ORIGINAL ARTICLE

POST OPERATIVE OUTCOMES IN OPEN REDUCTION AND INTERNAL FIXATION OF ZYGOMATIC BONE FRACTURES: TWO POINT VERSUS THREE POINT FIXATION

[1]KHURRAM LATIF, [2]YOUSEF MUSARRAH ALANAZI, [3]MOHAMMAD RAJI ALRWUILI
[4]SAAD MOHAMEDNAGIB ALFERGANI, [5]NASSER ATTALLAH ALENZI, [6]ABDULLAH SAAD ALQARNI

ABSTRACT

Objective of this study was to highlight the post-operative outcomes in ORIF of zygomatic bone fractures, by comparing two point versus three point fixation techniques, in Al-Qurayyat, Saudi Arabia, population. Fifty patients who visited the Department of Oral and Maxillofacial Surgery of Gurayat General Hospital, Al-Qurayyat, Saudi Arabia, were included in the study. The study was conducted from March 2014 to April 2017. Fifty patients constituted the study and were randomly divided into two groups. Group A had twenty five patients who underwent open reduction and internal fixation (ORIF) at two points. Group B comprised of twenty five patients and ORIF with three point fixation was done for them. Males were more than females in both the groups; 36/50 (72%) in total. Post-operative complications like vertical dystopia and malar height prominence were recorded at 1st week, 3rd week and 6th week of the operation. Age range was from 15-60 years with the mean 32.62 ±12.826. The statistical analysis showed that patients who underwent ORIF with three point fixation (Group B) suffered with fewer complications like vertical dystopia and altered malar height as compared to Group A. There was a significant difference ($p<0.05$), as far as the post-operative stability of the fractured zygomatic bone was concerned. Among the two groups; group B showed more promising results. So it was concluded from our study that ORIF using three point fixation technique in the treatment of zygomatic bone fractures is a better option in order to minimize the post-operative complications like altered malar height, vertical dystopia and stability of the bone.

Key Words: *Zygomatic Bone Fracture, Vertical Dystopia, Malar Height, Open Reduction.*

INTRODUCTION

Beauty is a complex phenomenon intrinsic to interactions between individuals. Horizontal and vertical proportions of various facial features are related to the facial beauty. The surgeon relies on certain facial proportions and relationships to provide a basis for diagnosis and planning in facial surgeries. The zygomaticomaxillary complex (ZMC) plays a key role not only in the structure and function but also in the aesthetic appearance of the facial skeleton. It provides normal cheek contour and separates the orbital contents from the infra temporal fossa and the maxillary antrum.[1] The zygoma is the origin for the masseter muscle and has important role in mastication. The mobility of the extraocular muscles is dependent upon the correct positioning of the bones of the orbit and zygoma contributes to it by making inferior and lateral orbital walls. The infraorbital nerve passes just inferior to the orbital rim. The fractures of ZMC lead to numbness and parasthesia of the upper lip, gingiva, lateral surface of the nose and skin of the cheek. The ZMC provides lateral globe support necessary for binocular vision. The zygomatic arch is the insertion site for the masseter muscle and protects the temporalis muscle and the coronoid process.[2,3]

The frequency of ZMC fractures is second only to nasal fractures, which are the most common type of facial fracture and overall represents 13% of all craniofacial fractures.[4] Some studies conclude that the zygomaticomaxillary region (ZM) is the third most commonly fractured facial area.[5] It is a prominent structure on the face making it vulnerable to receive the impact directly. ZMC fractures can result in functional and aesthetic

[1] Khurram Latif Specialist, Oral and Maxillofacial Surgeon
Correspondence: Dr Khurram Latif, Flat # 11, Building # 3, Street # 40, Mataar, Qurayyat, Saudi Arabia
Email: drkhurramshah@hotmail.com
Cell Phone: +966 508248985
[2] Yousef Musarrah Alanazi, Registrar, Oral Medicine
[3] Mohammad Raji Alrwuili, General Dentist
[4] Saad Mohamednagib Alfergani, General Dentist
[5] General Dentist
[1-5] All at Specialized Dental Center, Gurayat General Hospital, Al-Qurayyat, Saudi Arabia.
[6] Abdullah Saad Alqarni, General Dentist, King Khalid Hospital, Al-Kharj, Saudi Arabia

