Original Article – Evaluative Study

Rationale, Relevance, and Efficacy of "Surgery First, Orthodontics Later" Approach in the Management of Cases of Severe Malocclusion with Skeletal Discrepancy

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Abstract

A good esthetic outcome and optimal functional occlusion is the goal of management of any dentofacial anomaly. Conventional orthognathic surgery, as commonly practiced, entails a rather long-drawn management protocol comprising a triphasic treatment approach, with the surgical procedure being both preceded and followed by pre- and post-surgical orthodontics, respectively. This has numerous well-known drawbacks such as an uncertain and unpredictable patient compliance and poor motivation due to the inevitably long duration of orthodontic therapy; a transient and temporary worsening of the facial appearance brought about by presurgical orthodontic decompensation of occlusal relationships; and the inevitably prolonged time frame involved in ultimately achieving the desired esthetic and functional results. Further, unforeseen interruptions along the course of the long treatment period can result in unfavorable and even disastrous outcomes. The newer concept and technique of "Surgery First Orthodontics After" (SFOA) approach or "surgery-first approach" (SFA) entails first performing orthognathic surgery, thereafter following it up and finishing the case with postsurgical orthodontic settling and correction of the occlusion. It has two very distinct advantages over the erstwhile approach, first, an immediate and early correction of the facial deformity resulting in a remarkable improvement in facial appearance, which in most cases was what had prompted the patient to seek treatment for, in the first place. The patient, encouraged and motivated by the obvious and appreciable esthetic results, complies willingly and well with the subsequent postsurgical orthodontic treatment, even if it is lengthy or inconvenient, thus ensuring an optimal ultimate occlusion with complete functional rehabilitation as well. The second advantage of SFA is a markedly reduced overall treatment time, which is greatly appreciated by the patients. This article presents three cases of severe malocclusion with associated skeletal discrepancies, treated expeditiously and effectively using the SFA protocol. The overviews of SFA, including its rationale and relevance, indications, general and specific guidelines, different protocol variations, clinical outcome and success rate, as well as possible complications and potential problems encountered with this novel treatment protocol are also discussed.

Keywords: Orthognathic surgery, surgery-first approach, surgery-first orthognathic approach

Introduction

Historically, orthognathic surgeries were usually performed without any presurgical orthodontic treatment till the 1960's.[1] However, due to the primitive surgical and orthodontic concepts, practices, techniques, and skill, the treatment outcomes were not very promising. The slower "three-stage" philosophy of orthognathic surgery was then adopted to overcome these limitations of predictive planning and is still propounded by many clinicians till date.

This contemporary treatment modality which is currently in vogue for the correction of severe malocclusions and facial deformities by orthognathic surgery comprises a triphasic treatment approach, which was first popularized in 1960's.[1] The first phase is presurgical orthodontic decompensation of the occlusal relationships and attainment of an ideal dental alignment, followed by the surgical phase involving mandibular and/or maxillary osteotomy and repositioning of the jaw segments to the desired alignment and relative

Access this article online	
Quick Response Code:	Website: www.amsjournal.com
	DOI: 10.4103/ams.ams_272_18

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How to cite this article: Jeyaraj P, Chakranarayan A. Rationale, relevance, and efficacy of "surgery first, orthodontics later" approach in the management of cases of severe malocclusion with skeletal discrepancy. Ann Maxillofac Surg 2019;9:57-71.

positions, thereafter followed by the third phase comprising orthodontic settling and finishing of dental relationships so as to achieve optimal and stable esthetic occlusal as well as functional results.[2]

This approach has the obvious disadvantage of orthodontic interventions both before and after orthognathic surgery, prolonging the entire treatment period to 2–4 years or even longer. The presurgical orthodontic treatment of these patients requiring orthognathic surgery has been the main area of concern, as it is the most time-consuming stage of treatment. The mean length of this stage has been reported anywhere between 7 and 47 months.[1] Further, there are numerous attendant issues resulting from the extended period of use of Orthodontic Appliances. These include masticatory discomfort, dental caries, gingival recession, fenestration, root resorption, etc.[2,3] Another drawback associated with Phase-1 orthodontics is a temporary worsening of the facial appearance brought on by dental decompensation, which dampens the patient's morale and adversely affects their opinion, motivation, and enthusiasm for the treatment.

The concept of "Surgery-First and Orthodontics After (SFOA)" with the goal of reducing some of the disadvantages and inconveniences of presurgical orthodontics was proposed by Brachvogel *et al*.[4] in 1991, based on the premise that normalizing surrounding soft tissues (lips, cheeks, and tongue) settled teeth into better positions after surgery, thus facilitating remaining orthodontic tooth movement and thereby reducing the total orthodontic treatment period.

Further, following orthognathic surgery, a period of rapid metabolic activity within healing tissues and a bone remodeling process ensues, which is known as the regional acceleratory phenomenon (RAP), first described by Frost in 1983.[5] RAP can be harnessed to facilitate and hasten the subsequent orthodontic tooth movement, thus reducing the treatment duration, and this forms the broad basis for implementation and success of SFOA.[5-7]

The proposed mechanism for this decrease in orthodontic treatment time is the increase in cortical bone porosity, secondary to jaw osteotomy or ostectomy that results in decreased resistance to tooth movement. The results of a study show that orthognathic surgery triggers 3–4 months of higher osteoclastic activities and metabolic changes in the dentoalveolus.[8] During the subsequent healing process, there is an increase in blood flow above the presurgical levels which stimulates bone turnover that can potentially speed up orthodontic tooth movement.[9-11]

Our study presents three cases of malocclusion with associated skeletal discrepancies, treated expeditiously and effectively using the SFOA protocol. The overviews of SFOA, including its rationale and relevance, clinical outcome and success rate, as well as possible complications and potential problems encountered with this novel treatment protocol have also been discussed.

Case Reports

Case 1

A 19-year-old male patient presented with the complaints of an unsatisfactory facial appearance due to a prominent and asymmetric lower jaw. Clinical evaluation revealed facial asymmetry, a skeletal Class III and dental Class III malocclusion with a crossbite on the left side, a retrognathic maxilla, prognathic mandible, and a mandibular median line deviation of 13 mm to the left [Figure 1a-d]. Photographic analysis revealed a deep mentolabial sulcus and an increased width of the nose. The tip of the nose and the tip of the chin did not lie on the same straight line, and there was an obvious slewing and deviation of the chin to the left.

Dental crowding was observed in the upper and lower anterior region [Figure 1e-i]. The maxillary arch was narrow and constricted. Upper and lower incisors were in an edge-to-edge relationship. Molar relationships were Class 1 on the right side and Class 2 on the left side. There was a posterior crossbite bilaterally. There was a shift of the mandibular dental midline to the left by 13 mm. Ratio of the upper-to-middle to lower third of face which should normally be 1:1:1 was 25:26:30, the inference which could be drawn was that there was an increased height of the lower third of the face.

$$\text{Facial Index} = \frac{\text{Bi} - \text{Zygomatic width} \times 100}{\text{Length of Face}}$$

$$= \frac{46 \times 100}{55} = 83\,\%$$

This showed the face to be brachycephalic.

