

Square Face Correction by Gonial Angle and Masseter Reduction

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Abstract

Introduction: The association of mandibular gonial angle, facial height, and jaw relationship in masseteric hypertrophy (MH) has not been adequately described for the typical Indian population. The aim of this study was to report the gonial angle relationship with facial height parameters in cases diagnosed with bilateral MH and its possible influence on the treatment plan. **Materials and Methods:** This is a retrospective study based on archival records of bilateral MH cases surgically treated over a 10-year period at the author's center. Patients' records fulfilling inclusion and exclusion criteria were considered for the study. Age, gender, upper anterior facial height (UAFH), lower anterior facial height (LAFH), upper posterior facial height (UPFH), ramus height (also a reflection of the lower posterior facial height), and gonial angle were collected along with the type of bite (open/normal/deep), surgical procedure (debulking with/without bone removal), and concomitant jaw bone corrections (yes/no). These were subjected to statistical analysis using SPSS, and $P \leq 0.05$ was taken as statistically significant. **Results:** Overall, 21 patients formed the study group comprising 9 females and 12 males. Gender influenced the UAFH, LAFH, UPFH, ramus height, and gonial angle significantly. Males had higher values than females. Normal bite had an obtuse gonial angle than the deep bite, and the difference was statistically significant ($P = 0.036$). When the gonial angle was acute or square faced, the need for other surgical procedures was high and the difference was statistically significant ($P = 0.048$). **Discussion and Conclusion:** The results are discussed in the light of Indian skeletal anthropometry. The relationship of the gonial angle with facial height parameters in bilateral MH cases in this part of the world is presented.

Keywords: Deep bite, genioplasty, gonial angle, masseteric hypertrophy, square face

INTRODUCTION

Reports of masseteric hypertrophy (MH) in recorded medical literature were described by Legg in 1880 that was erroneously reported as a tumor mass.^[1-3] Subsequent to this, there were several reports with varying clinical situations reported, including the enlargement of the mandibular bone along the masseter attachment. It was in 1941, Coffey by biopsy ruled out other pathologies.^[1,4] Since then, various treatment modalities were proposed. Gurney removed part of the muscle and reported in 1947, followed by Adams in 1949, who performed debulking along with the removal of a minor involved portion of the mandible, which was also enlarged.^[5,6] Subsequently, several treatment modalities emerged.^[1,2]

Currently, there are several accepted modalities of treatment of MH. There is no general consensus or recommended guidelines and the treatment is entirely customized, based on the clinical presentation. The etiology of the MH may

be idiopathic, genetically passed on or secondary to muscle hyperactivity subsequent to parafunctional habits or due to anatomical abnormalities. The alterations of the gonial angle and adjacent structures play a vital role in the determining the treatment.^[1,2,7,8]

Facial esthetics of the lower facial third is strongly influenced by the mandibular profile. Of the mandibular parameters, both esthetically and functionally, the mandibular or the gonial angle plays an important role. In humans, Johnson has reported that

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the size of the gonial angle is reliant on the proportion between the height of the face and the ramus height. When this delicate balance is disturbed, the gonial angle is altered. An increase of the facial height causes obtuse gonial angle, causing open bite becomes more obtuse, as may be seen in many cases of open bite. If the gonial angle becomes acute, there is a tendency to develop overbite. In general, as the vertical and sagittal discrepancies are highly correlated, the existence of abnormalities in sagittal discrepancies needs to be looked into.^[9,10]

There are very few reports on the upper anterior facial height (UAFH), lower anterior facial height (LAFH), upper posterior facial height (UPFH), ramus height, and gonial angle relationship in the MH cases reported in this part of the world.^[10] This manuscript aims to report the gonial angle relationship with facial height parameters in cases diagnosed with bilateral MH and its possible influence on the treatment plan.

MATERIALS AND METHODS

This is a retrospective study based on archival records of bilateral MH cases surgically treated at the author's center during January 2009 to December 2018. Only those cases who had bilateral MH that warranted surgical correction, of either gender, had follow-up for at least for 6 months, with no systemic illness, and had consented for the surgery were included for this study. Cases without documents, basic details, and radiographs were not included in this study. Similarly, patients who did not undergo surgery and had temporomandibular joint problems or abnormal parafunctional habits were excluded from this study.

