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Original Article

Comparison of aesthetic outcomes of maxilla-only, mandible-only, and bimaxillary orthognathic surgeries: A retrospective analysis

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Abstract *Background/purpose:* Orthognathic surgery addresses craniofacial and occlusal deformities caused by skeletal discrepancies. This study compares the aesthetic outcomes of maxilla-only, mandible-only, and bimaxillary surgeries, focusing on facial angles, proportions, and soft tissue aesthetics. It also identifies parameters most influencing postoperative aesthetics.
Materials and methods: Sixty Taiwanese patients (30 males, 30 females) were divided into three groups: maxilla-only, mandible-only, and bimaxillary surgeries (20 patients per group). Pre- and postoperative cephalograms were analyzed using six cephalometric methods. Paired and independent t-tests ($P < 0.05$) were conducted to evaluate changes and deviations from reference norms.
Results: The results of the study showed that maxilla-only surgery could lead to significant improvements in midface aesthetics, especially a notable increase in the nasolabial angle ($P < 0.05$) and a reduction in UL-E line distances ($P < 0.05$). The mandible-only surgery could enhance the lower facial symmetry with significant changes observed in the H angle ($P < 0.05$), SN-MP angle ($P < 0.05$), and LL-E line distances ($P < 0.05$). Bimaxillary surgery resulted in the most comprehensive improvements, including a significant increase in the lower anterior facial height (LAFH, $P < 0.05$), an enhanced nasolabial angle ($P < 0.05$), and an overall improvement in facial balance. However, a decrease in postoperative nasal prominence was observed across

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all surgical types when compared to reference norms, suggesting that secondary adjustments may be required.
Conclusion: Maxilla-only surgery improves midface proportions, while mandible-only surgery enhances lower facial balance. Bimaxillary surgery provides the most comprehensive outcomes. Individualized surgical planning and potential nasal refinements are crucial for optimal results.

Introduction

Craniofacial and occlusal deformities resulting from skeletal discrepancies frequently necessitate orthognathic surgery as a definitive treatment. Depending on the specific case, the surgical approach may involve upper jaw surgery, lower jaw surgery, or a combination of both, often complemented by orthodontic treatment. The main types of jaw surgeries include Le Fort I maxillary osteotomy for the upper jaw, bilateral sagittal split mandibular osteotomy (BSSO) for the lower jaw, and genioplasty for chin modification.[1,2]

Upper jaw surgery is performed to enhance midfacial support, correct underbites, or address conditions such as gummy smiles, facial asymmetry, or open bites.[1,2] Conversely, lower jaw surgery can involve lengthening, shortening, or rotation to treat retrusion, protrusion, or asymmetry.[1,2] In many cases, a combination of upper, lower, or chin surgeries is employed to achieve optimal functional and aesthetic outcomes. Two-jaw surgery, also referred to as "bimaxillary osteotomy," allows for comprehensive adjustments across all planes, offering greater stability and reducing undesirable soft tissue effects. By addressing asymmetry in one jaw and proportional discrepancies in the other, this approach ensures a more balanced and harmonious facial result.[3] Personalized treatment planning remains essential, as the surgical approach—single-jaw or two-jaw—depends on the patient's unique clinical needs.

In cases of malocclusion, two-jaw surgery has been shown to provide superior improvements in facial symmetry, proportions, and profile.[3] When combined with thorough evaluation and shared decision-making, this approach is a highly effective option for achieving enhanced facial harmony and aesthetics. Orthognathic surgery aims to improve facial proportions through precise diagnosis and analysis. Common methods for profile evaluation include Burstone's B-line, Ricketts' E-line, and other cephalometric tools.[4–8] The B-line is noted for its consistency and sensitivity, whereas the E-line is favored for its clinical simplicity.[9,10] These tools are essential for assessing the impact of surgical interventions on facial esthetics·

Facial esthetics play a central role in the success of orthognathic surgery, particularly in the correction of facial disharmony. Two-jaw surgery is often more effective than single-jaw surgery due to its broader influence on the entire facial structure.[11,12] However, the specific effects of esthetic parameters, such as the relationship between nasal-lip-chin proportions and different surgical approaches, have not been extensively investigated.

To compare facial aesthetic outcomes among single-jaw maxillary surgery, single-jaw mandibular surgery, and double-jaw surgery, and to identify the parameters with the greatest impact on aesthetics. This study aimed to analyze differences in aesthetic effects across these surgical methods, assess changes in facial angles and contours post-surgery relative to reference norms, and determine whether nasal-lip and chin protrusion align with aesthetic standards.

Materials and methods

This retrospective study included 60 Taiwanese patients who underwent orthognathic surgery at Chung Shan Medical University (CSMU) Hospital, with approval from the institutional review board of CSMU (IRB approval number: CS2-23023). The patients were categorized into three groups based on the surgical approach: maxillary surgery (n = 20), mandibular surgery (n = 20), and bimaxillary surgery (n = 20) (Table 1).