The patient had a concave facial profile with anterior divergence of the face.

Orthopantomogram revealed impacted third molar teeth [Figure 2c and d], which were then surgically removed.

Posteroanterior and lateral cephalograms were obtained [Figure 2a and b], and cephalometric analyses were carried out [Figure 2h-J and Tables 1-4].

Facial soft tissue (Arnett and Holdaway's) analysis [Table 2] revealed an orthognathic profile, prominent chin, retrusive lips, large nose, increased upper lip thickness, evident strain of upper lip evident, and procumbent lower lip with reduced lower sulcus depth.

The problem list drawn for this patient included:

1. Facial proportion and esthetics
    a. Facial asymmetry and deviation to the left side
    b. Obtuse nasolabial angle
    c. Deep mentolabial sulcus
    d. Toothy smile
    e. Prominent chin.
2. Dental alignment and symmetry
    a. Proclined upper incisors and retroclined lower incisors
    b. Crowding in upper and lower incisor regions
    c. Lower dental midline shift to the left

Figure 1: (a-d) A 19-year-old patient with facial asymmetry, slewing of the chin to the left, concave facial profile, anterior divergence of face, skeletal Class III malocclusion with retrognathic maxilla and prognathic mandible. (e-g) Proclined upper anteriors, retroclined lower anteriors with crowding, edge-to-edge bite on the right side and cross bite on the left side. A mandibular dental midline deviation to the left by 13 mm, was noted. (h, i) A constricted and narrow maxillary arch and dental crowding in the lower arch

Table 1a: Steiners analysis

Measurement	Mean	Actual	Inference
SNA	82°	74°	Retrognathic Maxilla
SNB	80°	82°	Orthognathic Mandible
SND	76°		
ANB	2°	-8°	Class III Skeletal Base
GO-GN to SN	32°	30°	Average Growth Pattern
Upper Incisor-NA (Angle)	22°	42°	Proclined Upper Incisors
Upper Incisor- NA (mm)	4 mm	11 mm	Forwardly Placed Upper Incisors
Lower Incisor-NB (angle)	25°	8°	Retroclined Lower Incisors
Lower Incisor- NB (mm)	4 mm	1.5 mm	Backwardly placed Lower Incisors
Interincisal Angle	130°	138°	Proclined Upper & Retroclined Lower Incisors
PO-NB (mm)	Not established	-	-
PO & Lower incisor to N-B (diff)	-	-	-
Occlusal Plane-SN	14°	14°	Average cant of Occlusal Plane
'S' line	Retrusive U/Lip		Average L/Lip

Table 1b: Tweeds analysis

Measurement	Mean	Actual	Difference	Inference
FMA	25°	29°	4°	Vertical Growth Pattern
FMPA	65°	78°	13°	Retroclined lower incisors
IMPA	90°	730°	-17°	Retroclined lower incisors

  d. Posterior crossbite
  e. Class 3 relation on the right side.
  f. Edge to edge bite.

3. Anteroposterior relationship
   a. Class III skeletal base with retrognathic maxilla and prognathic mandible

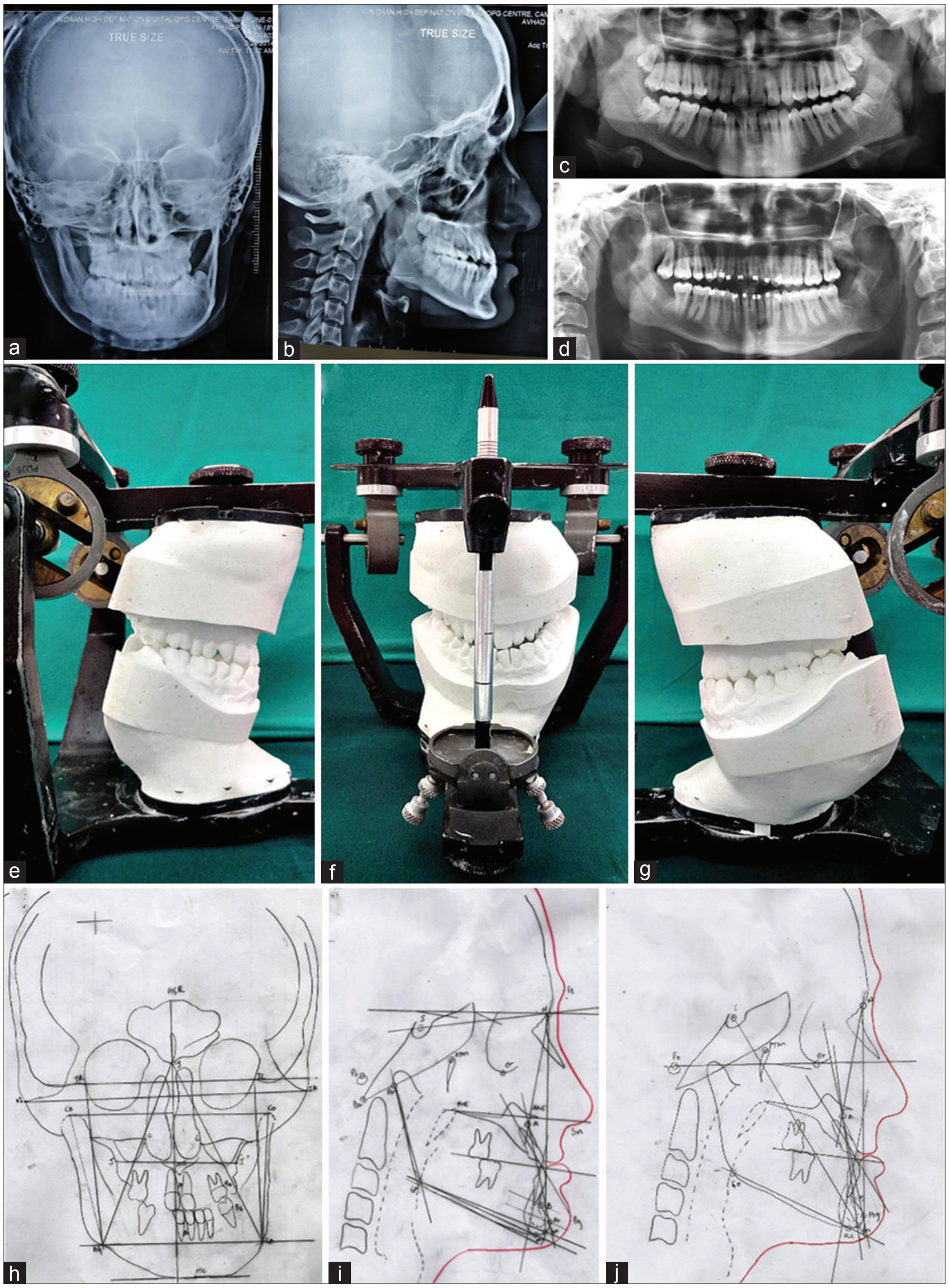

Figure 2: (a and b) Posteroanterior and lateral cephalogram. (c and d) Orthopantomograms of the patient before and after surgical extraction of the impacted third molar teeth. (e-g) Maxillary and mandibular models articulated by means of face bow transfer. (h-j) Cog's, McNamara's, and Holdaway's cephalometric analyses

Table 1c: Wits appraisal

Measurement	Mean	Actual	Inference
BO-AO	F-O mm M-+I mm	BO ahead of AO by 12 mm	Class III Skeletal Base

   b. Class III molar relationship on the right side.
4. Vertical relationship
   a. Skeletal vertical growth pattern.