From the records, the patient demographic data of age and gender were collected. From the cephalograms, the UAFH, LAFH, UPFH, ramus height (also a reflection of the lower posterior facial height), and gonial angle were measured, as per the standard prescribed method, by both the authors, and the mean was taken as the final value.^[11,12] Furthermore, details of the type of bite (open/normal/deep), surgical procedure (debulking with/without bone removal), and concomitant jaw bone corrections (yes/no) were also collected.

Statistics

All data thus collected were entered using the Statistical Package for the Social Sciences (SPSS, version 23.0, IBM, Chicago, IL, USA). Descriptive statistics were presented for all variables. Chi-square test was employed to find the association of type of bite with the gender, type of surgery, and other procedures planned and executed. One-way analysis of variance test was carried to assess the difference between the gender, type of surgery, and other procedures planned and executed in terms of UAFH, LAFH, UPFH, ramus height, and gonial angle. $P \leq 0.05$ was taken to be statistically significant.

Diagnosis of masseteric hypertrophy

Patients reporting with a complaint of a painless, facial swelling in the mandibular angle region, which was on both sides and insidious, slow growing and nontender were included in the study. Local oral examination was done to rule out other

pathologies (diagnosis by exclusion), and masseteric palpation done at rest and during clench was done to confirm the diagnosis.^[2,13] Later, all possible causes that could cause masseter thickness alteration such as dental caries, parafunctional habits, and occlusal abnormalities were corrected. If the "swelling" persisted even after all nonpharmacological interventions, surgical correction was planned [Figures 1-8].

Surgical technique for masseteric hypertrophy correction

Consenting patients underwent surgical debulking of the hypertrophied masseteric muscle with/without mandibular

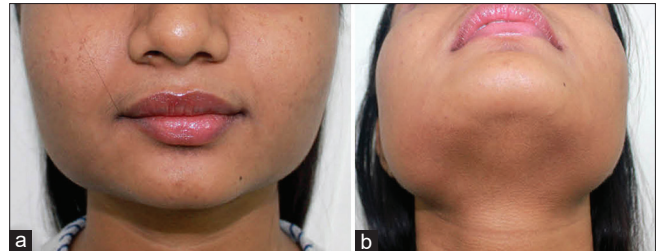


Figure 1: (a and b) Preoperative anterior and inferior view of bilateral hypertrophic masseter muscle

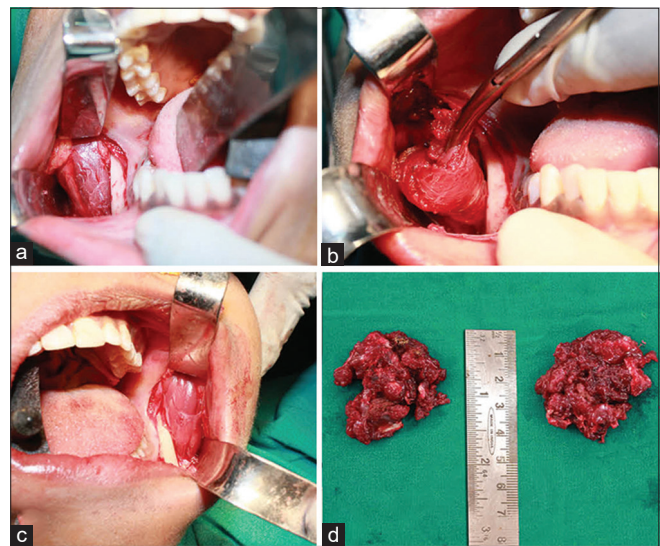


Figure 2: (a) Intraoperative view of incision in the right mandibular sulcus for muscle reduction surgery, (b) excess muscle tissue excised from the right masseter muscle, (c) intraoperative view of left mandibular sulcus with dissection down to the masseter muscle, and (d) specimens from the bilateral excised masseter muscle

