Hard and Soft Tissue Changes Following Maxillary Distraction Osteogenesis and Mandibular Setback with Bilateral Sagittal Split Osteotomy

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Abstract

Aims of this Study (1) To highlight the role of intraoral submerged device in distraction osteogenesis (DO) of patients requiring two jaw surgeries for the correction of severe developmental maxillary hypoplasia (MH) and mandibular prognathism (MP) (2) To analyse the hard and soft tissue changes following maxillary DO and mandibular setback with bilateral sagittal split osteotomy (BSSO) in patients with severe MH and MP requiring two jaw surgeries.

Materials and Methods During the period Jan 2004 to Dec 2006, five patients with severe developmental MH along with MP were treated. In 1st stage maxillary distraction was done. Distraction started on 6th postoperative day, 1 mm distraction was carried out for 10–15 days on either side. Serial radiographs were taken immediate postoperative period for baseline comparison, post-distraction and at the end of distraction. After a period of 3–4 months of distraction 2nd stage was done. In 2nd stage, mandibular setback was done with BSSO and distractors were removed under general anesthesia. Radiographs were taken immediately and at 4 months post-operatively. Cephalometric tracings were carried out

preoperatively, post DO and finally after mandibular setback with BSSO.

Results The mean horizontal movement of maxilla was 11.4 mm at ANS and 9.6 mm at A point. Upper incisor edge was advanced by 8.8 mm. SNA increased by 8.4° and SNB decreased by 4.6°. Nasal projection advanced by 4°. Nasolabial angle normalized in all patients, mean change achieved was 10.8°. Upper lip moved forward by 5.4 mm. Lower lip moved backward by 5.4 mm. Mandible positioned backward by 4 mm at B point. No vertical change occurred in the position of A, ANS and upper incisor edges. Mean increase in skeletal angle of convexity was 26.4°. Concave profile was significantly changed to convex in all patients.

Conclusion Maxillary DO and mandibular setback with BSSO was associated with improved facial balance and esthetics.

Keywords Hypoplasia · Distraction osteogenesis · Prognathism · Intraoral submerged device

Introduction

Distraction osteogenesis (DO) is a technique of generating new bone by stretching the callus. This concept of bone lengthening was first described by Codivilla [1] who used it to elongate a femur by traction forces. This concept was then popularized by Prof. Ilizarov [2, 3], a Russian orthopaedic surgeon who revolutionized the practice of orthopaedic surgery by virtue of a new insight into the biology of tissue regeneration that is bone, ligament, skin, muscle, vessel and nerves. His achievement in both experimental and clinical subjects by far surpassed the traditional treatment modalities.

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In the beginning, DO in cranio-maxillofacial field was used in the treatment of developmental or acquired mandibular deficiency cases and subsequently found vast implications in the maxillofacial regions [4–9]. DO has been used successfully for procedures such as maxillary advancement, TMJ reconstruction, alveolar augmentation and mandibular widening in the literature [10–18]. Snyder et al. [6] were the first to apply this technique to the craniofacial region on canine mandibles. McCarthy [7], further opened a new horizon in the craniofacial surgery with the publication of the first application of DO in the mandible of the human craniofacial skeleton. McCarthy applied this technique successfully in four patients to lengthen the human mandible with Hemifacial Microsomia and Nagai's syndrome. Since the introduction of his pioneering work, DO has rapidly become the keystone for the reconstruction of many craniofacial anomalies.

Today, DO is useful in a wide variety of craniofacial dysostoses with maxillary or midface deficiency e.g. Hemifacial Microsomia, Treacher Collins's Syndrome, Crouzon's Syndrome, Pfeiffer Syndrome, Soft tissue malformations as in haemangioma, complex facial deformities, patient with severe maxillary hypoplasia (MH), MH associated with cleft lip and palate patient or facial cleft, Hemifacial atrophy, Micrognathia, sleep apnea in adults, children and even new born with a deficiency in their upper airway dimension [10, 11, 13–21]. It is also indicated in acquired deformities such as, segmental bone deficiency after acute trauma, and in reconstruction of bone, and in patients [19, 22].