The maxillary surgery group included one patient who underwent a one-piece Le Fort I osteotomy, two patients with three-piece Le Fort I procedures, and 17 patients who underwent anterior segmental osteotomy (ASO). All patients in the mandibular surgery group underwent bilateral sagittal split ramus osteotomy (BSSO). The bimaxillary surgery group consisted of nine patients with a one-piece Le Fort I procedure, ten with a two-piece Le Fort I procedure, and one with a three-piece Le Fort I procedure, all combined with mandibular BSSO. Each group was composed of 10 male patients (mean age: 28.3 years) and 10 female patients (mean age: 29.8 years) (Table 1). The reference norm is based on the study conducted by Chen et al.[13] This research involved 48 Taiwanese adults, consisting of 23 males (average age: 24.9 years) and 25 females (average age: 23.5 years). The participants were selected according to specific criteria, including proper occlusion, a skeletal Class I pattern, lip competence in a relaxed state, and soft tissue positioning within the boundaries of the Esthetic (E) line. Comprehensive standardized soft tissue facial analyses were performed on all participants.

Inclusion and exclusion criteria

Eligible patients were non-growing adults with no history of prior orthodontic or orthognathic treatment and with complete pre- and postoperative cephalometric records.

Table 1 A comparison of the sample size, gender, and age distribution between this study and the reference study is illustrated.

			Sample size		Total sample size	Average year
			Male	Female		
Orthognathic surgery group	One-jaw	Maxilla	10	10	60	Male: 28.3
		Mandible	10	10		Female: 29.8
	Two-jaw	Bimaxillary	10	10		
Reference Norm[13]	Non surgery		23	25	48	Male: 24.9 Female: 23.5

The reference norm data were retrieved from the report by Chen et al.[13]

Patients with incomplete records, ongoing growth, or previous treatments were excluded from the study.

Imaging and cephalometric analysis

The lateral cephalogram was taken from the patient's initial examination and after surgery X-rays. Pre- and postoperative lateral cephalograms were obtained using a standardized X-ray system (Sirona Co., Erlangen, Germany) with a magnification factor of approximately 10 %. The cephalometric landmarks and tracing definitions are presented in Tables 2 and 3, and their illustrations are provided in Fig. 1. Cephalometric analysis was conducted using six methods: skeletal analysis, Burstone analysis, Ricketts analysis, Holdaway analysis, Steiner analysis, and Merrifield profile angle analysis (Table 3, Fig. 2). The postoperative results were evaluated by comparison with Chen's reference norms.[13]

Statistical analysis

All statistical analyses were conducted using JMP software (SAS Institute, Cary, NC, USA). Paired t-tests were employed to evaluate differences between preoperative and postoperative outcomes, while independent t-tests were used to compare postoperative outcomes with reference norms. One-way ANOVA was performed to assess differences among the three surgical types, followed by Bonferroni post-hoc testing. Statistical significance was set at $P < 0.05$ for all analyses. A total of eight skeletal measurements and twenty soft tissue measurements were

Table 2 The cephalometric tracing reference points and their definitions.

	Landmark	Abbreviation	Definition
Skeletal	A-point	A	The most posterior point on the curve of the maxilla between the anterior nasal spine and supradentale.
	Anterior nasal spine	ANS	The most anterior point at the sagittal plane on the bony hard palate.
	B-point	B	The point most posterior to a line from infradentale to pogonion on the anterior surface of the symphyseal outline of the mandible.
	Gonion	Go	Midpoint of the angle of the mandible, found by bisecting the angle formed by the mandibular plane and a plane through articulare, posterior and along the portion of the mandibular ramus inferior to it.
	Menton	Me	The most inferior point on the symphyseal outline.
	Nasion	N	The most anterior point on the frontonasal suture.
	Orbitale	Or	The lowest point on the inferior margin of the orbit. A plane connecting Or and Po is the frankfort horizontal plane.
	Pogonion	Pg	The most anterior point on the contour of the symphysis of the mandible.
	Porion	Po	A point located at the most superior point of the bony margins of the external acoustic canal.
	Sella turcica	S	The center of the pituitary fossa of the sphenoid bone.
Soft tissue	Columella	Col	Point on the lower surface of the nose, determining the anterior limit of the nasolabial angle.
	Soft tissue menton	Me'	The most inferior point on the soft tissue chin.
	Soft tissue nasion	N'	The point of greatest concavity in the midline between forehead and nose.
	Soft tissue pogonion	Pg'	The most anterior point on the chin.
	Stomion inferius	Stmi	The uppermost point on the vermilion of the lower lip.
	Stomion superius	Stms	The lower most point on the vermilion of the upper lip.
	Subnasale	Sn	The most posterior point where columella (nasal septum) merges with the upper lip.

Table 3 The measurements and definitions of various cephalometric analyses.