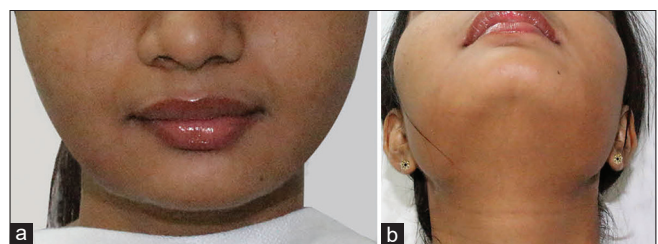


Figure 3: (a and b) Postoperative anterior and inferior views of restored feminine facial esthetics

angle recontouring only via the intraoral approach. The procedure was carried out under standard general anesthesia via conventional fiberoptic nasoendotracheal intubation. The surgical site was aseptically prepared. Local infiltration with 2% lignocaine with 1:80,000 adrenaline was done at the site to aid efficient hemostasis during surgery. The extent of myoplasty (or myotomy) depended on the extent of thickness and was planned for bone removal. Bone removal was planned based on the bite, other basal bone anomalies, and ramus length [Figures 2,5,8,9].^[13-15]

If any additional surgeries such as osteotomy were planned, it was executed at first. For the MH correction, a linear incision was made in the mandibular buccal vestibule corresponding to the mandibular first molar and extended till approximately half of the anterior border of the ascending ramus. The buccinator muscle was carefully dissected to expose the anterior border of the ramus. Later, the anterior border of the masseter was identified. Dissection was carried out to view the lateral surface of the muscle where in the approach was limited to the masseteric fascia plane. The fascia was split from the musculoaponeurotic system. Similarly, the medial surface was also separated from the ramus. The required amount of debulking, as previously planned, was carried out along the lateral surface.^[13-15]

If bone removal was planned, through the extended intraoral incision, the medial pterygoid was also carefully negotiated to reach the bone. The desired amount of bone was removed

either by stamp cut method or removed and recontoured using surgical hand and rotary instruments. The area was cleaned for bone debris. The debulked muscle belly was then sutured back to the free margin of the pterygomasseteric sling and the incision was closed primarily in layers.^[13-15]

After the procedure, hemostasis was achieved, and primary closure of the incision was done in layers with resorbable sutures. In the immediate postoperative period, an extraoral pressure dressing was maintained for at least 24–48 h over the surgical site, as and when required. Intravenous antibiotics and analgesics were prescribed for the 1st day and later with parenteral route. Appropriate mouth opening exercises were advised at the earliest from 2nd postoperative day [Figures 3,6,10].

RESULTS

Overall, 21 patients fulfilled the criteria and were considered for this study. There were 9 females and 12 males. The mean age of males was 28.92 ± 4.36 years, while for females, it was 24.33 ± 3.97 years. The difference was statistically significant ($P = 0.023$). The cohort had simultaneous debulking, and the angle bone trimming was more common than debulking alone. There were 8 cases who had a normal bite, while 13 had deep bite.

Gender appeared to influence the UAFH, LAFH, UPFH, and ramus height and gonial angle significantly. Males had



Figure 4: (a-d) Preoperative anterior, inferior, right lateral, and left lateral views of hypertrophic masseter muscle

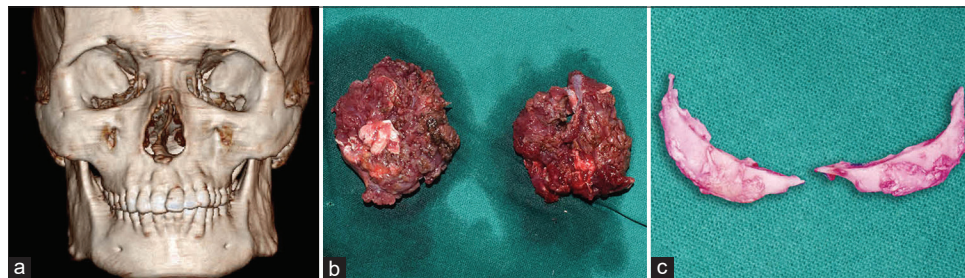


Figure 5: (a) Three-dimensional computed tomography scan revealing bony hypertrophy of bilateral gonial angles, (b) excised masseter muscle tissue from bilateral angle of mandible, and (c) excised bony excess from bilateral gonial angles