Thus DO has advanced the field of maxillofacial surgery because of its versatility, simplicity and possibility of avoiding bone grafts, infections, blood transfusions, or intermaxillary fixation for long periods of time. These advantages uplifts DO to be a good alternative in many cases where conventional surgical techniques are rather difficult to use and the results are so impressive that today we are even more confident about using it.

ISD used in this study for five patients was situated adjacent to bone, under the mucosa with the activation port exiting intraorally. Thus facial scars were minimized as there were no pin tract sites. The distraction devices were fixed with the anchoring plates on each side of the osteotomy.

Materials and Methods

A prospective study was conducted in one of the main teaching hospital i.e. Nair Hospital and Dental College, Mumbai. Patients with moderate to severe MH associated with MP were selected during the period January 2004 to December 2006.

Criteria for Patient Selection

Five patients who had severe MH associated with MP were included in this study. All five patients selected had severe developmental MH that was not associated with cleft lip and palate along with MP. Patients included in this study were ruled out for any history of systemic illness. Out of 5 patients 3 were females and 2 were males. The patients, age ranged from 19 to 25 years with an average of 20 years. All patients had taken presurgical orthodontic treatment for a period of 6 months to 1 year.

Pre-operative Patient Preparation

Informed consent and ethical aspect special consent was taken from the patients on consent forms after explaining all details to them in the language that they best understood.

Routine blood investigation were done and all patients were assessed for general anaesthesia fitness. All patients were evaluated with radiographs (OPG and lateral cephalogram), study models, bite registration, model analysis, photographs and cephalometric tracings. Data recording and details of the patients, work up were recorded. Clinical photographs were taken for esthetic evaluation in front, profile and 3/4th views. Extra oral examination was done to assess the extent of MH and MP. Besides the following features prominence of malar eminence, recession of paranasal area, position of the upper and lower lips, measurement of mandibular angles and projection of the nose were checked out. Intra-oral examination was done to verify occlusion, amount of overjet and overbite, dental midline, presence of any missing malposed teeth, maxillary and mandibular third molars and supernumerary teeth. In all patients, lateral cephalograms and OPG were taken. Cephalometric analysis was carried out to determine extent of maxillary deficiency and mandibular prognathism both for hard and soft tissues.

Following points, planes and linear and angular measurements were evaluated both for hard and soft tissues (Fig. 1).

Following points were selected (Fig. 1a):

1. Sella (S): The point representing the midpoint of the pituitary fossa or sella turcica. It is a constructed point in the mid sagittal plane.
2. Nasion (N): The most anterior point midway between the frontal and nasal bones on the fronto-nasal suture.
3. Point A: It is the deepest point in the midline between the anterior nasal spine and alveolar crest in between the two central incisors. It is called subspinale.

Fig. 1 **a** Reference points, **b** reference planes and reference angles

4. Anterior Nasal Spine (ANS): It is the anterior tip of the sharp bony process of the maxilla in the midline of the lower margin of the anterior nasal opening.
5. Posterior Nasal Spine (PNS): The intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose, marking the distal limit of maxilla.
6. Point B: It is deepest point in the midline between the alveolar crest of mandible and the mental process. It is called supra mentale.
7. Pogonion (Pg): It is the most anterior point of the bony chin in the median plane.
8. Menton (Me): It is the most inferior middling point on the mandibular symphysis.
9. Subnasale (Sn): The point at which the base of the nose merges with the upper cutaneous lip.
10. Soft Tissue Nasion (N'): The deepest point of the bridge of the nose.
11. V_u: Most prominent point on the upper vermillion.
12. V_l: Most prominent point on the lower vermillion.
13. Soft Tissue Menton (Me'): The lower most point on the soft tissue chin in the sagittal plane.
14. Soft Tissue Pogonion (Pg'): The foremost point on the soft tissue chin in the mid sagittal plane.
15. Prn: The most anterior point on the nose.
2. X-axis—is the line drawn 7° below the S–N Plane.
3. Y-axis—is perpendicular to X-axis through sella.
4. Mandibular Plane—A line connecting gonion and menton.