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deformities even if it is minimal. Accurate repair of ZMC fractures requires perfect diagnosis, adequate surgical exposure, and precise reduction and fixation to reconstitute the complex 3-D anatomy.[6] Vertical orbital dystopia and altered malar height or prominences are the two most important clinical signs and variables which are addressed during the reduction and fixation of the ZMC fractures. With vertical dystopia the orbits do not lie on the same horizontal plane leading to the esthetic as well as functional disability.[7] The face is divided roughly into thirds: upper third from hairline to glabella, middle third from glabella to subnasal, and lower third from subnasal to menton. The lower two thirds are further divided into 3 parts: in essence dividing the face roughly into ninths. The malar prominence appears within the middle third, at about 4/9th from the chin, and the eye canthus appears at about 5/9th from the chin. The malar prominence is thus found at approximately 4/5th of the distance from chin to eye canthus.[8]

Three point fixation technique for the treatment of zygomatic bone fractures has gained popularity over the years due to inadequate post-operative results with the one point and two point fixation techniques previously. This study focused towards evaluating the efficacy of post-operative outcomes after treating the zygomatic bone fracture by ORIF using two point fixation and ORIF using three point fixation techniques. There was no previous study conducted on this topic, which showed any data or comparative analysis, in the population of Al-Qurayyat, Saudi Arabia as per our knowledge. This study was conducted to achieve the better clinical results with fewer complications contributing to the selection of the best treatment option for the patients.

METHODOLOGY

The results of patients, with zygomatic bone fracture reduction and fixation, presented in the Department of Oral and Maxillofacial Surgery of Gurayat General Hospital/ Specialized Dental Center, Al-Qurayyat, Saudi Arabia, from March 2014 to April 2017, were assessed. The patient's data record registers, electronic data base (OAISIS) and log books of the authors, were used to extract the required details. Fifty healthy patients were scheduled for treatment of zygomatic bone fractures. The study was approved by the institutional ethical Committee. Randomization was done by using computer based software "EpiCalc2000". Numbers were generated from 1-50 which were allotted to the patients. Patients were randomly distributed into 2 groups. Group A: Twenty five patients were treated with open reduction and internal fixation using 2 point fixation technique. Group B: Twenty five patients were treated with open reduction and internal fixation using 3 point fixation technique. In the Group A, Intraoral Keens[9] approach via buccal sulcus incision was used to expose and reduce the zygomatic maxillary buttress region. Lateral brow incision[10] was used to expose and reduce the fracture at the fronto-zygomatic suture. In Group B, apart from keens approach and lateral brow incision, the subcilliary incision[9] was selected to expose and reduce the infra orbital margin. The points for fixation in group A were only 2 i.e. fronto-zygomatic suture area and zygomatic buttress region. Three point fixations were achieved in group B by application of the fixation device at fronto-zygomatic, zygomatic buttress and infraorbital margin. The observer did not know about the kind of therapy applied at the time of the patient examinations. Surgeons treating the patients were blinded to the randomization scheme. The patients were not blinded because they were informed that the study was designed to compare the 2 point fixation technique with 3 point fixation technique on malar height and vertical dystopia.

Reduction Method

Upper buccal sulcus incision measuring 1.5-2.00 cm was given to expose the zygomatic buttress. Row's zygomatic disimpaction forceps was used to reduce the zygomatic bone by lifting it upwards and outwards. The snapping sound was heard once the fracture was reduced into its position.[11]

Fixation Method:

Miniplates and microplates, with compatible mini and micro screws, were used to achieve the fixation at different sites. To expose the fractured site and fixation of the bony segments, Keen's approach (buccal sulcus incision) was used to fix the buttress region, lateral brow incision for the frontozygomatic region and subcilliary incision for the infra-orbital margin. In Group A, miniplates of 2mm diameter were used to fix the buttress and frontozygomatic regions. In Group B, additional point at the infra-orbital suture was fixed with 0.9mm microplate along with the other two points as in Group A.