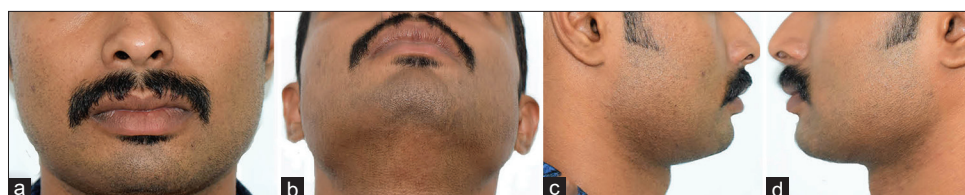


Figure 6: (a-c) Postoperative anterior, inferior, right lateral, and left lateral views of corrected hypertrophic angle of the mandible

higher values than females [Tables 1 and 2]. The outcome parameters were not influenced by the normal–deep bite,



Figure 7: (a-c) Preoperative view of the bilateral hypertrophic masseter muscle

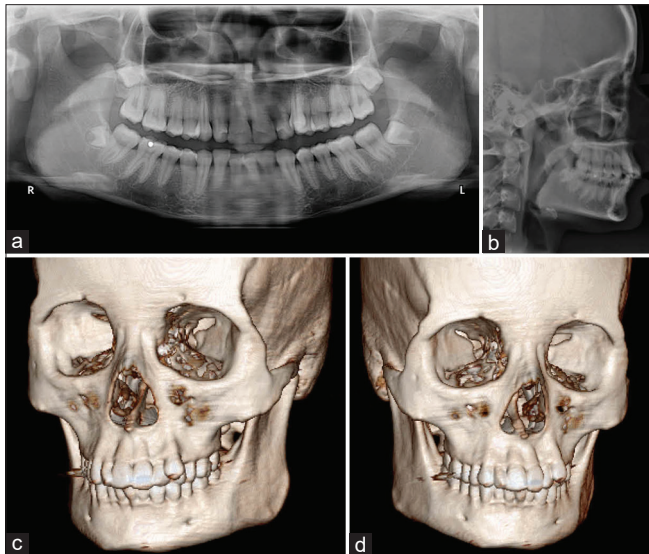


Figure 8: (a) Orthopantomogram showing bilateral prominent bony enlargement of gonial angle of the mandible, (b) lateral cephalogram showing prominent bony enlargement of left gonial angle of the mandible, and (c and d) three-dimensional computed tomography scan of the left and right sided hypertrophic masseter muscle

except for the gonial angle. Normal bite had an obtuse gonial angle than the deep bite and the difference was statistically significant ($P = 0.036$) [Table 3].

When the LAFH was higher, debulking alone was preferred, while when it was relatively lower, a combination of debulking and bone reduction was preferred [Table 4]. Similarly, the obtuse angle would require debulking alone, while the MH acute angle would be square faced and would require partial removal of the bone [Table 4]. Similarly, when the gonial angle was acute or square faced, the need for other surgical procedures was high and the difference was statistically significant ($P = 0.048$) [Table 5].

The UFAH was directly correlated with LAFH, UPFH, and ramus height with statistical significance. The LAFH was directly correlated with the ramus height. Hence, the anterior facial height appeared to be a reflection of the ramus height. However, the gonial angle was positively correlated with UPFH with statistical significance [Table 6].

DISCUSSION

Gonial angle is an important anatomical landmark and it marks a position where the mandible makes a turn, thereby enabling the formation of the well-developed lower jaw. Evolutionarily, the lower animals like reptiles were devoid of the same, while in primates, it was well developed, reflecting its importance in form and function. However, there is an increase of the angle in the transition from anthropoids to man which might be explained as a result of a decrease in the muscle mass and change in diet and facial form. With the shift to erect position and proper