The goals of treatment were to align the maxillary and mandibular dental arches, to improve the maxillary and mandibular incisor inclinations, to obtain ideal overjet and overbite, to correct the deviation of the lower median line, to achieve a good functional occlusion, and finally to improve the skeletal and soft-tissue profile.

A surgery-first approach (SFA) was planned for the patient, involving Le Fort I maxillary advancement surgery, bilateral

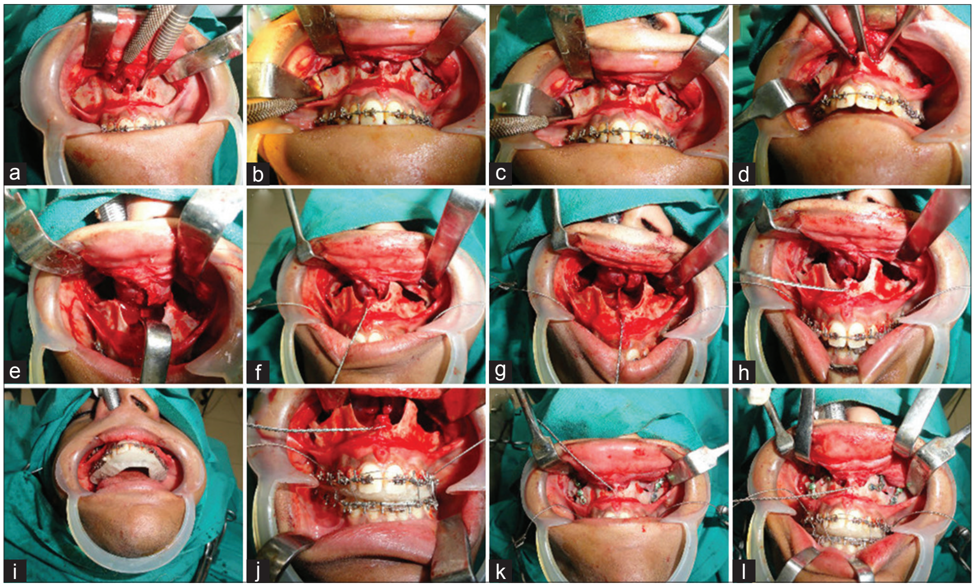

Figure 3: (a-c) High Le Forte I level osteotomy. (d) Nasal septal osteotome used to separate the base of the septum from the maxillary segment. (e) Downfracture of the osteotomized maxilla. (f-h) Maxilla advanced by application of anterior traction. (i) Prefabricated occlusal wafer splint secured to the maxilla and used to reposition the mobilized maxilla into the predetermined occlusal relation with the mandible. (k and l) Rigid fixation carried out using Titanium minibone plates and screws

Table 1d: MC namara analysis

Measurement	Mean	Actual	Inference
N Perp- A	0±2mm	-12.5 mm	Retrognathic maxilla
N Perp to Pogonion	0-4 mm	2 mm	Average Mandible
Facial axis angle	0°	+4°	Horizontal Growth Pattern
Mand Plane angle	22±4°	25°	Average Growth Pattern
Eff Man Mandibular length	-	122 mm	Decreased length of mandible
Maxilllomandibular differentia	-	44 mm	
Lower anterior Face ht	-	65 mm	Average LAFH
Upper Incisor-A	4-6 mm	8 mm	Proclined Upper Incisors
Nasolabial angle	90°-110°	125°	Obtuse Nasolabial angle
Pharyngeal analysis U L	15-20 mm	16 mm	Average Airway
	11-14 mm	18 mm	
Maxillary length	84 mm	78 mm	Decreased maxillary length
Lower incisors - A Pog	1-3 mm	3 mm	Average Lower Incisor

sagittal split osteotomy of the mandible with setback, thereafter to be followed by orthodontic treatment.

After a careful extraoral analysis, the treatment planning was carried out using the Dolphin Digital Systems that can generate visual treatment objective (VTO) by overlapping the presurgical cephalometric tracing with the postsurgery one on the basis of the programmed skeletal movements. First, a VTO was generated, with repositioned dental elements and even the skeletal bone bases.

For preparation of the occlusal wafer splints, the maxillary and mandibular models were articulated by means of face bow transfer [Figure 2e-g] and thereafter set up in a proper Class 1 molar relationship and with a positive overbite. The most challenging and time-consuming step is the prediction of the final occlusion based on the current position of teeth. The term "intended transitional malocclusion" (ITM) is used to describe the occlusion that is used to fabricate the surgical splint and surgeon's guide during surgery. At least, a three-point contact must be established between the upper and lower models when deciding ITM.

Maxillary advancement was carried out first [Figures 3 and 4], followed by mandibular setback with rotation [Figure 5] to correct the mandibular dental midline shift to the left. Occlusal wafer splints fabricated separately before each of the two surgeries, assisted in correct positioning of the maxilla and mandible intraoperatively prior to rigid internal fixation of the osteotomized segments. The anteroposterior decompensation for moderately retroclined and crowded lower incisors this Class III case could be achieved by setting up the molars in a Class I relationship with an excessive incisor overjet, and then the lower incisors could be aligned postoperatively to obtain a normal overjet [Figure 6].