Inclusion criteria were set which included all those patients who signed the written informed consent and had displaced isolated zygomatic bone fracture in any direction. All those patients were excluded from the study that had comminuted bone fracture e.g. gunshot injuries, medically unfit for the surgery (pregnancy, cardio-pulmonary, liver and kidney disease, drug addiction, and diseases like metabolism, CNS, infectious, circulation, malignant and immune system affecting diseases as well as blood coagulation disorders and allergic reactions to pharmaceuticals and antibiotics), pathological fractures and open infected fractures.

The malar prominence was defined as the most prominent part of the cheek when using oblique views. As such, it represented a combined soft tissue/hard

tissue landmark. Care was taken to distinguish the cheekbone from fatty submalar areas in heavier or older patients when empirically locating the cheek. Preoperatively malar height was measured from vertex view of the patient comparing fractured site with normal site and measuring with a vernier calliper. For measurement of malar height, a single reference point (intersection point of midsagittal line with the intercanthal line) was taken and second point was taken at the maximum height of malar region as viewed from vertex view of the patient and distance was measured between these two points preoperatively and post operatively.

Vertical dystopia was measured preoperatively and postoperatively by palpation of the orbital margins at different levels and was compared with the normal side by scale. Waters view was used to place the tracing paper and infra-orbital margin was outlined.

Post-operative Analysis:

Malar height and vertical dystopia were measured at 1st, 3rd and 6th week post-operatively. 3D-CTscan was used to evaluate the stability of the zygoma at the 6th week follow-up. The results were entered in a Performa. At the sixth week malar height and vertical dystopia were confirmed, completing the six weeks follow up assessment. Data was analyzed by using SPSS version 20. Quantitative variables like age, malar height and vertical dystopia were presented as mean + standard deviation. T-test was applied to the quantitative variables for the comparison between the two groups; significant value was taken as $p < 0.05$. Chi-square test was applied to the qualitative variables, like stability.

RESULTS

Fifty healthy patients were included in the study and results were analyzed. These patients were divided into 2 groups. Group A; 25 patients underwent ORIF with two point fixation and Group B; 25 patient underwent ORIF with three point fixation. The patients were randomly divided into two groups. According to the gender there were 36 (72%) males in both the groups combined. 19/36 (52.78%) underwent two point fixation and 17/36 (47.22%) underwent three point fixation. Among the 14 (28%) females, 6/14 (42.86%) were operated by two point fixation and 8/14 (57.14%) were operated by three point fixation. Males to females ratio was 2.57:1 in this study. At the 6th week of follow-up, there was significant difference in the malar height and vertical dystopia between the two groups i.e. p=0.004 and p=0.000 respectively. Group B showed more malar height prominence, less vertical dystopia and more stability at the 6th week follow-up. Final assessment revealed that there was significant difference (p=0.001) in stability of the fractured bone between the groups at 6th week. So over all Group B showed more promising results than Group A.

DISCUSSION

Although the prevalence of zygomatic bone fracture is very high worldwide, still there is no consensus regarding the best management approach. Trauma of the zygomatic complex constitutes 45% of all midface fractures. Various specialties including plastic surgery, otolaryngology and maxillofacial surgery deal with this kind of fracture and differ in their approach towards reduction and fixation of the processes of the zygomatic bone.[12] The malar eminence is the most prominent portion of the zygomaticomaxillary complex (ZMC) and is located approximately 2 cm inferior to the lateral canthus. The malar eminence is approximately the central portion of the ZMC.[4] bony attachments to the skull are evident from the center of the zygomatic bone, namely, a superior attachment to the frontal bone (frontal process of the zygomatic bone), a medial attachment to the maxilla (maxillary process or buttress of the zygomatic bone), a lateral attachment to the temporal bone (temporal process of the zygomatic bone) and a deep attachment to the greater wing of the sphenoid bone (sphenoidal process of the zygomatic bone).[13] Using this definition, ZMC fractures are called tripod fractures. However, the term tetrapod fracture is a more accurate description because 4 suture lines are disrupted.