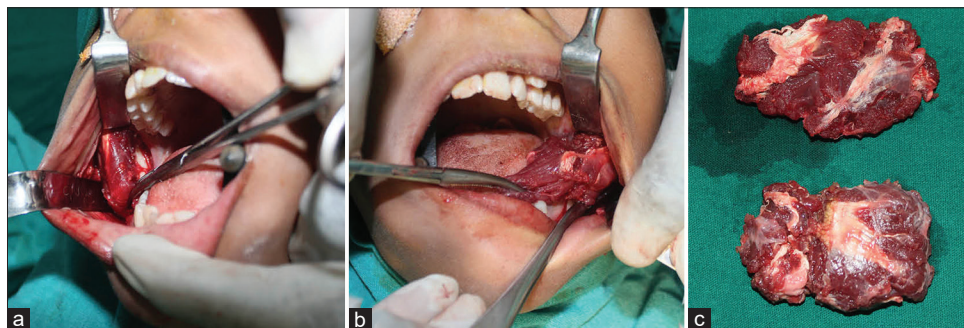


Figure 9: (a and b) Intraoperative view of hypertrophic masseter muscle mass reduction left and right and (c) excised masseter muscle tissue with bilateral angle of mandible reduction



Figure 10: (a-c) Postoperative views of bilateral reduced masseter mass

Table 1: The outcome variables based on the gender

Outcome variable	Gender	n	Mean±SD	95% CI for mean		Minimum	Maximum	P
				Lower	Upper			
Age	Female	9	24.33±3.97	21.28	27.38	19	30	0.023
	Male	12	28.92±4.36	26.15	31.69	21	36	
UAFH	Female	9	53.86±1.51	52.7	55.02	51.6	56.7	0.05
	Male	12	55.05±1.11	54.35	55.75	52.6	56.3	
LAFH	Female	9	64.47±0.75	63.89	65.05	63.2	65.3	0.019
	Male	12	66.01±1.68	64.94	67.08	62.4	68.1	
UPFH	Female	9	53.23±0.63	52.75	53.72	52.4	54.2	0.002
	Male	12	54.73±1.11	54.03	55.44	52.7	56.4	
Ramus height	Female	9	53.96±0.77	53.36	54.55	53.2	55.8	0.041
	Male	12	54.82±0.98	54.20	55.44	52.8	56.1	
Gonial angle	Female	9	106.44±2.13	104.81	108.08	103	109	0.021
	Male	12	109.42±3.03	107.49	111.34	105	115	

UAFH=Upper anterior facial height; LAFH=Lower anterior facial height; UPFH=Upper posterior facial height; CI=Confidence interval; SD=Standard deviation

Table 2: Comparison of demographic procedures based on type of treatment

	Debulking only	Debulking and bone contouring	P
Gender			
Male	2 (25)	7 (53.8)	0.201
Female	6 (75)	6 (46.2)	
Bite			
Normal	5 (62.5)	3 (23.1)	0.09
Deep bite	3 (37.5)	10 (76.9)	
Additional procedures			
No	8 (100)	5 (38.5)	0.006
Yes	-	8 (61.5)	

gait (differing from simian gait), the need for stronger neck muscle emerged. Accompanying this was the increase in frontal brain size, bringing base of skull down. Resultantly, the jaws were brought back, as compared to eye and nasal positioning. All these changes had an impact on the human gonial angle. The influences of age, gender, and race on the gonial angle are well-documented.^[9] The human desire for ideal mandibular angle and jaw line has been recently reported.^[16,17] When the MH occurs, often, the gonial angle is modified and there is a perceived need to correct it. The surgery could be the only effective and immediate solution. In this situation, cosmetic correction is performed. There are other nonsurgical options that are often short lived or do not yield the desired results.^[2]

In the present study, the type of treatment varied significantly between the uses of additional surgical procedures. This is because probably of the basal bone disparity being much pronounced in cases who have severe MH [Table 6]. Gender has a significant influence on age, UAFH, LAFH, UPFH, ramus height, and gonial angle. This probably stems from the anthropometrical values of the jaw between the gender and has been reported earlier.^[9] For the age, the strong

socio-religio-cultural outlook, as reported earlier, should be considered^[18] [Table 1].