Following Angular measurements were considered for hard and soft tissues (Fig. 1b)

1. SNA Angle—is an indication of the relationship of maxilla to the cranial base in the sagittal plane. Normal range is 82 + 2°.
2. SNB Angle—is an indication of the relationship of the mandible to the cranial base, in the sagittal plane. Normal range is 80 + 2°.
3. ANB Angle—is an indication of the relationship of the maxillary and mandibular bases to one another. Normal range is 1°–3°. A is lying anterior to B.
4. SNMP or Mandibular plane angle—is the angle formed between S.N. Plane and Mandibular Plane. Normal Value is 32°.
5. N-A-Pg or Angle of Convexity—The angle is formed by intersection of a line from nasion to point A and a line from point A to pogonion.
A positive angle or increased angle suggests a prominent maxillary denture base relative to the mandible.
A decreased angle of convexity or a negative angle is indicative of a prognathic profile.
Normal value is 0°, Normal Range is negative 8.5 to +10°.
6. Nasolabial Angle (NLA)—Angle formed by intersection of columella of the nose and labial philtrum. Normal Value is 110°.

The following planes were considered (Fig. 1b)

1. S–N Plane—It is the cranial line between the centre of sella tursica (sella) and the anterior point of the fronto-nasal suture (nasion). It represents the anterior cranial base.

Pre-operative, post-maxillary distraction and post-operative (after mandibular setback) radiographs were evaluated for changes in lip position, antero-posterior changes in maxilla, nose and incisal edges of maxillary central incisors.

Anterior changes in maxilla—that was surgically produced was measured in relation to Y-axis at point ANS, A point and incisal edge of maxillary central incisor (I).

Positional changes in the upper lips—were measured in relation to Y axis at point V_u (the most superiorly protruding point on the upper lip).

A positional change in the lower lip—was measured in relation to Y axis at point V_l (the most protruding point on the lower lip).

A change in the nose—was measured in relation to Y-axis at point Prn.

Changes in the chin—were measured at point B and at point Pg in relation to Y-axis.

Nasolabial angle—pre and post-operative changes in the Nasolabial angle were recorded.

Following Linear measurements (Fig. 1b) were considered for hard and soft tissue changes.

Hard Tissue Linear Measurement

1. ANS—Y axis
2. A—Y axis
3. U_l —Y axis
4. B—Y axis
5. Pg—Y axis

Soft Tissue Linear Measurements

1. Prn—Y axis
2. V_u —Y axis
3. V_l —X axis
4. B—Y axis
5. Pg—Y axis

Distraction Appliance Used (Fig. 2)

In all 5 patients Intraoral Submerged Devices (ISD) were used in the maxilla bilaterally. Distraction devices are available in various sizes i.e. 10, 15, 20 and 25 mm. The

Fig. 2 Intraoral submerged distraction device with screw driver

size of the device was predetermined with clinical and radiographic evaluation. ISD is placed under the mucosa with the activation port existing intraorally.

It is to be activated daily 1 mm/day as per the requirement of the case.

Based on the comprehensive evaluation of existing deformity, cephalometric analysis and prediction tracing, the following surgical procedures were carried out in two stages.

In Stage I—Bilateral Lefort I osteotomy and fixation of distraction devices were carried out under general anesthesia (Fig. 3).

