Treatment of Micrognathia by Intraoral Distraction Osteogenesis: A Prospective Study

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Abstract

Purpose: Maxillofacial deformities are always psychologically and physically distressing to the patients and are also challenging to the treating surgeons. The term Micrognathia means a “small jaw”. True micrognathia, where the maxilla or the mandibular skeleton does not grow to the full size can be congenital or acquired. Distraction osteogenesis also called as callus distraction or callostasis or osteodistraction or distraction histogenesis is a biological process of regenerating newly formed bone and adjacent soft tissue by a gradual and controlled traction of surgically separated bone segments. The purpose of this prospective study was to assess the versatility of distraction osteogenesis in the treatment of micrognathia. Materials and Methods: Four patients (three males and one female) with micrognathia of mandible were included in this prospective study. The patients were between the age group of 10-20 years. Facial asymmetry was the chief complaint of all the patients. In all the patients following treatment protocol was carried out, Osteotomy and placement of intraoral distraction device under general anaesthesia, latency phase (5-7 days), activation period-rate 1.5 mm per day, consolidation period of 8 weeks, removal of distraction device under local anaesthesia. The parameters assessed were ramus height, body length, hyo mental distance, posterior pharyngeal airway space, chin projection, facial symmetry occlusion, mid line shift pre and post operatively. Results: The mean increase in ramus height achieved was 9.2 ± 2.17 mm and the mandibular body length achieved was 10.4±1.67 mm. There was an average increase in hyo-mental distance of 2.75 cm ±0.9 cm postoperatively showing a definitive improvement in the airway. The posterior pharyngeal space measured from the lateral cephalogram preoperatively ranged from 3-6 mm and post operatively from 6-9 mm. Intraorally there was a shift in occlusion to class I molar relation in three patients and there was posterior open bite in one patient. Marked correction of facial asymmetry was noticed in all cases both clinically and in PA cephalogram. There was a restoration of dental as well as lip midline and improved lip competence. There was a significant improvement in chin projection and occlusal cant however further chin correction was needed in one case by means of advancement genioplasty. Conclusion: A definite improvement in all parameters such as body length, ramus height, chin projection, occlusal cant was observed in all patients. Moreover the patients were subjectively satisfied with the outcome of the results. Distraction Osteogenesis is definitely a boon to the oral and maxillofacial surgeons in treating large deficiencies of mandible in terms of stability.

Keywords: Distraction osteogenesis, intraoral distraction, micrognathia

Introduction

Maxillofacial deformities are always psychologically and physically distressing to the patients and are also challenging to the treating surgeons. The term micrognathia means a “small jaw.” True micrognathia, where the maxilla or the mandibular skeleton does not grow to the full size, can be congenital or acquired and it most often occurs due to failure of growth of one or both condyles. Congenital deformities leading to mandibular hypoplasia are hemifacial microsomia, Treacher Collins syndrome, congenital micrognathia, Pierre-Robin syndrome, Nagers syndrome, Goldenhar syndrome, arthrogryposis, and condylar hypoplasia. Acquired causes of micrognathia usually occur due to trauma or temporomandibular joint (TMJ) ankylosis.[1] The main objectives of the treatment of micrognathia are to restore joint function, allow for mandibular growth, and improve the patient’s facial esthetics and balance. The micrognathia leads to a narrowed airway and obstructive sleep apnea. Ankylosis also increases the risk of temporomandibular joint (TMJ) ankylosis and temporomandibular joint (TMJ) ankylosis. Therefore, early treatment of micrognathia is essential to prevent further complications. Distraction osteogenesis is a well-established technique for the treatment of micrognathia. It involves the gradual distraction of bone segments and the regeneration of new bone and soft tissue. This technique has been used successfully in various congenital and acquired conditions, including micrognathia. It is important to note that distraction osteogenesis is a complex and time-consuming procedure, and it requires a multidisciplinary approach involving surgeons, orthodontists, and speech therapists.
apnea, and it is the aspect of micrognathia which complicates the condition even more.