From Table 4, one could identify that age, UAFH, LAFH, UPFH, and ramus height did not significantly differ between deep bite and normal bite. This indicates that, to a certain extent, normal bite can have MH. When such an MH occurs, there is no significance in terms of age, UAFH, LAFH, UPFH, and ramus height. However, gonial angle was different. Although very close, the difference was statistically significant. As the bite depth increases, the angle decreases. This is consistent with previously reported literature. From Table 5, it is understood that when the LAFH increases, debulking has been sufficed. This is because lower LAFH would have a deep bite, square face, and naturally smaller ramus height as compared to the normal bite. As the gonial angle increases, face debulking would suffice. When the gonial angle becomes more squared or acute, removal of the bone is needed. This is consistent with the previous observation. Furthermore, such a lesser gonial angle often requires additional basal bone correction; as the vertical and sagittal discrepancies are highly correlated, the existence of abnormalities in sagittal discrepancies is also a possibility^[9,10,15] [Table 6].

The interesting observation comes from correlation of the outcome variable. UAFH is highly correlated with LAFH. UPFH and ramus height are all vertical abnormalities, while the gonial angle is not correlated. Ramus height correlates with UAFH and LAFH with significance, indicating that ramus height is dependent on these two factors but not on the gonial angle. The gonial angle is correlated to the UPFH, indicating that the MH is not a loco-regional problem, limited to ramus but may have spilled from the dental apparatus. It is not sure whether this is a cause or an effect of the MH. However, the existence of correlation underlines that jaw correction may be needed if there is a discrepancy.^[15]

When the UPFH increases, there is an increasing gonial angle. The treatment goal should, therefore, consider establishing

Table 3: The outcome variables based on the type of bite

Outcome variable	Nature of Bite	n	Mean±SD	95% CI for mean		Minimum	Maximum	P
				Lower	Upper			
Age	Normal	8	27.88±5.54	23.24	32.51	19	36	0.495
	Deep bite	13	26.38±4.25	23.81	28.95	20	35	
UAFH	Normal	8	54.68±1.47	53.45	55.91	52.6	56.3	0.735
	Deep bite	13	54.45±1.41	53.60	55.30	51.6	56.7	
LAFH	Normal	8	66.01±1.29	64.93	67.09	64.6	67.8	0.125
	Deep bite	13	64.94±1.59	63.98	65.90	62.4	68.1	
UPFH	Normal	8	54.15±1.10	53.23	55.07	52.7	56.2	0.863
	Deep bite	13	54.05±1.29	53.28	54.83	52.4	56.4	
Ramus height	Normal	8	54.63±1.06	53.74	55.51	53.2	55.8	0.534
	Deep bite	13	54.34±0.95	53.77	54.92	52.8	56.1	
Gonial angle	Normal	8	109.88±3.00	107.37	112.38	106	115	0.036
	Deep bite	13	107.08±2.60	105.51	108.65	103	112	

UAFH=Upper anterior facial height; LAFH=Lower anterior facial height; UPFH=Upper posterior facial height; CI=Confidence interval; SD=Standard deviation

Table 4: The outcome variables based on the type of surgery

Outcome variable	Nature of surgery	n	Mean±SD	95% CI for mean		Minimum	Maximum	P
				Lower	Upper			
Age	Debulking	8	27.50±3.07	24.93	30.07	22	32	0.687
	Both	13	26.62±5.58	23.25	29.98	19	36	
UAFH	Debulking	8	54.91±1.45	53.70	56.13	52.6	56.3	0.349
	Both	13	54.31±1.37	53.48	55.14	51.6	56.7	
LAFH	Debulking	8	66.21±1.27	65.15	67.27	64.6	67.8	0.041
	Both	13	64.82±1.50	63.91	65.72	62.4	68.1	
UPFH	Debulking	8	54.49±1.40	53.32	55.66	52.7	56.4	0.24
	Both	13	53.85±1.03	53.23	54.47	52.4	55.8	
Ramus height	Debulking	8	54.58±0.80	53.92	55.25	53.4	55.6	0.642
	Both	13	54.37±1.10	53.71	55.03	52.8	56.1	
Gonial angle	Debulking	8	110.12±3.09	107.54	112.71	106	115	0.014
	Both	13	106.92±2.33	105.52	108.33	103	110	