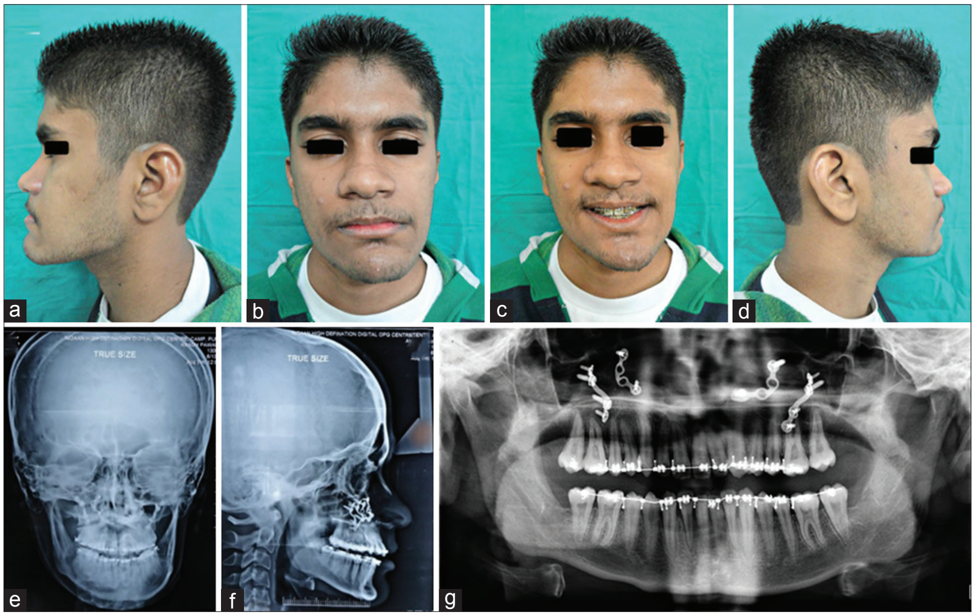

Figure 4: (a- d) Facial appearance (Frontal and Profile) following the Maxillary advancement. (e-g) Postero-Anterior and Lateral Cephalograms; and Orthopantomogram following the Maxillary advancement

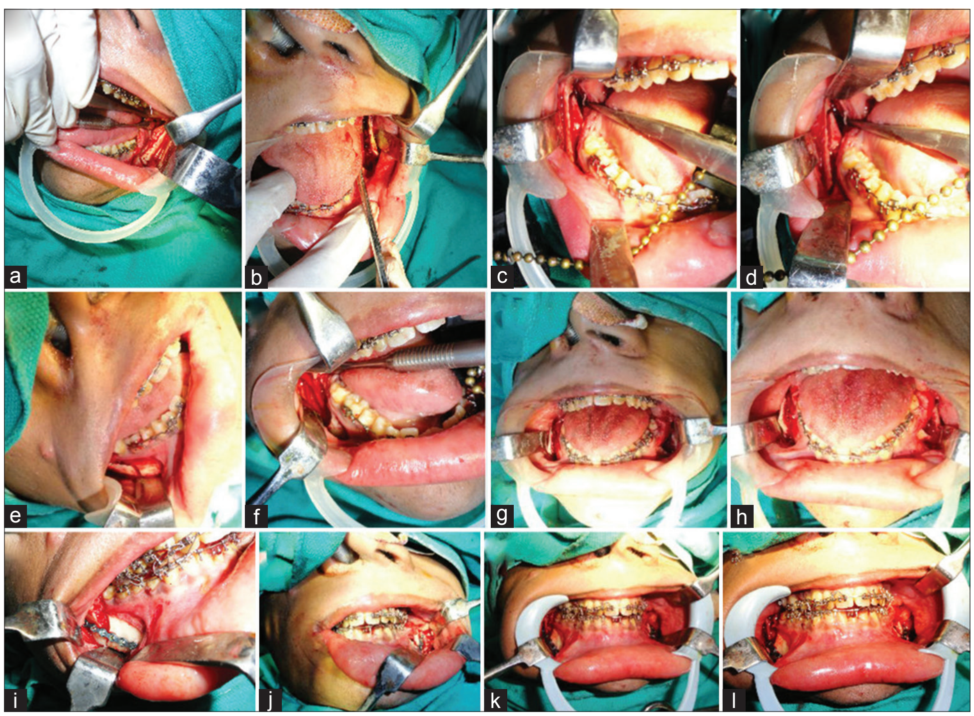

Figure 5: (a-h) Bilateral sagittal split ramal osteotomy (BSSRO) carried out. (i-l) Mandibular setback carried out along with rotation to the right, in order to counter the existing mandibular midline deviation to the left

The anteroposterior decompensation for the proclined maxillary incisors was accomplished after surgery, which resulted in further improvement in the facial profile.

The upper and lower dentitions were bonded and banded preoperatively, but no arch wires were placed. Orthodontic arch wires were placed 1-week postoperatively and orthodontic treatment for the dental alignment begun, while the osteotomized jaw bones were held steadily by the rigid fixation. During the 6-month treatment period, excellent esthetic results and good functional occlusion were achieved [Figures 7 and 8].

Case 2

A 19-year-old male patient reported with the complaint of unsatisfactory facial appearance due to prominent upper front teeth and backwardly placed lower front teeth. On clinical examination, on profile view, he had a convex profile with

Figure 6: (a-d) Immediate postoperative appearance following the mandibular setback. (e-h) Occlusion following the orthognathic surgical procedures. (i-k) Successful correction of the concave facial profile, facial asymmetry, mandibular deviation, and skeletal Class III occlusion

Table 1e: (i) Bolton Analysis

$$\text{ANT RATIO} = \frac{\text{MAND 6 TM} \times 100}{\text{MAX6TM}} = 77.2\% \pm 0.22$$

$$= \frac{40 \times 100}{49} = 81.6\%$$

$$\text{OVERALL RATIO} = \frac{\text{MAND 12 TM} \times 100}{\text{MA}\times 12} = 91.3\% +\_0.26$$

$$= \frac{90 \times 100}{99} \;\; - \;\; 90.0\%$$

Amount of Anterior Mandibular

$$\text{Excess} = 40 - \left[\frac{49 \times 77.2}{100}\right]$$

$$= 2.2\text{mm}$$

Amount of overall Maxillary Excess

$$= 99 - \left[\frac{90 \times 100}{91.3}\right]$$

$$= 0.42 \text{ mm}$$

retrognathia [Figure 9a-d]. The upper and middle face, eye, nose, and ear measurements were within normal limits. However, cephalometrically, there was a mandibular corpus deficiency of approximately 8 mm in the sagittal plane. The dental arches were U shaped and well aligned with minimal compensation in the lower anterior teeth, incisor-to-mandibular plane angle being close to 90°. Based on the above findings, it was diagnosed as a case of mandibular body deficiency of 8 mm, which was planned to be addressed by mandibular advancement by bilateral sagittal split osteotomy using the SFA [Figure 9e and f]. The presurgical steps remained the same as explained for Case 1, i.e., construction of a splint after face bow transfer and articulation of the diagnostic cast. However, the orthodontic appliance was applied just prior to surgery in order to avoid the inconvenience to the patient in the immediate postoperative state. Bilateral sagittal split ramus osteotomy (BSSRO) was performed, and the mandible was advanced by approximately 8 mm [Figure 9e]. The prefabricated splint was used to determine the final position for fixation of the mandible [Figure 9f].