Analyses	Landmarks	Definitions
Skeletal	UAFH (mm)	Upper anterior facial height. Linear distance between points nasion and anterior nasal spine.
	LAFH (mm)	Lower anterior facial height. Linear distance between points anterior nasal spine and menton.
	PFH (mm)	Posterior facial height is the ramal length. The distance from sella turcica to gonion.
	FMA angle (°)	Frankfort-mandibular plane angle. Formed by the intersection between the Frankfort plane and the mandibular plane.
	L1 — NB (mm)	Mandibular incisor to NB. Distance between the tip of the mandibular incisor and the line from nasion to point B.
	Pg — NB (mm)	Pogonion to NB. Distance between pogonion and a line from nasion to point B.
	ANB angle (°)	Angle between the nasion-point A line and nasion- point B line. Obtained by subtracting SNB from SNA.
	SN — MP angle (°)	Sella turcica to mandibular plane. Angle between sella turcica-nasion line and gonion-menton line.
Burstone	UL — B line (mm)	Upper lip to Burstone line. Distance from upper lip to the Burstone line (subnasale to soft tissue pogonion).
	LL — B line (mm)	Lower lip to Burstone line. Distance from lower lip to the Burstone line (subnasale to soft tissue pogonion).
	UL length (mm)	Upper lip length. Distance from subnasale to stomion superius.
	LL length (mm)	Lower lip length. Distance from stomion inferius to soft tissue menton.
Ricketts	Nose prominence (mm)	Distance between nose tip to Burstone line (subnasale to soft tissue pogonion).
	UL — E line (mm)	Upper lip to Esthetic line. Distance from upper lip to Esthetic line (nose tip to soft tissue chin).
	LL — E line (mm)	Lower lip to Esthetic line. Distance from lower lip to Esthetic line (nose tip to soft tissue chin).
Holdaway	Sn—H line (mm)	Subnasale to Holdaway line. Distance from subnasale to H line (line between outer prominent surface of upper lip to soft tissue chin).
	LL — H line (mm)	Lower lip to Holdaway line. Distance from lower lip to H line (line between outer prominent surface of upper lip to soft tissue chin).
	H angle (°)	Holdaway angle. Angle between H line and soft tissue nasion-soft tissue pogonion line.
	Soft tissue chin thickness (mm)	Distance from hard tissue pogonion to soft tissue pogonion.
	Superior sulcus depth (mm)	Distance between upper lip vermillion border line perpendicular Frankfort plane to upper lip sulcus.
	Inferior sulcus — H line (mm)	Distance between inferior sulcus to Holdaway line (line between outer prominent surface of upper lip to soft tissue chin).
	UL thickness (mm)	Upper lip thickness. Distance between upper lip vermillion border to anterior of upper incisor.
Steiner	UL — S line (mm)	Upper lip to Steiner line. Distance between upper lip to S line (line from midpoint between subnasale and nose tip to soft tissue pogonion).
	LL — S line (mm)	Lower lip to Steiner line. Distance between lower lip to S line (line from midpoint between subnasale and nose tip to soft tissue pogonion).
Profile angles	Nasolabial angle (°)	Angle formed by intersection of anterior upper lip border and columella at subnasale.
	Z angle (°)	Angle between frankfort horizonal plane and line from most prominent lip to soft tissue pogonion.
	Profile angle (°)	Angle between frankfort horizontal plane and a profile line drawn from the point where frankfort horizontal plane intersects with the nasal outline to soft tissue pogonion.
	N' — Pg' [FH] (mm)	Distance between soft tissue pogonion and soft tissue nasion line perpendicular to the frankfort horizontal plane.

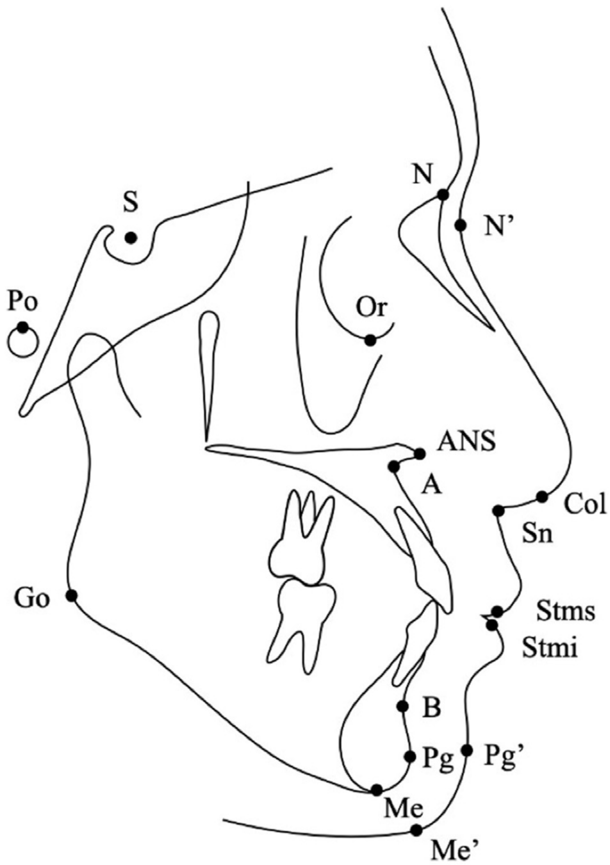

Figure 1 Displays the landmarks used in cephalometric analysis.

analyzed to identify significant differences in the mean values of the variables.

Results

Comparison of aesthetic outcomes in male patients

The aesthetic outcomes before and after orthognathic surgery in male patients undergoing maxilla-only, mandible-only, and bimaxillary procedures were analyzed, with the key findings summarized in Table 4.

Maxilla-only surgery

Upper and lower lip position adjustments: Significant reductions were observed in UL − B line and LL − B line, indicating improved lip positioning relative to the aesthetic baseline ($P < 0.05$). Nasal appearance changes: A slight increase in nose prominence was noted, while Sn—H line significantly decreased ($P < 0.05$). Additionally, the nasolabial angle demonstrated a significant increase, enhancing midfacial harmony.