Various classification systems have been designed by different authors for better understanding of the zygomatic complex fractures. On the basis of these classifications it is quiet easy to decide the treatment plan, ranging from conservative to extensive surgical repair. The most popular and clinically significant classification systems were proposed by Knight and North[14], Rowe and Killey[15] (Table 11), Henderson[16], Larsen and Thomsen[17], Ellis[18], Manson[19], Zing[5] and Rowe and Williams.[20] These authors have classified the zygomatic bone fractures on the basis of displacement of the fractured segments, fractured parts of the zygomatic complex and the extent of the impact. The most important parameter considered prior to the treatment planning of these fractures is the degree and direction of the displacement (Table 11). Almamidou et al[5] conducted a study on zygomatic bone and arch fractures and came to the conclusion that the age range of the patients, suffered from this injury, was 10-70 years with a mean of 32.33. Majority of the patients were males (80.6%). A study conducted by Q.-W. Zhuang[21] on ZMC fractures showed that age range in their patients was 14-55 years with a mean of 34. 27/31 (87.1%) were males. Salentijn et al[22] concluded that most fractures were found in the age group of 20-29 years for males and the age group of 50 years and older for females. Our study showed the similar results to all these studies mentioned. Males were 36 (72%) with the mean age of 32.6 and age range was from 15-60 years. Several

TABLE 1: DISTRIBUTION OF THE PATIENTS ACCORDING TO THE GENDER

		Frequency and Percentages		Total
		Group A	Group B	
Gender of the patients	Females	6(24%)	8(32%)	14(28%)
	Males	19(76%)	17(68%)	36(72%)
Total		25(100%)	25(100%)	50(100%)

Group A= 2 point fixation; Group B= 3 point fixation

TABLE 2: DESCRIPTIVE STATISTICS OF AGE OF THE PATIENTS (YEARS)

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients (N)	25	25	50
Mean	30.44	34.80	32.62
Standard Deviation	12.526	13.003	12.826
Standard Error Mean	2.505	2.6006	1.814
Minimum age of a patient (years)	15	15	15
Maximum age of a patient (years)	59	60	60

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 0.161 and t-test= -1.207; P-value= 0.233

TABLE 3: DESCRIPTIVE STATISTICS OF MALAR HEIGHT (MM) AT 1ST WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	68.90	68.86	68.88
Standard Deviation	1.347	1.428	1.374
Standard Error Mean	0.269	0.286	0.194
Minimum	67.00	65.00	65
Maximum	71.00	71.00	71

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 0.325 and t-test= 0.10

P-value= 0.921

TABLE 4: DESCRIPTIVE STATISTICS OF MALAR HEIGHT (MM) AT 3RD WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	67.191	68.449	67.820
Standard Deviation	1.480	1.425	1.572
Standard Error Mean	0.296	0.285	0.222
Minimum	64.00	65.00	64.00
Maximum	71.10	71.00	71.10

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 0.171 and t-test= -3.063; P-value= 0.004

TABLE 5: DESCRIPTIVE STATISTICS OF MALAR HEIGHT (MM) AT 6TH WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	66.875	68.510	67.692
Standard Deviation	1.096	0.858	1.277
Standard Error Mean	0.219	0.171	0.181
Minimum	65.00	67.00	65.00
Maximum	68.00	71.00	71.00

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 5.513 and t-test= -5.874 P-value= 0.000

TABLE 6: DESCRIPTIVE STATISTICS OF VERTICAL DYSTOPIA (MM) AT 1ST WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	1.771	1.838	1.804
Standard Deviation	0.554	0.624	0.585
Standard Error Mean	0.110	0.124	0.082
Minimum	1.00	1.00	1.00
Maximum	3.00	3.00	3.00

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 0.493 and t-test= -0.407 P-value= 0.686

TABLE 7: DESCRIPTIVE STATISTICS OF VERTICAL DYSTOPIA (MM) AT 3RD WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	2.243	2.110	2.176
Standard Deviation	0.703	1.007	0.862
Standard Error Mean	0.141	0.201	0.121
Minimum	1.23	1.23	1.23
Maximum	5.00	5.00	5.00