The patient was treated with injection augmentin 1.2 g intravenous (IV) 12 h, injection amikacin 750 mg IV OD,

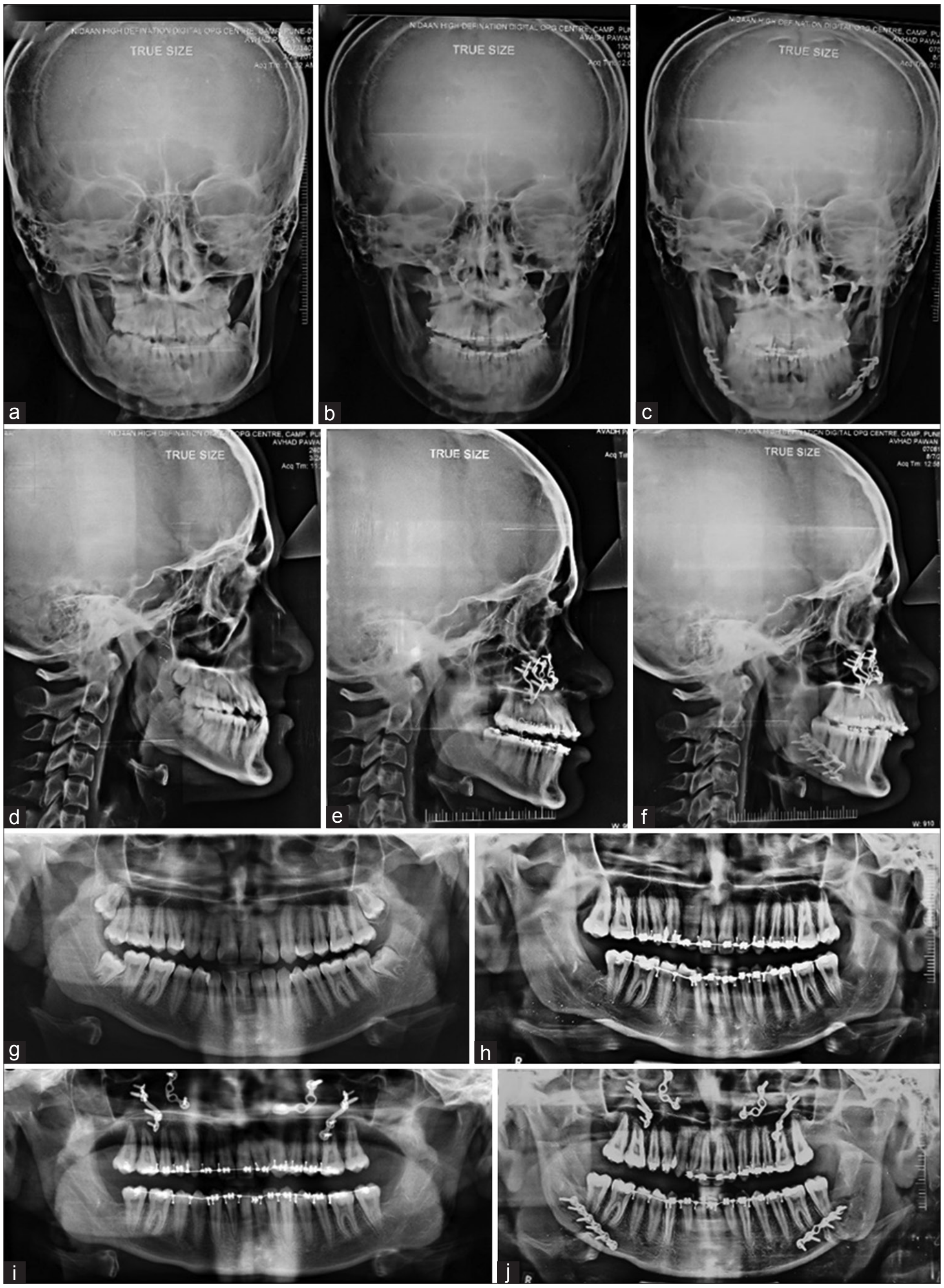

Figure 7: (a) Pre-treatment Posteroanterior Cephalogram (PA Ceph). (b) PA Ceph following the Stage 1 surgery (Maxillary Advancement procedure). (c) PA Ceph following the Stage 2 surgery (Mandibular Setback procedure). (d) Pre-treatment Lateral Cephalogram (Lateral Ceph). (e) Lateral Ceph following the Stage 1 surgery (Maxillary Advancement). (f) Lateral Ceph following the Stage 2 surgery (Mandibular Setback). (g) Pre-treatment Orthopantomogram (OPG). (h) OPG showing upper and lower dentitions bonded and banded, with arch wires in place. (i) OPG following the Stage 1 surgery (Maxillary Advancement). (j) OPG following the Stage 2 surgery (Mandibular Setback).

injection metronidazole 500 mg IV 8 h, injection paracetamol 1 g IV 12 h, and injection dexamethasone 8 mg iv 12 h for 5 days, thereafter followed by oral antibiotics and pain killers for 3 days. Silk sutures were removed after 7 days, and the patient was discharged on the 8th postoperative day. Orthodontic treatment was started after 2 weeks, as soon as the postsurgical tenderness has subsided. The treatment was completed within 8 months [Figure 9g-i].

Case 3

A 16-year-old female patient reported with the complaint of forwardly placed lower teeth. On clinical examination, on profile view, she had a concave profile. The upper and middle face, eye, and ear measurements were within normal limits. However, the nose showed flattening of the tip, with the widening of the alae. Mouth opening and temporomandibular joint were within normal limits, and the occlusal relationship