Mandible-only surgery

Facial height and angle adjustments: Significant increases were recorded in FMA and SN − MP, indicating improved vertical and angular dimensions of the mandible ($P < 0.05$). Reduction in nasal prominence: A decrease in nose prominence was observed postoperatively. Lip and chin relationship Adjustments: LL − H line and H angle exhibited notable changes, while Inferior sulcus − H line and UL − S line significantly increased ($P < 0.05$), indicating enhanced soft tissue harmony. Profile angle alterations: Significant reductions in Z angle and Profile angle were observed ($P < 0.05$), reflecting changes in overall facial contour.

Bimaxillary surgery

Comprehensive facial proportion adjustments: Significant increases in FMA and SN − MP were documented, highlighting effective adjustments in overall facial proportions. Reduction in nasal prominence: A significant decrease in nose prominence was recorded ($P < 0.05$), necessitating postoperative consideration for nasal refinement. Enhancements in lip and chin angles: Significant increases in H angle and Inferior sulcus − H line were observed, indicating improved lower facial harmony. Profile angle alterations: Both Z angle and profile angle showed significant reductions ($P < 0.05$), reflecting changes in the facial profile postoperatively.

Based on ANOVA statistical analysis, the measurements with significant differences among the three surgical types include: skeletal parameters (FMA, SN − MP, ANB), soft tissue parameters (UL − B line, LL − H line, H angle), and aesthetic angles (nasolabial angle, Z angle).

Male parameters with the most significant impact on aesthetic standards

Nasolabial angle: Maxilla-only and bimaxillary surgeries showed the greatest improvements, highlighting their importance in midface aesthetics ($P < 0.05$). SN—MP angle: Mandible-only and bimaxillary surgeries significantly impacted this parameter, reflecting mandibular adjustments ($P < 0.05$). LAFH: Bimaxillary surgery demonstrated significant improvements, emphasizing its critical role in lower facial harmony ($P < 0.05$). UL—E line and LL—E line: Improvements in lip position were observed across all surgical types, indicating their relevance in achieving balanced facial proportions ($P < 0.05$).

Comparison of aesthetic outcomes in female patients

The aesthetic outcomes before and after orthognathic surgery in female patients undergoing maxilla-only, mandible-only, and bimaxillary procedures were analyzed, with the key findings summarized in Table 5.

Maxilla-only surgery

Lip position adjustments: Postoperative reductions were observed in UL − B line and LL − B line, indicating significant improvements in upper and lower lip positioning ($P < 0.05$). Nasal appearance changes: Nose prominence increased following surgery, reflecting enhanced nasal

Figure 2 Displays the cephalometric analysis measurements for facial aesthetics under different methods.

projection ($P < 0.05$). Nasolabial and profile improvements: Significant enhancements were noted in UL—E, LL—E, Nasolabial angle, and Z angle, contributing to an improved side profile ($P < 0.05$). Nasal tip and lip adjustments: Both Sn—H line and UL − S line showed significant reductions, indicating refined nasal—lip relationships ($P < 0.05$).

Mandible-only surgery

Facial height changes: A reduction in posterior facial height (PFH) was observed ($P < 0.05$). Mandibular angle adjustments: Significant increases in FMA and SN − MP indicated improved mandibular angles and vertical alignment ($P < 0.05$). Mandibular proportion and contour: Significant changes were recorded in H angle and profile angle, reflecting improved mandibular proportions and facial contours ($P < 0.05$). Nasal tip and lip position: Significant adjustments were observed in Inferior sulcus − H line and UL − S line, enhancing lower facial aesthetics ($P < 0.05$).

Bimaxillary surgery

Overall facial proportion adjustments: Decreases in PFH and increases in FMA and SN − MP highlighted comprehensive adjustments to overall facial proportions ($P < 0.05$). Nasal aesthetic changes: A significant reduction in nose prominence was noted postoperatively ($P < 0.05$). Comprehensive proportion enhancements: LL − H line and H angle exhibited significant changes, reflecting improvements in facial balance and harmony ($P < 0.05$). Nasal tip

Table 4 Mean and standard deviation comparing presurgical and postsurgical measurements in male patients.