Distraction protocol followed was

1. Latency period—After 5 days of latency period, activation of distraction appliances were started on 6th day.
2. Rhythm—1 mm distraction was done daily with two turns of 360° with the specified screw driver.
3. Distraction period—Distraction was carried out until the full amount of desired overjet and occlusal relation as pre-determined was obtained.
4. Retention or consolidation phase—with the help of power chain, maxilla was immobilised for average of 6–8 weeks.
5. Device removal—Distractors were removed after a period of 3–4 months. Radiographic and clinical examination should revealed bone between the distraction gap.

Pre-operative, radiographs (OPG and lateral cephalogram) and immediately postoperative, during distraction and post-distraction were taken and cephalometric tracings were carried out respectively.

In Stage II (Fig. 4 a, b)—After 3–4 months of distraction, mandibular setback was done with BSSO and maxillary distractors were removed under general anesthesia. Post-operatively IML was done with the splint in position

Fig. 3 Le Forte I osteotomy and complete down fracture of maxilla, Right and Left side distraction appliance secure in place

Fig. 4 a, b Mandibular setback with Bilateral Sagittal Split Osteotomy, Fixation done with *four hole* stainless steel plates on *right and left side*

for 1–2 months. Postoperative orthodontic therapy was started 8 weeks after the second stage was completed.

Postoperative Care and Instructions: All patients were given IV antibiotics for 5 days and kept on ryle's tube feeding for a week. Post-operative pain was controlled by giving analgesics for 3–5 days.

All patients were advised to take liquid diet during latency and consolidation period. All patients were followed up after 15 days for initial 2 months and once in a month for next 6 months up to 1 year.

Results

Following were the significant changes following maxillary DO and mandibular setback with BSSO (Tables 1, 2, 3, 4, 5, 6, Figs. 6, 7).

The mean horizontal movement of maxilla was 11.4 mm at ANS and 9.6 mm at A point. Upper incisor edge was advanced by 8.8 mms. SNA angle increased 8.4° and SNB angle decreased 4.6°. Nasal projection advanced by 4°. Nasolabial angle normalized in all patients, mean change achieved was 10.8°.

Upper lip moved forward by 5.4 mm. Lower lip moved backward by 5.4 mm. Mandible positioned backward by 4 mm at B point. No vertical changes occurred in the position of A, ANS, and upper incisor edges. Mean increase in skeletal angle of convexity was 26.4°. Concave profile was significantly changed to convex in all patients.

Discussion

Distraction osteogenesis (DO) has emerged as an important modality in maxillofacial surgery for the correction of maxillo-mandibular deformities. DO is a technique of bone

lengthening by gradual traction which was first reported by Codivilla [1] to correct a discrepancy in limb lengthening. Polley and co-authors were the first to clinically apply the midface distraction when they used an externally fixed cranial halo to distract the midface [11]. Thus maxillary DO became one of the most important aspects of treatment planning in the management of severe MH.

In this study, five patients with severe developmental MH and MP were selected. All the patients had moderate to severe MH which was not secondary to cleft lip and palate or other craniofacial disorders. All the patients had associated severe MP requiring 2nd surgery for the correction of deformity.

Maxillary DO using ISD was carried out in the patients to achieve the desired effect. All the patients tolerated the distraction procedure well. There was no surgical morbidity in any of the patients. ISD were used in the patients which were placed intraorally beneath the mucosa, the distraction port exiting intraorally. Selection of the size of ISD was done by clinical and cephalometric analysis. In Stage I, Lefort I osteotomy and down fracture of maxilla was performed (Fig. 3). Bilateral maxillary distraction appliances were then fixed. Activation of the distraction appliances started on the 6th post-operative day at a rate of 1 mm/day. The duration of the activation period was determined clinically and radiographically by assessing cephalometric analysis, the severity of the maxillary hypoplasia and anterior reverse dental cross-bite (Fig. 5a–e). This was followed by a consolidation period of 6–8 weeks. After 3–4 months of distraction, 2nd surgery was performed to correct MP. The main advantage of the two jaw surgery procedure was that there was improved function and esthetics of patient. Serial radiographs were taken pre-operatively, during distraction and post-distraction and finally after mandibular setback and at 6 months post operative (Figures 5e, 6e, 7e). Cephalometric tracings were done pre-operatively, post-distraction and post-operatively after mandibular setback. Both hard and soft tissue profile changes were measured (Tables 1, 2, 3, 4, 5, 6). Both linear and angular measurements were recorded.