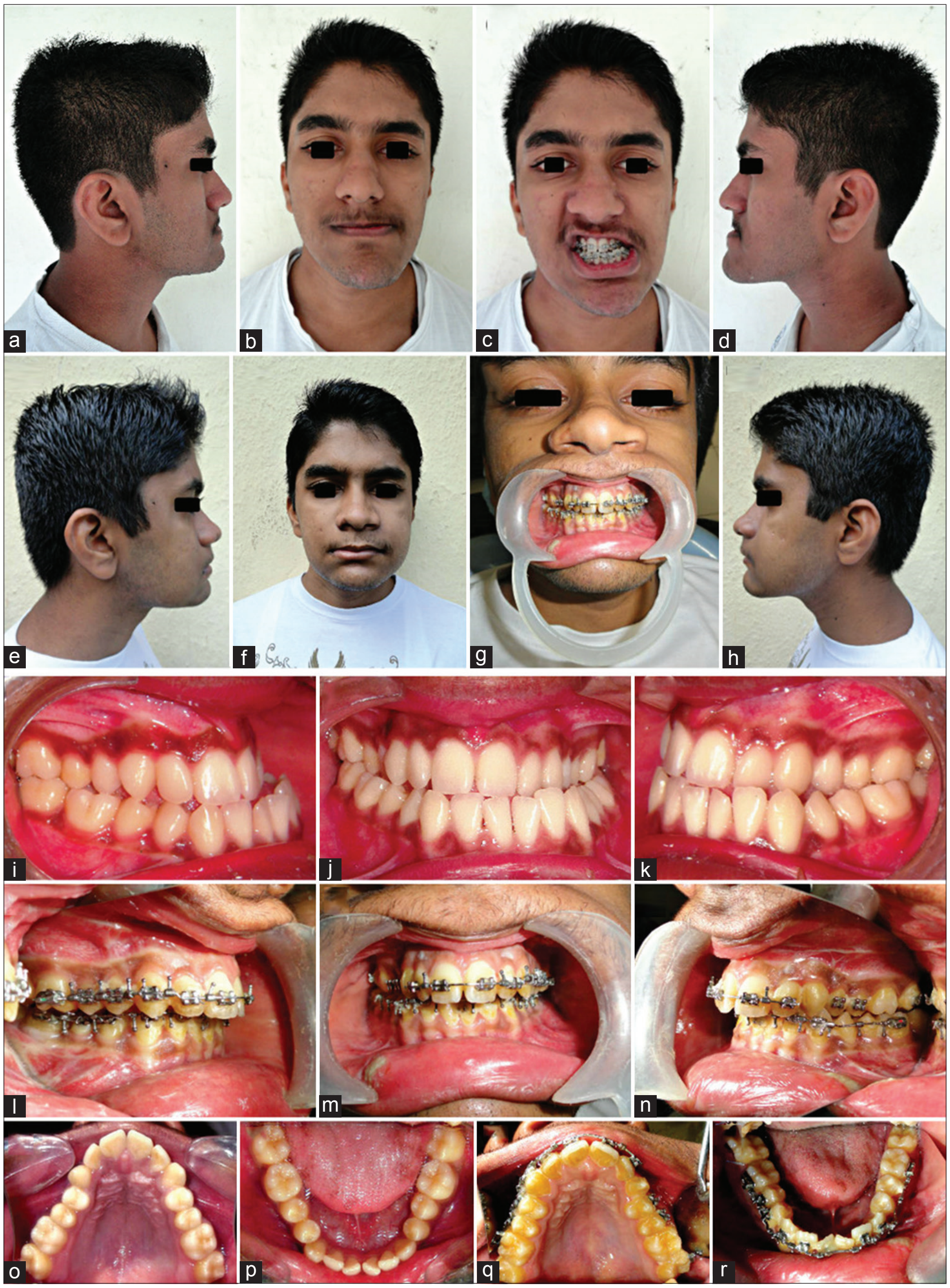

Figure 8: Comparison of pre-treatment (a-d) and posttreatment (e-h) Facial appearance. Comparison of pre- (i-k) and post-treatment (l-n) occlusion. Dental arches pre- (o and p) and post-treatment (q and r)

was in Class III [Figure 10a-e]. The dental arches were U shaped and well aligned with minimal compensation in the upper and lower anterior teeth. Cephalometrically, there was a mandibular corpus excess of approximately 6 mm. Based on the above findings, it was diagnosed as a case of mandibular body excess of 6 mm, which was planned to be addressed by mandibular setback by BSSRO, using the SFA [Figure 10f]. The presurgical steps remained the same as explained for case one. BSSRO was done, and the mandible was setback approximately 7 mm. The prefabricated splint was used to determine the final position for fixation of the mandible.

The patient was treated with injection augmentin 1.2 g IV 12 h, injection amikacin 750 Mg IV OD, injection metronidazole 500 mg IV 8 h, injection paracetamol 1 g IV 12 h, and injection dexamethasone 8 mg IV 12 h for a period of 5 days, thereafter followed by oral antibiotics and pain killers for 3 days. The intraoral silk sutures were removed after 7 days, and the patient was discharged on the 8th postoperative day. Orthodontic treatment to correct the posterior open bite and settle the occlusion [Figure 10g], was started after 2 weeks, as soon as the postsurgical tenderness has subsided and was completed within a year [Figure 10 g and h].

Figure 9: (a-d) A 19-year-old patient with skeletal Class II malocclusion with a mandibular corpus deficiency by 8 mm. (e and f) SFOA employed. BSSRO carried out and Mandible advanced by 9 mm guided by the interocclusal wafer splint. (g-i) An excellent esthetic as well as functional outcome achieved at the end of 8 months of postsurgical orthodontic settling of the occlusal discrepancies

Table 1: (a) Steiner's; (b) Tweed's; (c) Wit's; (d) Mc Namara's; (e) Bolton's Analyses

(ii) Skeletal values derived from the bolton standards (*n*=16) for each sex at each age standardized 8% enlargment (in mm)

	6 yrs		9 yrs		12 yrs		14 yrs		16 yrs		18 yrs	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Female												
Mandibular Length (CO -GN)	97.7	3.4	106.1	3.4	113.1	3.6	118.9	3.0	120.0	3.4	121.6	4.5
Maxillary Length (CO-Pt. A)	79.8	2.2	85.0	2.3	19.6	2.4	92.3	2.7	92.7	2.3	93.6	3.2
Difference	17.9	8.1	21.1	2.7	23.5	3.0	26.8	4.1	27.3	3.0	28	12
Lower ant Face ht	57.9	3.4	60	2.9	62.6	4.5	65.6	4.9	66.1	4.3	67.2	4.7
Male												
Mandibular Length (CO -ON)	99.3	3.6	107.7	3.5	114.4	4.3	120.6	4.3	126.8	4.7	131	4.6
Maxillary Length (CO -PLA)	81.7	3.4	87.7	4.1	92.1	4.1	95.2	3.2	28.9	4.4	100.9	3.9
Difference	17.5	22	20	26	22.3	2.1	25.4	3.5	27.9	3.3	30.1	3.9
Lower ant Face ht	58.4	3.1	61.4	3.6	61.3	3.6	66.3	3.9	69.4	4.3	71.6	4.9