Analysis	Variables	Maxilla				Mandible				Bimaxillary			
		Presurgical		Postsurgical		Presurgical		Postsurgical		Presurgical		Postsurgical	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal	UAFH (mm)	59.14	0.48	57.69	1.94	57.38	3.52	57.15	3.38	58.24	2.55	57.24	2.77
	LAFH (mm)	74.09	1.48	72.65	3.23	68.01	3.25	71.02	3.40	75.43	7.78	77.72[a]	6.88
	PFH (mm)	90.42	6.51	90.65	4.04	85.98	8.02	81.90	9.25	87.42	5.91	84.52[a]	5.03
	FMA (°)	24.83	7.72	22.42	6.45	21.90	4.08	28.30[a]	4.85	27.37	6.50	31.76	6.37
	L1 – NB (mm)	9.98	4.11	8.26	2.66	4.14	1.97	5.45	1.28	7.25	2.73	8.14	2.77
	Pg - NB (mm)	1.20	0.27	3.96	2.46	2.08	0.80	2.36	1.30	1.66	0.91	1.93	0.72
	ANB (°)	8.65	2.56	6.87	2.90	−4.54	2.28	1.42[a]	0.92	−2.81	2.82	3.09[a]	2.89
	SN – MP (°)	32.66	7.70	30.01	7.11	30.69	5.30	37.19[a]	6.42	35.12	6.14	39.54	5.84
Burstone	UL – B line (mm)	10.56	1.85	6.30[a]	1.90	4.11	1.45	5.39[a]	1.05	4.94	1.82	6.71[a]	1.77
	LL – B line (mm)	8.57	2.90	3.81[a]	2.56	5.68	1.40	4.68	0.89	7.02	2.94	5.76	2.70
	UL length (mm)	25.83	3.85	25.97	2.96	21.47	2.45	23.98[a]	2.05	24.66	2.99	26.58	2.57
	LL length (mm)	43.15	4.97	45.05	2.17	49.42	2.62	48.77	2.24	53.64	5.56	51.34	3.90
	Nose prominence (mm)	8.42	2.72	9.41	2.96	14.49	1.22	12.50[a]	1.36	13.81	1.84	11.26[a]	1.76
Ricketts	UL – E line (mm)	5.90	2.73	1.56	2.61	−4.56	1.66	−1.69[a]	1.23	−3.26	1.83	0.36[a]	1.55
	LL – E line (mm)	6.07	3.34	1.06[a]	2.22	−0.24	1.74	0.04[a]	1.24	1.47	3.04	1.66	2.43
Holdaway	Sn–H line (mm)	14.72	2.27	9.81[a]	2.92	5.73	2.04	7.78[a]	1.60	6.94	2.49	9.60[a]	2.28
	LL – H line (mm)	2.70	2.04	0.10	1.70	2.91	1.45	1.16[a]	0.68	3.72	2.25	1.43[a]	1.86
	H angle (°)	29.10	4.56	22.22	4.08	8.03	3.83	14.39[a]	3.41	10.41	2.84	18.58[a]	3.28
	Soft tissue chin thickness (mm)	14.01	3.84	13.39	0.87	11.40	1.70	12.42	1.48	13.06	1.99	13.42	2.83
	Superior sulcus depth (mm)	5.60	2.16	3.14	1.47	6.91	1.35	5.46[a]	1.43	7.14	2.51	5.45	2.04
	Inferior sulcus – H line (mm)	4.29	1.21	5.84	2.85	1.76	0.86	3.75[a]	0.96	1.47	1.01	3.77[a]	1.36
	UL thickness (mm)	13.97	1.10	14.9	2.57	14.50	1.89	13.90	1.88	15.33	1.33	15.90	2.01
Steiner	UL – S line (mm)	6.47	2.39	2.57	2.24	−2.17	1.34	−0.04[a]	1.05	−0.89	1.81	1.66[a]	1.44
	LL – S line (mm)	6.40	3.19	1.64	2.28	1.41	1.58	1.13	1.05	3.08	3.07	2.50	2.45
Profile angles	Nasolabial angle (°)	92.04	25.64	101.87	15.66	80.83	6.09	89.18[a]	7.46	84.80	10.55	92.64[a]	11.68
	Z angle (°)	57.93	8.46	67.31	6.56	86.43	4.55	80.22[a]	4.26	80.83	6.48	74.93[a]	5.45
	Profile angle (°)	74.03	5.46	76.99	4.40	91.09	2.87	83.45[a]	2.98	88.57	4.35	81.53[a]	3.63
	N' – Pg' [FH] (mm)	−5.69	8.19	−1.05	6.08	19.76	4.84	8.67[a]	5.01	16.35	6.73	6.85[a]	6.05

P-values comparing presurgical data to postsurgical data.
[a] P-value <0.05.

and lip refinements: Significant changes in Inferior sulcus – H line and UL – S line indicated refined nasal and lip positioning ($P < 0.05$).

Based on ANOVA statistical analysis, the measurements with significant differences among the three surgical types include: skeletal parameters (FMA, SN – MP, ANB), soft tissue parameters (UL – B line, LL – H line, H angle), and aesthetic angles (nasolabial angle, Z angle).

Female parameters with the most significant impact on aesthetic standards

Nasolabial angle: Improved across all surgical types, emphasizing its importance in midfacial harmony ($P < 0.05$). H angle: Mandible-only and bimaxillary surgeries showed the greatest impact, highlighting their significance in chin-to-face proportions ($P < 0.05$). LAFH: Bimaxillary surgery demonstrated the most significant increases, reinforcing its role in achieving balanced lower facial aesthetics ($P < 0.05$). UL–E line and LL–E line: Improvements were observed across all surgical types, indicating their importance in lip prominence and overall facial proportions ($P < 0.05$).

Comparison of postoperative outcomes with reference norms

The postoperative measurements in male patients revealed statistically significant differences ($P < 0.05$) from reference norms in UAFH, LAFH, PFH, nose prominence, nasolabial angle, and H angle. Similarly, aesthetic profile and curve parameters such as UL-E line, LL-E line, and superior sulcus depth also demonstrated statistically significant differences ($P < 0.05$) (Table 6).

Table 5 Mean and standard deviation comparing presurgical and postsurgical measurements in female patients.

