fm, frontozygomatic suture; HP, horizontal plane; MSP, midsagittal plane; Or, Orbitale; Pt, pterygomaxillary fissure; U6, upper first molar; Zm, zygomaxillary suture; Zy, Zygion.

* $P < .05$.

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FIGURE 4. A 14-year-old patient who underwent mandibular reconstruction with a free fibula flap. (*A*, *B*) Preoperative photograph and panoramic radiograph; (*C*, *D*) Photograph and panoramic radiograph at the age of 18 years.**(Fig 4 continued on next page.)**

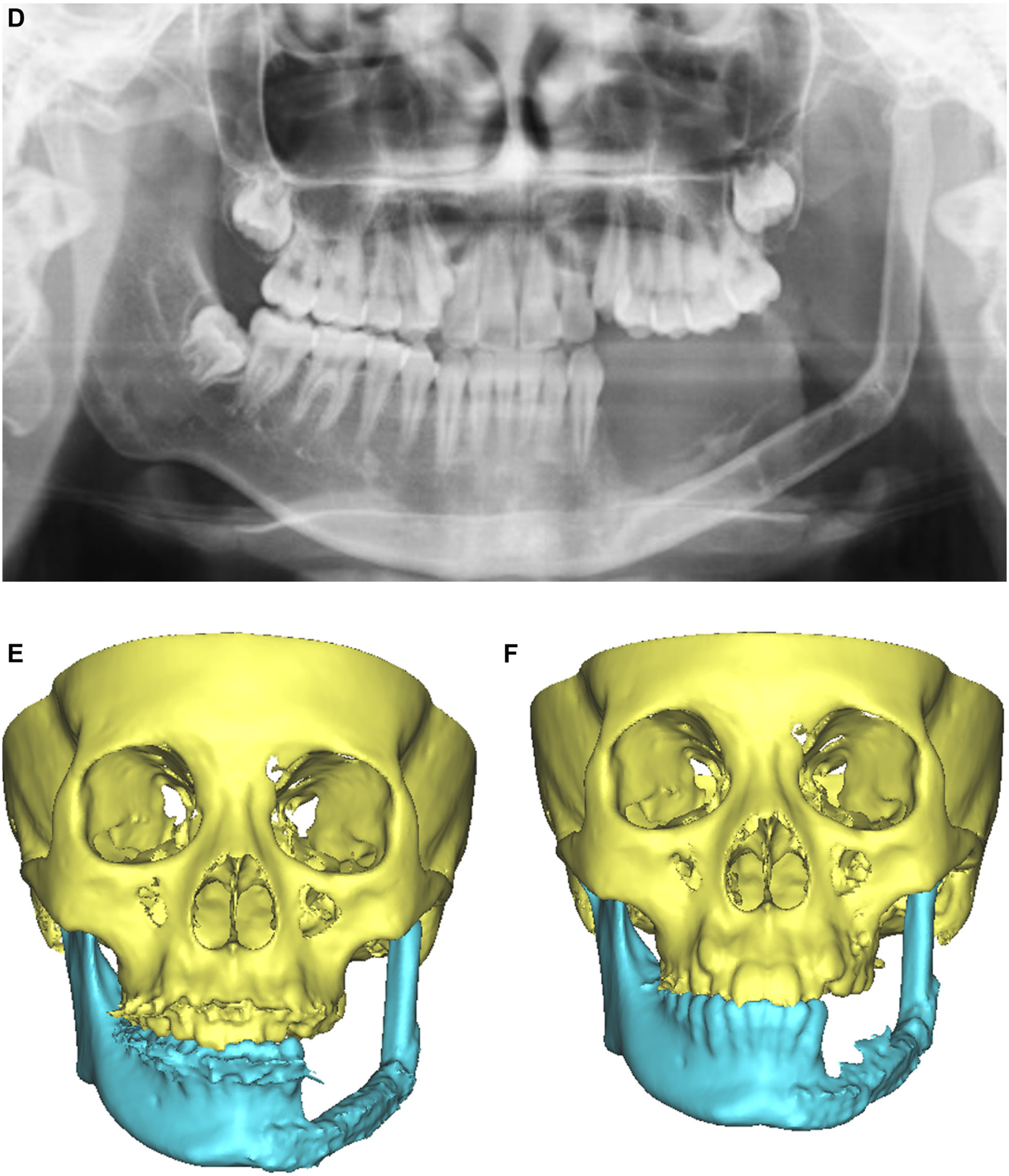

FIGURE 4 (cont'd). (*E-G*) Three-dimensional CT at 1 week after surgery, 6 months after surgery, and at the age of 18 years showing midfacial symmetry.**(Fig 4 continued on next page.)**

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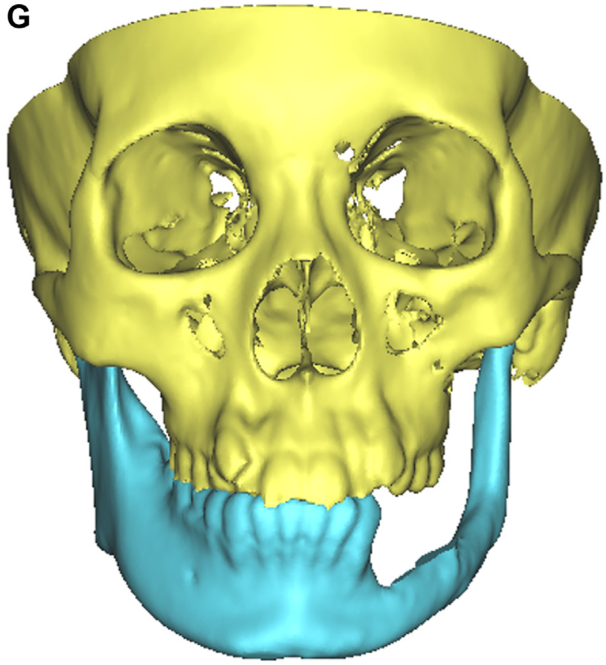

FIGURE 4 (cont'd).

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be replaced regularly to maintain the masticatory stimulation and promote the growth and development of the midface.

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