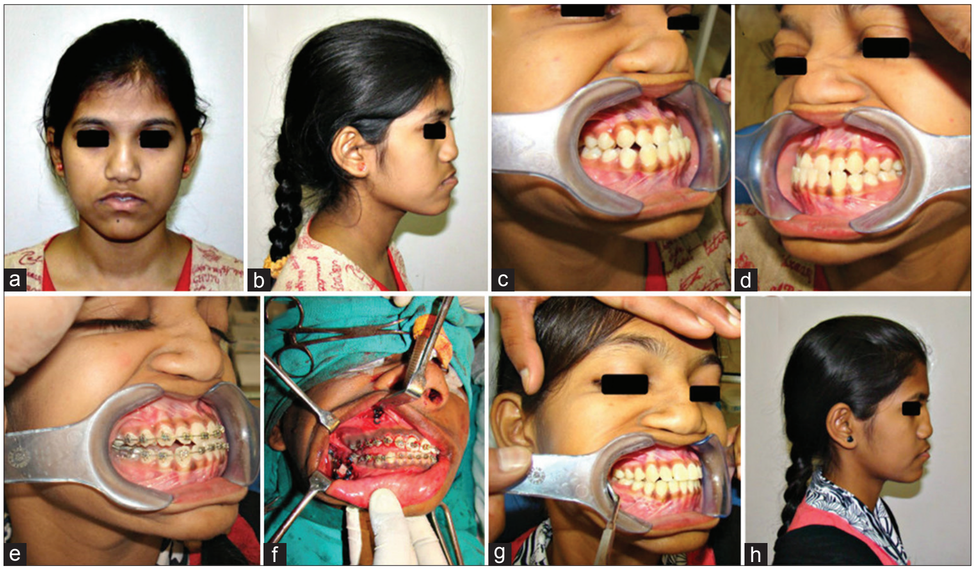

Figure 10: (a-d) A 16-year-old patient with skeletal Class III malocclusion with mandibular corpus excess by 6 mm. (e, f) Bilateral sagittal split ramus osteotomy with mandibular setback by 7 mm. The posterior open bite is apparent intraoperatively. (g and h) Postsurgical orthodontic correction of dental occlusion resulting in a good functional as well as esthetic outcome by the end of 7 months

Table 2a: (i) Down's skeletal pattern

Measurement	Mean	Actual	Inference
Facial angle	82-95°	89°	Average Facial Angle
Angle of Convexity	-8.5-+10°	-22°	Mandible ahead of Maxilla
A-B plane angle	-9-0°	-18°	Class III Skeletal Base
Mandibular Plane angle	17-28°	25°	Average Growth pattern
Y -axis	53-66°	60°	Average Growth pattern

Table 2a: (ii) Down's dental pattern

Parameter	Range	Actual	Inference
Cant of Occlusal Plane	+1.5-14°	8°	Average Cant of Occlusal Plane
1 to T	130-150.5°	138	
Perpendicular to Occlusal Plane	+3.5-+20°	+3m	
Perpendicular to Mand Plane	-8.5-+7°	1.5 mm	
Perpendicular to A - P Plane	-1 mm-+5 mm	3 mm	

Table 2b: Rickett's analysis

Measurement	Mean (for 9 years)	Age adjustment	Difference	Inference
Facial Axis B4-Na to Pt-Gn	90±3°	None		
Facial Angle (N-pog to FH)	87+3°	+1/3yr		
Mandibular plane angle	26+4°	-1/3yr		
Convexity at Point A	2+2°	-1mm/5yr		
Lower incisor-Apog	1+2 mm	+1mm/yr		
Upper Molar-ptv	Age +3 mm	+1mm/yr		
Lower Incisor inclienation	22+4	None		
Lower Lip- E Plane	-2mm	Decreases		

Discussion

"Safety" and "Predictability" have hitherto been the watchwords in orthodontics and orthognathic surgery for correction of severe malocclusion and facial asymmetry/deformity. "Speed" is the new necessity, which is being increasingly demanded for and expected by the patient clientele. One of the key reasons for reluctance on the part of patients to undertake the conventional "triphasic" procedure of orthognathic surgery involving both pre- and post-surgical orthodontics, and also for their loss of motivation or desire to persevere with the treatment once started, is the prolonged and extended duration of the entire management protocol.[2] Unforeseen interruptions during the course of the long-drawn treatment period further complicate the case and delays achievement of appreciable results, which in turn often leads to discouragement of the patient and discontinuation of treatment with unsatisfactory outcomes.[12]

Another important consideration is the fact that these are the category of patients who are deeply concerned with their appearance and are primarily seeking treatment for improvement in esthetics along with achievement of good function. The decompensatory worsening of both, however transient, which accompanies the triphasic approach, is often perceived as an exacerbation of the patient's chief complaint and serves as a deterrent to continue with the treatment.

These limitations of the conventional three-stage model of orthosurgical management have given rise to the resurgence of the SFA,[13] akin to the practices prior to 1960s, however now, better equipped with improved diagnostics, concepts, techniques, and surgical skill.[14] This approach involves orthognathic surgery being carried out first to correct the skeletal discrepancies, followed by orthodontic treatment to align the teeth and attain a functional occlusion, all carried out

Table 2c: Holdaway's soft tissue analysis

Measurement	Mean (for 9 years)	Actual	Inference
Facial angle	90 + 3°	91°	Orthognathic Profile/No facial
Upper Lip Curvature	2-5mm	0	Upper Lip Curvature diverges
Skeletal convexity at point A	+2±5mm		
H line Angle	7-15°	-3°	Prominent chin, Retrusive lip
Nose tip to H line	12 mm	17 mm	Big Nose
Upper sulcus depth	5 mm	0 mm	Decreased Upper sulcus depth
Upper lip thickness	15 mm	17 mm	Increased Upper lip thickness
Upper lip strain	2 mm	5 mm	Strain present
Lower Lip H line	9 mm	3.5 mm	Procumbent lower lip
Lower Sulcus depth	5 mm	2 mm	Decreased Lower sulcus depth
Soft tissue chin thickness	10-12 mm	11 mm	Avg soft tissue thickness

Table 3: Cephalometric analysis for orthognathic surgery (COGS)

Measurements	Mean	Mean	Actual	Inference
Cranial Base	Females	Males		
Ar - PTM (II to HP)	32.1±1.9 mm	37.1±2.3mm	31 mm	Posterior Cranial Base reduced
PTM-N (II to HP)	50.9±3 mm	52.8±4.3mm	53 mm	Anterior Cranial Base average
Horizontal (Skeletal)				
N-A-Pg (angle)	2.6±5.1°	3.9±6.4°	-23°	Concave profile
N-A (II to HP)	-2 + 3.7 mm	0.0 + 3.7 mm	-10 mm	Retrognathic Maxilla
N-B (II to HP)	-6.9±4.3 mm	-53±6.7 mm	-2.5 mm	Orthognathic Mandible
Vertical (Skeletal & Dental)				
N - ANS (Perp to HP)	50±2.4 mm	54±3.2 mm	58 mm	Average Middle third of face
ANS - Gn (Perp to HP	61.3±3.3 mm	68.6±3.8 mm	65 mm	Avg lower third of face
PNS - N (Perp to HP)	50.6±2.3	53.9±1.7	55 mm	Normal Posterior Maxillary height
MP - HP (angle)	24.2±5°	23.0±59°	25°	Non divergent face
Upper I - NF (Perp to NF)	27.5±1.7 mm	30.5±2.1 mm	27 mm	Intruded upper incisors
Lower I - MP (Perp to MP)	40.8±1.8	45±2.1 mm	36 mm	Intruded lower incisor
Upper 6 Np (1NP)	23±1.3 mm	26.2±2 mm	25 mm	Average upper Molar
Lower 6-MP (IMP)	32±1.9mm	35.8±26 mm	28 mm	Intruded lower Molar
Maxilla and Mandible				
PNS - ANS (II to HP)	52.5±3.5 mm	57.5±2.5 mm	45 mm	Decreased Maxillary length
Ar - Go (linear)	46.8±2.5mm	52±4.2mm	56 mm	Ramus Length normal
Go-Pg (linear)	74.3±3.8 mm	83.7±4.6 mm	75 mm	Decreased body length
B - Pg (II MP)	7.2±1.9 mm	8.9±1.7 mm	8 mm	Average Chin
Ar - Go - Gn (angle)	122±6.9°	119±6.5°	126°	Increased Gonial angle
Dental				
CP Upper-HP (Angle)	7.1°±2.5°	6.1°±5.1°	8°	Avg Facial Height
Upper Incisor - NF (angle)	112°±5.3°	111°±4.7°	125°	Proclined upper incisor
Lower Incisor - MP (angle)	95.9°±5.7°	95.9°±5.7°	78°	Retroclined lower incisor