Analysis	Variables	Surgery type											
		Maxilla				Mandible				Bimaxillary			
		Presurgical		Postsurgical		Presurgical		Postsurgical		Presurgical		Postsurgical	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal	UAFH (mm)	52.05	2.78	51.63	2.94	53.57	2.00	53.24	2.98	54.64	1.72	52.64	2.49
	LAFH (mm)	67.67	6.20	67.34	5.99	61.90	4.07	65.75	4.92	69.99	4.32	72.40	3.48
	PFH (mm)	75.98	10.24	75.70	8.92	77.84	3.35	74.09[a]	4.49	79.50	3.58	76.51	4.31
	FMA (°)	28.47	9.35	28.52	8.46	22.03	3.69	29.54[a]	4.40	27.29	6.69	31.17	6.24
	L1 — NB (mm)	9.71	2.27	7.65[a]	1.92	3.42	1.53	5.33[a]	1.64	5.44	2.34	6.56	2.13
	Pg - NB (mm)	0.89	0.79	1.34	0.92	1.37	1.04	2.03	1.09	1.50	1.28	2.31	1.16
	ANB (°)	7.81	1.45	5.63[a]	1.82	−4.30	2.23	2.48[a]	1.87	−2.62	1.94	3.13[a]	1.84
	SN — MP (°)	35.87	10.42	35.52	8.06	30.66	3.17	37.94[a]	4.84	36.31	6.20	39.98	5.25
Burstone	UL — B line (mm)	8.85	1.98	5.61[a]	1.65	3.95	1.09	5.11	1.55	5.24	1.69	10.58	14.02
	LL — B line (mm)	7.35	1.88	3.57[a]	1.12	5.19	1.71	3.67	1.52	5.82	2.79	4.14	1.91
	UL length (mm)	23.33	2.44	23.08	2.32	19.52	1.80	21.98[a]	1.75	22.33	1.89	23.74	1.42
	LL length (mm)	39.09	4.02	43.02[a]	3.49	46.71	3.70	45.51	3.84	50.52	4.43	48.94	4.10
	Nose prominence (mm)	8.99	1.63	10.29	1.81	13.23	1.07	10.96[a]	1.48	12.91	0.83	10.74[a]	1.00
Ricketts	UL — E line (mm)	3.93	2.34	0.01[a]	1.75	−4.20	1.21	−1.23[a]	1.42	−2.47	1.49	0.18[a]	1.46
	LL — E line (mm)	4.42	2.17	0.11[a]	1.15	−0.47	1.69	−0.47	1.53	0.67	2.81	0.19	1.88
Holdaway	Sn—H line (mm)	12.52	2.90	8.16[a]	2.30	5.38	1.41	7.13[a]	2.11	7.37	2.30	8.91	2.22
	LL — H line (mm)	1.99	1.70	0.11[a]	0.90	2.46	1.29	0.34[a]	1.05	2.32	2.08	0.08[a]	1.21
	H angle (°)	25.64	4.16	18.70[a]	3.42	6.95	2.31	14.61[a]	2.48	9.85	3.19	16.89[a]	3.24
	Soft tissue chin thickness (mm)	13.15	2.17	13.22	2.16	10.62	1.34	11.27	1.33	13.37	3.23	13.84	2.27
	Superior sulcus depth (mm)	5.56	1.84	3.61[a]	1.59	6.47	1.04	4.99	1.99	7.07	1.67	5.79	1.30
	Inferior sulcus — H line (mm)	3.40	1.28	3.80	0.95	1.54	0.77	4.01[a]	0.94	1.88	1.17	4.41[a]	1.40
	UL thickness (mm)	11.62	1.18	11.82	0.97	12.24	1.50	12.23	1.16	13.58	1.97	13.83	1.05
Steiner	UL — S line (mm)	4.74	2.19	1.24[a]	1.58	−1.68	1.25	0.38[a]	1.38	−0.24	1.50	1.54[a]	1.53
	LL — S line (mm)	4.91	2.03	0.87[a]	1.17	1.29	1.77	0.58	1.52	2.17	2.75	1.07	1.91
Profile angles	Nasolabial angle (°)	90.48	7.21	98.23	9.29	81.40	3.60	92.77[a]	9.21	78.55	8.04	92.94[a]	10.28
	Z angle (°)	62.80	6.24	70.32[a]	4.96	87.50	4.49	78.47[a]	3.12	83.82	8.19	78.09	6.25
	Profile angle (°)	75.91	3.92	77.21	3.20	91.44	2.49	82.55[a]	2.90	89.51	4.30	84.29[a]	4.43
	N' — Pg' [FH] (mm)	−2.71	6.14	−1.72	5.03	16.78	3.77	5.36[a]	5.05	16.01	6.77	8.79[a]	6.42

P-values comparing presurgical data to postsurgical data.
[a] P-value <0.05.

For female patients, postoperative measurements exhibited statistically significant differences compared to reference norms in UAFH, LAFH, PFH, FMA, nasolabial angle, Z angle, profile angle, nose prominence, UL—E line, and LL—E line ($P < 0.05$). Aesthetic profile and curve parameters with significant differences ($P < 0.05$) included nasolabial angle, Z angle, profile angle, nose prominence, UL—E line, LL—E line, and superior sulcus depth (Table 7).