UAFH=Upper anterior facial height; LAFH=Lower anterior facial height; UPFH=Upper posterior facial height; CI=Confidence interval; SD=Standard deviation

Table 5: The Outcome variables based on the other concomitant surgical procedures

Outcome variable	Concomitant Surgeries	n	Mean±SD	95% CI for Mean		Minimum	Maximum	P
				Lower	Upper			
Age	No	13	27.15±4.6	24.38	29.93	19	36	0.81
	Yes	8	26.62±5.18	22.29	30.96	20	35	
UAFH	No	13	54.7±1.2	53.98	55.42	52.6	56.3	0.513
	Yes	8	54.28±1.73	52.83	55.72	51.6	56.7	
LAFH	No	13	65.75±1.23	65.012	66.5	63.8	67.8	0.128
	Yes	8	64.69±1.86	63.14	66.24	62.4	68.1	
UPFH	No	13	54.24±1.28	53.46	55.01	52.7	56.4	0.482
	Yes	8	53.85±1.062	52.96	54.74	52.4	55.8	
Ramus height	No	13	54.48±0.85	53.97	54.99	53.2	55.7	0.86
	Yes	8	54.4±1.23	53.38	55.43	52.8	56.1	
Gonial angle	No	13	109.15±3.21	107.21	111.09	103	115	0.048
	Yes	8	106.5±1.85	104.95	108.05	104	109	

UAFH=Upper anterior facial height; LAFH=Lower anterior facial height; UPFH=Upper posterior facial height; CI=Confidence interval; SD=Standard deviation

an ideal UPFH. It has been previously reported that as the masseter becomes voluminous, the anterior maxillary region

shifts downward, as related to the cranial base, and the posterior region tended to shift upward. There is a decrease observed in

Table 6: Correlation of the outcome variables amongst themselves

Outcome variable	Statistics	UAFH	LAFH	UPFH	Ramus height	Gonial angle
UAFH	Pearson correlation	1	0.545*	0.509*	0.642**	0.246
	Significant (two-tailed)		0.011	0.018	0.002	0.282
LAFH	Pearson correlation	0.545*	1	0.245	0.728**	0.278
	Significant (two-tailed)	0.011		0.285	0.000	0.223
UPFH	Pearson correlation	0.509*	0.245	1	0.274	0.446*
	Significant (two-tailed)	0.018	0.285		0.23	0.043

* $P < 0.05$, ** $P < 0.01$. UAFH=Upper anterior facial height; LAFH=Lower anterior facial height; UPFH=Upper posterior facial height

LAFH/TAFH and increase in LPFH/TPFH as the size of the masseter muscle increases. This could be influenced by the inclination of the mandibular plane and this clockwise rotation of the maxilla.^[10]

Holistically, irrespective of the method used to correct MH, the psychological impact of over- or undercorrection is to be considered. For a male, the usual preference is for an acute angle that accentuates the jaw line is preferred. If overcorrection is performed, in such situations, the face becomes more feminine, leading to a need for more surgery. If undercorrection is performed, the residual MH could cause more esthetic concern and possibly functional discrepancies.^[16] From a female perspective, overcorrection could result in more feminine feature.^[19] If that is not a concern, the need for re-surgery may be avoided. If undercorrected, the residual MH would still contribute to the failure of the surgery. Hence, the surgeon needs to balance the over- and undercorrection. This could only be achieved by understanding the patient expectation, studying the patient facial anatomy, and proper planning of the surgery besides surgical dexterity.

The limitation of the study includes nonconsideration of bite force, measurement of muscle thickness, and electromyographic studies that may yield more clues.

CONCLUSION

The relationship of the gonial angle with facial height parameters in bilateral MH cases in this part of the world is presented. The influences of age, gender, type of correction, bite status, and facial height parameters and its possible influence on the treatment plan are presented. However, the present findings need to be validated on a larger sample size in a multicentric pattern.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient's mother has given her consent for the child's images and other clinical information to be reported in the journal. The patient's mother understands that the child's name and initial will not be published, and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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