with the prime objective of reducing the overall time taken to complete the entire treatment.[15,16]

An additional advantage of the SFOA is a change in the facial appearance for the better immediately following the surgery, which encourages and motivates the patient,[17] thereby enhancing compliance and ensuring the achievement of optimal esthetic as well as ideal occlusal and functional outcomes.[18]

The practice of SFOA requires a change of mindset, in terms of planning the treatment. The clinicians must develop the ability to identify intermediate targets and achieve them while working toward the final goal.[19] Treatment planning requires choosing the desired appearance and skeletal relationships, mounting the casts in the position determined by the skeletal change, and then planning the postoperative orthodontic tooth movements.[20] The surgical movement must be sufficient to allow complete dental decompensation after the surgical procedure.[21]

Irrespective of the type and extent of the skeletal discrepancy, i.e., ranging from simple anteroposterior deformities[22,23] to gross vertical or transverse facial asymmetries,[24] the orthodontist needs to decide on the approximate surgical bone repositioning required, to closely mimic the final position

Table 4: Dental arches analyses

Upper arch measurement	
Sum of anterior maxillary 6	49 mm
Sum of Maxillary 12 (Total tooth material)	= 99 mm
Palatal Depth	17 mm
Amount of Crowding	5 mm
Amount of spacing	-
Arch Perimeter	-
Amount of Proclination	7 mm
Arch shape	=‘V’ shaped arch
Rotation	=Tooth 13
Arch Symmetry	=Asymmetric
Lower arch measurement	
Sum of anterior Mandibular 6	40 mm
Sum of Mandibular 12 (Total tooth material)	=90 mm
Curve of Space	=2 mm on right side 2-5 mm on left
Amount of Crowding	=3 mm
Amount of spacing	=-
Amount of Proclamation	=-
Arch perimeter	=-1
Arch Shape	=U Shaped arch
Arch Symmetry	=Apparently Symmetrical
Rotation	=Teeth 34, 35
Upper arch analysis	
(A) Pont index	
Determination of measured premolar with (M.P.V)	=33 mm
Determination of measured molar value (M.M.V)	=46 mm
Determination of calculated premolar value (C.P.V) S.1/80×100	$\frac{33}{80}$×100=41,25 mm
Determination of calculated molar value (C.M.V) 5.1/64×100	$\frac{33}{64}$×100=51.6mm

Region	Measured value	Calculated value	Dirrerence	Reference
Premolar	33	41.25		Need for expansion
Molar	46	51.6		

b) Ashley howe’s index	
Determination of total tooth material (T.T.M)	99 mm
Determination of premolar diameter (P.M.D)	38 mm
Determination of premolar basal arch width	35 mm
Or canine fossa width (P.M.B.A.W)	
P.M.B.W%=P.M.R./T.T.M×100	$\frac{35}{99}$×100= 35.35%

of the bone, in which he/she would finally align the teeth in occlusion.[25] This is not simple because it must be done with the help of scans and models of compensated teeth positions. Splints based on such predictive positions are to be fabricated which serve as guides for surgical repositioning of the bone.[26] The surgical challenge is to accurately move and stabilize the bone as per the guiding splints.[27]

Prediction techniques such as computer-aided surgical simulation software are currently available, such as Dolphin and Nemoceph, which are helpful aids in this management protocol enabling the orthodontist and maxillofacial surgeon to confidently predict the intermediate and the final facial appearance as well as jaw and teeth positions.

Albeit the success reported with this novel archetype of SFOA in the expeditious management of skeletal malocclusions and deformities/asymmetries, this procedure has been reported to be have certain disadvantages and limitations. Based on a recent meta-analysis,[28] a possible drawback of the SFOA approach could be a poorer postoperative stability as the mandible tends to rotate counterclockwise more in this group than in patients treated by the conventional triphasic approach.[19] This would indicate the importance of careful patient screening, accurate diagnosis, and careful review of the treatment plan to compensate for possible postoperative relapse when adopting SFOA.[29] Despite the evident advantages of an SFA, patients with TMD symptoms or advanced periodontal conditions are contraindicated for this approach because of the added instability to an already semistable postsurgical occlusion.[30]

A recent study[31] has contraindicated this treatment approach in patients who need definite decompression, patients with severe crowding, arch incoordination, and patients with severe vertical or transverse discrepancies and jaw asymmetries. The study also proposed that dental as well as skeletal midlines must coincide or be close to it with proper bilateral buccal overjet in the selection criteria.[31] However, in our study, we found SFOA equally effective even in cases of severe transverse skeletal discrepancies with midline shift and even in those patients with severe crowding. We were also able to achieve ideal occlusion even in the presence of pretreatment multiple dental interferences.

An experienced, skillful, and perfectly coordinated team comprising the orthodontist as well as maxillofacial surgeon, who have the ability to understand each other's requirements pertaining to the case, can foresee and work toward the final goal, and compensating for each other's situational limitations along the way, can produce good clinical results.

Conclusion

Surgery first, orthodontics after (SFOA) approach is a versatile and expeditious treatment option in the management of dentofacial deformities. It is superior to the conventional triphasic orthosurgical treatment approach, in terms of shortened treatment time and immediate esthetic improvement. However, to achieve the desired outcome, the most important consideration in using this technique, is the ability to correctly predict and visualize the desired final jaw positions, relations and dental occlusion, and to be able to arrange the skeletal components to match the predicted positions and occlusion, surgically.

Although the intricacy of planning tends to make the average clinician choose the safer conventional triphasic option, however, for the sufficiently experienced and skilled clinician, SFOA is the preferred modality of choice in the management of dentofacial deformities.

There exists a certain lack of consensus in literature reports, with regard to patient selection criteria and technical surgical-orthodontic protocol for SFOA, including some disparity in opinions on long-term stability of results. In our experience, this management modality is efficacious even when the occlusal and skeletal discrepancies/asymmetries are severe, with no relapse encountered on follow-up.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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