Discussion

The present study evaluates the aesthetic outcomes of orthognathic surgeries in male and female patients, with specific attention to maxilla-only, mandible-only, and bimaxillary surgical approaches. The findings provide critical insights into the differential impacts of these procedures on key facial parameters, as well as the clinical implications for individualized treatment planning.

A comparative analysis of surgical outcomes in male patients highlights significant differences among the three approaches. Maxilla-only and bimaxillary surgeries were found to have a pronounced effect on the nasolabial angle, contributing to enhanced midfacial harmony. Mandible-only and bimaxillary surgeries primarily influenced the SN—MP angle, reflecting improvements in mandibular inclination and lower facial alignment. Additionally, bimaxillary surgery demonstrated a substantial increase in LAFH, underscoring its role in achieving balanced lower facial proportions.

Adjustments in UL—E line and LL—E line were observed across all surgical types, emphasizing the importance of lip position and prominence in overall facial aesthetics. However, postoperative nasal prominence consistently fell

Table 6 Mean and standard deviation comparing postsurgical males with reference norm.

Analysis	Variables	Orthognathic surgery type						Reference norm	
		Maxilla		Mandible		Bimaxillary			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal	UAFH (mm)	57.69	1.94	57.15	3.38	57.24	2.77	60.00	3.29
	LAFH (mm)	72.65	3.23	71.02	3.40	77.72[a]	6.88	74.77	3.09
	PFH (mm)	90.65	4.04	81.90	9.25	84.52	5.03	93.35	5.16
	FMA (°)	22.42	6.45	28.30	4.85	31.76	6.37	22.62	4.05
	L1 — NB (mm)	8.26	2.66	5.45	1.28	8.14	2.77	3.74	2.37
	Pg — NB (mm)	3.96	2.46	2.36	1.30	1.93	0.72	3.30	2.38
	ANB (°)	6.87	2.90	1.42	0.92	3.09	2.89	3.00	2.00
	SN - MP (°)	30.01	7.11	37.19	6.42	39.54	5.84	29.31	4.42
Burstone	UL — B line (mm)	6.30	1.90	5.39	1.05	6.71	1.77	5.57	1.23
	LL — B line (mm)	3.81	2.56	4.68	0.89	5.76	2.70	4.26	1.45
	UL length (mm)	25.97	2.96	23.98	2.05	26.58	2.57	23.92	0.10
	LL length (mm)	45.05**	2.17	48.77	2.24	51.34	3.90	55.38	3.50
	Nose prominence (mm)	9.41**	2.96	12.50	1.36	11.26[a]	1.76	16.46	1.97
Ricketts	UL — E line (mm)	1.56[a]	2.61	−1.69	1.23	0.36	1.55	−2.93	1.52
	LL — E line (mm)	1.06	2.22	0.04	1.24	1.66	2.43	−2.06	1.89
Holdaway	Sn—H line (mm)	9.81	2.92	7.78	1.60	9.60	2.28	8.12	1.41
	LL — H line (mm)	0.10	1.70	1.16	0.68	1.43	1.86	0.85	0.88
	H angle (°)	22.22[a]	4.08	14.39	3.41	18.58	3.28	13.54	3.46
	Soft tissue chin thickness (mm)	13.39	0.87	12.42	1.48	13.42	2.83	13.58	1.92
	Superior sulcus depth (mm)	3.14	1.47	5.46	1.43	5.45	2.04	6.85	1.09
	Inferior sulcus — H line (mm)	5.84	2.85	3.75	0.96	3.77	1.36	5.15	1.07
	UL thickness (mm)	14.90	2.57	13.90	1.88	15.90	2.01	15.35	1.27
Steiner	UL — S line (mm)	2.57	2.24	−0.04	1.05	1.66	1.44	1.04	1.03
	LL — S line (mm)	1.64	2.28	1.13	1.05	2.50	2.45	0.91	1.31
Profile angles	Nasolabial angle (°)	101.87	15.66	89.18	7.46	92.64	11.68	98.72	7.60
	Z angle (°)	67.31	6.56	80.22	4.26	74.93	5.45	74.42	4.92
	Profile angle (°)	76.99	4.40	83.45	2.98	81.53	3.63	84.42	3.25
	N' — Pg' [FH] (mm)	−1.05	6.08	8.67	5.01	6.85	6.05	−1.42	4.31

P-values comparing postsurgical data to reference norm.
[a] P-value <0.05.

below reference norms, suggesting the necessity for secondary refinements to optimize nasal-lip harmony.

Based on the above discussion, for male patients, different surgical approaches yield specific recommendations. Maxilla-only surgery is advised for individuals requiring midfacial corrections, while mandible-only surgery effectively addresses lower facial discrepancies. Bimaxillary surgery offers comprehensive improvements to facial proportions, delivering the most balanced and harmonious outcomes.

In female patients, the most significantly impacted parameters included the nasolabial angle, H angle, LAFH, and UL—E line/LL—E line. Maxilla-only surgery effectively addressed midfacial corrections, while mandible-only surgery improved lower facial proportions. Bimaxillary surgery provided the most balanced outcomes, particularly in enhancing vertical facial proportions and soft tissue harmony. Postoperative reductions in nasal prominence were also observed in female patients, emphasizing the importance of individualized treatment planning and the potential need for secondary refinements to achieve optimal nasal—lip relationships.