In this study the maxillary DO with ISD was found to be advantageous than conventional osteotomy for the following reasons.

As ISD was situated intraorally beneath the mucosa there was no facial scarring. The procedure was relatively simple to perform. There was no requirement of bone grafts, thereby eliminating donor site morbidity and risk of graft failure. Unlike the traditional osteotomies, distraction allowed simultaneous expansion of the soft tissues thus minimizing the risk of relapse. There was no limit to bone lengthening except for the length of the distractor, good compliance of the patient as the device was situated intraorally and there was near total

Table 1 Cephalometric Analysis (Case 1)

No.	Angular measurement (in degree)	Pre-operative	Post-maxillary distraction	Post-sagittal split	Significant changes
1.	SNA	77	85	85	Yes (+8)
2.	SNB	87	87	82	Yes (−5)
3.	ANB	−10	+2	+3°	Yes (+13)
4.	N-A-Pg	−25	−2	+4	Yes (+29)
5.	SN—MP	31°	31°	30°	Yes (−1)
<i>Linear measurements (in mm)</i>					
6.	ANS—Y-axis	62	74	74	Yes (+12)
7.	A—Y	60	67	67	Yes (+7)
8.	U _I —Y	59	71	71	Yes (+12)
9.	B—Y axis	72	72	68	Yes (−4)
10.	Pg—Y	77	77	72	Yes (−5)
<i>Soft tissue measurements</i>					
11.	Nasolabial angle (in degree)	118	93°	93°	Yes (−25°)
12.	Prn—Y	93	97	97	Yes (+4)
13.	V _u —Y	81	84	84	Yes (+3)
14.	V _I —Y	87	87	82	Yes (−5)
15.	B'—Y	81	81	77	Yes (−4)
16.	Pg'—Y	88	88	83	Yes (−5)

+ increase in angle or distance, − decrease in angle or distance

Table 2 Cephalometric Analysis (Case 2)

No.	Angular measurement (in degree)	Preoperative	Post-maxillary distraction	Post-sagittal split	Significant changes
1.	SNA	75	85	85	Yes (+10)
2.	SNB	84	84	80	Yes (−4)
3.	ANB	−9	+1	+5	Yes (+14)
4.	N-A-Pg	−20	+1	+5	Yes (+25)
5.	SN—MP	35	35	32	Yes (−3)
<i>Linear measurements (in mm)</i>					
6.	ANS—Y-axis	66	78	78	Yes (+12)
7.	A—Y	64	76	76	Yes (+12)
8.	U _I —Y	70	79	80	Yes (+10)
9.	B—Y	76	76	72	Yes (−4)
10.	Pg—Y	78	78	73	Yes (−5)
<i>Soft tissue measurements</i>					
11.	Nasolabial angle (in degree)	100	89	89	Yes (−11)
12.	Prn—Y	97	103	103	Yes (+6)
13.	V _u —Y	85	92	92	Yes (+7)
14.	V _I —Y	96	96	92	Yes (−4)
15.	B'—Y	91	91	87	Yes (−4)
16.	Pg'—Y	93	93	90	Yes (−3)

+ increase in angle or distance, − decrease in angle or distance

concealment of the device. Regenerate bone formed had the same quality as that of normal bone. Foot plates served as bone plates during consolidation period. Incremental movement allowed displacement over long

distances. There was no overcoming of major resistance from the soft tissue envelope. Results were predictable, stable and favourable. Expansion of soft tissues of the facial mask yielded pleasing results.