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 2.98 and t-test= 0.542; P-value= 0.59

TABLE 8: DESCRIPTIVE STATISTICS OF VERTICAL DYSTOPIA (MM) AT 6TH WEEK FOLLOW-UP

Description	Group A	Group B	Combined Groups (Total)
Total number of Patients(N)	25	25	50
Mean	3.726	2.473	3.098
Standard Deviation	0.931	1.070	1.176
Standard Error Mean	0.186	0.214	0.166
Minimum	2.11	1.23	1.23
Maximum	5.00	5.00	5.00

Group A= 2 point fixation; Group B= 3 point fixation; Equal variances assumed F= 0.026 and t-test= 4.404 P-value= 0.000

TABLE 9: FINAL ASSESSMENT

		Number of Patients(N)		Total
		Group A	Group B	
Stability of the Fractured bone	Stable	7(28%)	19(76%)	26
	Unstable	18(72%)	6(24%)	24
Total		25(100%)	25(100%)	50

Group A= 2 point fixation; Group B= 3 point fixation; Chi-square= 11.538; P-value= 0.001

TABLE 10: DISTRIBUTION OF THE PATIENTS ACCORDING TO THE CAUSE OF THE INJURY

Cause of the injury	Frequency (n)	Percentage (%)
Road traffic accidents	30	60%
Falls	8	16%
Inter-personal violence	8	16%
Sports	4	8%
Total	50	100%

TABLE 11: CLASSIFICATION OF ZYGOMATICO-MAXILLARY COMPLEX FRACTURE

Rowe & Killey Classification	
Type I	No significant displacement
Type II	Fractures of the zygomatic arch
Type III	Rotation around vertical axis
	a. Inward displacement
	b. Outward displacement
Type IV	Rotation around longitudinal axis
	a. Medial displacement of frontal process
	b. Lateral displacement of frontal bone
Type V	Displacement of complex bloc
	a. Medial
	b. Inferior
	c. Lateral
Type VI	Displacement of orbital-antral partition
	a. Inferiorly
	b. Superiorly (rare)
TypeVI I	Displacement of orbital rim segment
Type VIII	Complex comminuted fractures

Fig 1: One point fixation in zygomatic bone fracture

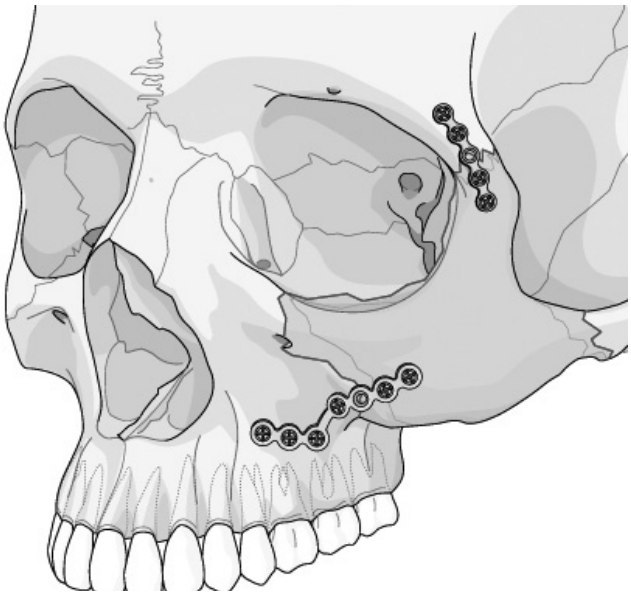

Fig 2: Two point fixation in zygomatic bone fracture

studies agree to the fact that worldwide the leading causes of maxillofacial injuries are road traffic accidents, violence and falls where males are affected more than the females. Not only is this reflected in our study but also in almost all the related previous articles and literature reviews.[23-25]

The management of ZMC fractures has been extensively studied worldwide. Comparison between post-operative complications using one-point, two-point and three point fixation techniques, after open reduction an internal fixation has been documented previously in many studies. A study conducted by Kim