Based on the above discussion, for female patients, different surgical approaches demonstrate distinct benefits. Maxilla-only surgery is highly effective for enhancing midfacial proportions. Mandible-only surgery is appropriate for achieving better lower facial balance. Bimaxillary surgery provides comprehensive corrections, particularly for individuals requiring substantial vertical adjustments and soft tissue improvements.

The present study showed orthognathic surgeries are effective in addressing key aesthetic parameters, such as nasolabial angle, SN—MP, LAFH, H angle, UL—E line, LL—E line, with bimaxillary surgery consistently offering the most comprehensive improvements. The findings of this study share similarities with previous research, as detailed below. Nasolabial angle adjustments, previous studies document the impact of maxillary advancement and impaction on the nasolabial angle, supporting the observed improvements in midfacial harmony following maxilla-only and bimaxillary surgeries.[14] Mandibular plane angle (SN—MP), alterations in the SN—MP angle during mandibular and bimaxillary surgeries align with studies highlighting the role of mandibular adjustments in resolving lower facial discrepancies.[15] Lower anterior face height (LAFH), the significant increase in LAFH following bimaxillary surgery corroborates findings that this procedure enhances lower facial balance.[16] Lip position relative to the aesthetic line,

Table 7 Mean and standard deviation comparing postsurgical females with reference norm.

Analysis	Variables	Orthognathic surgery type						Reference norm	
		Maxilla		Mandible		Bimaxillary			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Skeletal	UAFH (mm)	51.63	2.94	53.24	2.98	52.64	2.49	57.13	3.08
	LAFH (mm)	67.34	5.99	65.75	4.92	72.40	3.48	68.06	3.99
	PFH (mm)	75.70	8.92	74.09	4.49	76.51	4.31	81.06	4.71
	FMA (°)	28.52	8.46	29.54	4.40	31.17	6.24	27.72	3.81
	L1 — NB (mm)	7.65	1.92	5.33	1.64	6.56	2.13	5.07	2.29
	Pg — NB (mm)	1.34	0.92	2.03[a]	1.09	2.31[a]	1.16	1.76	1.21
	ANB (°)	5.63	1.82	2.48	1.87	3.13	1.84	2.59	1.79
	SN - MP (°)	35.52	8.06	37.94	4.84	39.98[a]	5.25	34.97	0.79
Burstone	UL — B line (mm)	5.61	1.65	5.11	1.55	6.26	1.61	5.06	1.32
	LL — B line (mm)	3.57	1.12	3.67	1.52	4.14	1.91	3.85	1.03
	UL length (mm)	23.08	2.32	21.98	1.75	23.74	1.42	22.63	1.80
	LL length (mm)	43.02	3.49	45.51	3.84	48.94	4.10	48.43	11.52
	Nose prominence (mm)	10.29[a]	1.81	10.96[a]	1.48	10.74[a]	1.00	14.22	2.17
Ricketts	UL — E line (mm)	0.01	1.75	−1.23	1.42	0.18	1.46	−1.89	1.83
	LL — E line (mm)	0.11	1.15	−0.47	1.53	0.19	1.88	−1.09	1.38
Holdaway	Sn—H line (mm)	8.16	2.30	7.13	2.11	8.91	2.22	7.38	1.76
	LL — H line (mm)	0.11	0.90	0.34	1.05	0.08	1.21	0.41	0.78
	H angle (°)	18.70	3.42	14.61	2.48	16.89	3.24	13.84	3.44
	Soft tissue chin thickness (mm)	13.22	2.16	11.27	1.33	13.84	2.27	13.34	3.12
	Superior sulcus depth (mm)	3.61	1.59	4.99	1.99	5.79	1.30	6.28	1.66
	Inferior sulcus — H line (mm)	3.80	0.95	4.01	0.94	4.41	1.40	4.69	1.13
	UL thickness (mm)	11.82	0.97	12.23	1.16	13.83	1.05	13.66	2.01
Steiner	UL — S line (mm)	1.24	1.58	0.38	1.38	1.54	1.53	0.8	1.62
	LL — S line (mm)	0.87	1.17	0.58	1.52	1.07	1.91	0.87	1.22
Profile angles	Nasolabial angle (°)	98.23	9.29	92.77	9.21	92.94	10.28	103.89	8.44
	Z angle (°)	70.32	4.96	78.47**	3.12	78.09**	6.25	73.63	4.57
	Profile angle (°)	77.21[a]	3.20	82.55[a]	2.90	84.29	4.43	84.22	3.79
	N' — Pg' [FH] (mm)	−1.72	5.03	5.36	5.05	8.79	6.42	−1.09	4.16

P-values comparing postsurgical data to reference norm.
[a] P-value <0.05.

adjustments in UL—E line and LL—E line reinforce the importance of lip inclination and prominence in achieving facial profile attractiveness.[17]

The consistent reduction in postoperative nasal prominence identified in this study represents a finding that is rarely emphasized in the existing literature. Although previous studies have explored nasal changes associated with orthognathic surgery, the necessity for secondary nasal refinements remains an area requiring further exploration.[18,19] This highlights the critical need for additional research to enhance our understanding and improve surgical planning, ultimately optimizing patient outcomes in clinical practice.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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