Table 3 Cephalometric Analysis (Case 3)

No.	Angular measurement (in degree)	Pre-operative	Post-maxillary distraction	Post-sagittal split	Significant changes
1.	SNA	77	85	85	Yes (+8)
2.	SNB	90	90	83	Yes (−7)
3.	ANB	−13	+5	+2	Yes (+15)
4.	N-A-Pg	−29	−5	+4	Yes (+33)
5.	SN—MP	34	34	31	Yes (−3)
<i>Linear measurements (in mm)</i>					
6.	ANS—Y	70	83	83	Yes (+13)
7.	A—Y	68	80	80	Yes (+12)
8.	U _I —Y	87	97	97	Yes (+10)
9.	B—Y	96	96	92	Yes (−4)
10.	Pg—Y	97	97	90	Yes (−7)
<i>Soft tissue measurements</i>					
11.	Nasolabial angle (in degree)	83	90	90	Yes (+7)
12.	Prn—Y	110	112	112	Yes (+2)
13.	V _u —Y	100	108	108	Yes (+8)
14.	V _I —Y	110	110	102	Yes (−8)
15.	B'—Y	107	107	102	Yes (−5)
16.	Pg'—Y	110	110	103	Yes (−7)

+ increase in angle or distance, − decrease in angle or distance

Table 4 Cephalometric Analysis (Case 4)

No.	Angular measurement (in degree)	Preoperative	Post-maxillary distraction	Post-sagittal split	Significant changes
1.	SNA	74	82	82	Yes (+8)
2.	SNB	84	84	80	Yes (−4)
3.	ANB	−10	−2	2	Yes (+12)
4.	N-A-Pg	−11	3	+5	Yes (+16)
5.	SN—MP	34	34	30	Yes (−4)
<i>Linear measurements (in mm)</i>					
6.	ANS—Y	58	66	66	Yes (+8)
7.	A—Y	57	62	62	Yes (+5)
8.	U _I —Y	67	69	69	Yes (+2)
9.	B—Y	65	65	61	Yes (−4)
10.	Pg—Y	66	66	62	Yes (−4)
<i>Soft tissue measurements</i>					
11.	Nasolabial angle (in degree)	83	85	87	Yes (+4)
12.	Prn—Y	90	92	92	Yes (+2)
13.	V _u —Y	77	80	80	Yes (+3)
14.	V _I —Y	80	80	76	Yes (−4)
15.	B'—Y	73	73	70	Yes (−3)
16.	Pg'—Y	74	74	71	Yes (−3)

+ increase in angle or distance, − decrease in angle or distance

DO provides greater advancement of more than 10 mm with no tendency of relapse [22–24]. Osteotomy procedures are not effective in severe maxillary hypoplasia where 10 mm or more anterior advancement of

maxilla is required. In osteotomy there is no expansion of overlying soft tissue only bony changes take place; therefore higher rates of relapse are reported [17, 18, 25].

Table 5 Cephalometric Analysis (Case 5)

No.	Angular measurement (in degree)	Pre-operative	Post-maxillary distraction	Post-sagittal split	Significant changes
1.	SNA	77	85	85	Yes (+8)
2.	SNB	85	85	82	Yes (−3)
3.	ANB	−10	0	3	Yes (+13)
4.	N-A-Pg	−24	−5	+5	Yes (+29)
5.	SN—MP	32	32	30	Yes (−2)
<i>Linear measurements (in mm)</i>					
6.	ANS—Y	62	74	74	Yes (+12)
7.	A—Y	60	72	72	Yes (+12)
8.	Ui—Y	65	75	75	Yes (+10)
9.	B—Y	90	90	86	Yes (−4)
10.	Pg—Y	93	93	88	Yes (−5)
<i>Soft tissue measurements</i>					
11.	Nasolabial angle (in degree)	85	92	92	Yes (+7)
12.	Prn—Y	104	110	110	Yes (+6)
13.	V _u —Y	98	104	104	Yes (+6)
14.	V _L —Y	106	106	100	Yes (−6)
15.	B'—Y	100	100	96	Yes (−4)
16.	Pg'—Y	102	102	97	Yes (−5)