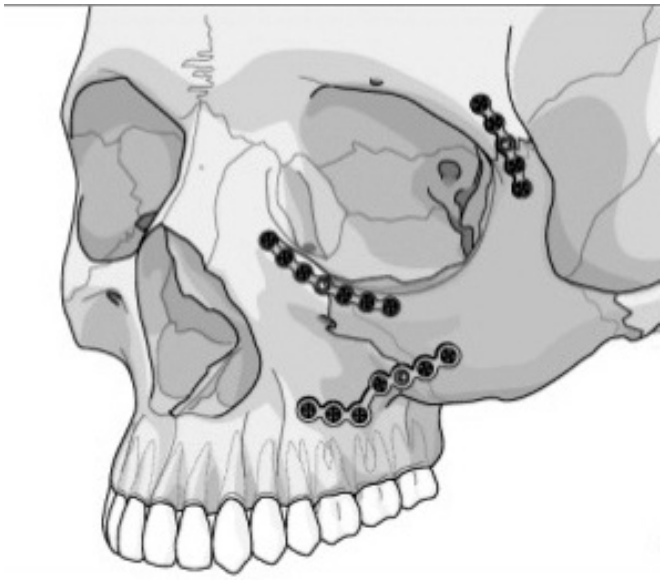

Fig 3: Three point fixation in zygomatic bone fracture

et al[26] showed that better esthetics is achieved when using one-point fixation technique in zygomatic bone fractures. Two point fixation needs additional incision thus leading to the facial scar which can be unacceptable to the patient. A study by Majeed Rana et al[27] revealed that post-operative complications, like decreased malar height prominence and persistent or increased vertical dystopia, were more frequent in two point fixation as compared to three point fixation technique. P-value for malar height prominence was significant at the 6th week follow-up (p=0.04), same as in our study in which P value at 3rd and 6th week of follow-up was p= 0.004 and p=0.000 respectively. Increase in vertical dystopia was insignificant at 1st and 3rd week post-operative among the two Groups in our study, p=0.686 and p= 0.59 respectively. At 6th week follow-up Group A (two point fixation) in the study showed increased vertical dystopia as compared to Group B (three point fixation) and was statistically significant (p= 0.000). Similar results were seen in the above mentioned study conducted by Majeed Rana et al[27] with a slight difference that at 1st week the P-value was insignificant (p= 0.897) for vertical dystopia among the two groups but as the time passed, in 3rd and 6th week, the findings became significant (p=0.001 and p=0.000 respectively). A study conducted by Atul et al[28] showed similar results as our study by concluding that three point fixation is the best modality to maintain the adequate stabilization in treatment of zygomatic bone fractures. They also declared that increase in the vertical dystopia and decrease in malar height prominence was highly significant with two point fixation when compared with the three point, p<0.01 and p=0.001 respectively.

Some studies conflict with our findings and strongly recommend one point or two point fixation of zygomatic bone fractures. Champy[29] and Mitchell[30] et al concluded that single bone plate in the frontozygomatic suture provides adequate three-dimensional stability to an unstable zygoma. Maski et al[31] concluded in their study that one plate fixation of zygomatic complex fracture showed excellent results but when there is comminuted fracture it is advisable to consider three point fixation to achieve best 3D-reconstruction and stabilization of the bone. A very recent study conducted by Jiawen et al[32] showed very similar results to our study mentioning that three point fixation is superior in achieving long term cosmetic and functional results as compared to one point or two point fixation.

Further studies should be conducted to compare the post-operative complications like scar, diplopia, enopthlamous, mouth opening, pain, swelling, mini and micro plate infection and need for its removal and esthetic suturing in one point, two point and three point fixation techniques for zygomatic bone fractures. This will help the surgeon to select the best possible treatment modality, with minimum adverse results for the patients. Studies should also be conducted to guide the law and order re-enforcement authorities to initiate and implement the strict traffic legislations in order to prevent such injuries.

CONCLUSION

It was concluded from our study that ORIF using three point fixation technique in the treatment of zygomatic bone fractures is a better option in order to minimize the post-operative complications like altered malar height and vertical dystopia.

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