+ increase in angle or distance, − decrease in angle or distance

Table 6 Master table

Change in angular and linear measurement	Case1	Case 2	Case 3	Case 4	Case 5	Mean
SNA (in degree)	+8	+10	+8	+8	+8	+8.4
SNB (in degree)	−5	−4	−7	−4	−3	−4.6
ANB (in degree)	+13	+14	+15	+12	+13	+13.4
NAPg (in degree)	+29	+25	+33	+16	+29	+26.4
SNMP (in degree)	−1	−3	−3	−4	−2	−2.6
ANS—Y axis (in mm)	+12	+12	+13	+8	+12	+11.4
A—Y axis (in mm)	+7	+12	+12	+5	+12	+9.6
Ui—Y axis (in mm)	+12	+10	+10	+2	+10	+8.8
B—Y axis (in mm)	−4	−4	−4	−4	−4	−4
Pg—Y axis (in mm)	−5	−5	−7	−4	−5	−5.2
Nasolabial angle (in degree)	−25	−11	+7	+4	+7	+10.8
Prn—Y axis (in mm)	+4	+6	+2	+2	+6	+4
V _u —Y axis (in mm)	+3	+7	+8	+3	+6	+5.4
V _L —Y axis (in mm)	−5	−4	−8	−4	−6	−5.4
B'—Y axis (in mm)	−4	−4	−5	−3	−4	−4
Pg'—Y axis (in mm)	−5	−3	−7	−3	−5	−4.6

+ increase in angle or distance, − decrease in angle or distance

In our study, all five patients had correction of the MH. All five patients had correction of MP and only in one patient additional surgery, reduction genioplasty was done for protruded chin. Distraction procedure was associated with excellent patient compliance. There was no pain, discomfort or loosening of devices. None of the devices

failed. No blood transfusion was needed. Duration of distraction ranged from D8 to D15. No IML was needed after maxillary DO. There were no complications of any bony dental or soft tissue viability. Stable results were obtained after 1 year of surgery, with no evidence of relapse. Subperiosteal presence of distractor did not hinder bone

Fig. 5 **a** Preoperative (Extraoral photograph) right profile, **b** frontal view, **c** Preoperative (Intraoral photographs) right profile, **d** Front view, **e** Preoperative lat cephalogram

Fig. 6 **a** Post distraction (Extraoral photograph) right profile view, **b** frontal view, **c** Post distraction (Intraoral photographs) right profile view, **d** frontal view, **e** Post distraction lat cephalogram

Fig. 7 **a** Final following mandibular setback with BSSO (Extraoral photograph) right profile view, **b** frontal view, **c** Intraoral right profile view, **d** Intra oral frontal view, **e** Final following mandibular setback, lat cephalogram

formation. Good consolidation of distraction sites was noted. Maxillary DO with ISD and Mandibular setback with BSSO resulted in significant changes of hard and soft tissues in all the five patients (Figs. 6, 7). Concave profile was significantly changed to convex in all patients.

Conclusion

Maxillary DO with ISD and Mandibular setback with BSSO was associated with improved facial balance and esthetics.

Maxillary DO and mandibular setback with BSSO improved the hard and soft tissue profile by:

Anterior movement of maxilla at point A and at point A.N.S. Increased soft tissue fullness in the malar bone region. Mandible moved back at point B. Nasal projection increased. Nasolabial angle was normalized. Upper lip

became more prominent. Increase in the fullness of the cheeks. Lower lip and chin moved back. Concave facial profile changed to convex. All patients had successful, stable advancement. Technique was found to be predictable, simple and clinically effective.

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