Distraction osteogenesis (DO) has taken precedence over orthognathic surgery in treating micrognathia as a treatment option among the surgeons since the amount of mandibular lengthening needed is more than 10 mm.

DO also called as callus distraction or callotasis or osteodistraction or distraction histogenesis is a biological process of regenerating newly formed bone and adjacent soft tissue by a gradual and controlled traction of surgically separated bone segments.\(^2\)

It was described first by Codivilla in 1905; however, this technique gained popularity after the extensive works of Ilizarov in limb-lengthening procedures.\(^3\) McCarthy \textit{et al}. are credited for performing the first human mandibular distraction in 1995 using an external distractor in patients with hemifacial microsomia.\(^4\) The healing process in DO differs from that of fracture healing in two basic aspects at the histological level, one being controlled microtrauma and the second aspect is that the ossification mechanism is membranous and not endochondral.\(^5\) In contrast to conventional mandibular osteotomies, distraction has an upper hand such as permitting surgery at a younger age without the need for bone grafts, soft tissue flaps, and prolonged surgeries and hospitalization.

Other major advantages of DO over orthognathic surgeries are the amount of lengthening achieved and stability of the results. Distraction histogenesis leads to adaptive changes in the soft tissues, thereby decreasing the risk of relapse.\(^6\) However, DO is very technique sensitive in terms of vector and device orientation.

The distraction devices can be classified as external or internal devices. The advantages of intraoral devices are elimination of skin scarring caused by fixation of transcutaneous pins, improved patient compliance during consolidation, improved stability in terms of attachment of the device to the bone, and minimal risk of injury to facial and inferior alveolar nerve; however, there is a difficulty in orientation of the device.\(^7\)

The purpose of this prospective study was to assess the versatility of DO in the treatment of micrognathia.

**Materials and Methods**

This single group nonrandomized and uncontrolled interventional study was a prospective study carried out from April 2012 to November 2014 following review and ethical clearance by the scientific review board and institutional ethical committee, and informed consent was obtained from each patient in the regional language (Tamil) explaining the nature of the surgical procedure and the study. Four patients (three males and one female) with micrognathia mandible who reported to Rajas Dental College were included in this prospective study. The patients were between the age group of 10 and 20 years. The inclusion criteria were patients with micrognathia of mandible, within the age group of 10–20 years, presenting with no systemic contraindication for a surgical procedure, those who were motivated enough to comply with treatment regime, and patients willing for regular follow-up.

Facial asymmetry was the chief complaint of all the patients. In three cases, there was a history of ankylosis and all the three patients had undergone gap arthroplasty for ankylosis and had an adequate mouth opening of 30 mm. The micrognathia in one patient was diagnosed as hemifacial microsomia.

Preoperative assessment of the patients included thorough history and clinical examination, photographs in frontal, profile, submental views, and intraoral photographs. Assessment of clinical parameters included maximal incisor opening, lateral excursions and protrusive movements, and deviation of midline and occlusion. Radiographic analysis included orthopantomogram (OPG), PA, and lateral cephalogram. PA cephalogram and lateral cephalogram were taken to assess the orthodontic evaluation of skeletal pattern, occlusion, and facial symmetry. Computed tomography (CT) scans were taken in all the three planes (axial, coronal, and sagittal) and 3D reconstruction to assess the extent of the deformity. Stereolithographic models [Figure 1] were done to know the three-dimensional extent of the deformity and to simulate the surgical procedure, and polysomnography was done to rule out obstructive sleep apnea (OSA).

In all the four patients, the following treatment protocol was carried out: Osteotomy and placement of intraoral distraction device under general anesthesia, latency phase (5–7 days), activation period-rate 1.5 mm/day, consolidation period of 8 weeks, and removal of distraction device under local anesthesia.

The patients were assessed postoperatively for wound infection. The length of the body of the mandible and ramus of mandible were evaluated using cephalometric analysis and CT scans pre- and post-operatively. The posterior pharyngeal space was measured using lateral cephalogram pre- and post-operatively. Mouth opening was assessed by maximal incisal opening, mid-line shift, occlusion, facial symmetry, and chin prominence; protrusive movement, laterotrusive movements, and hyomental distance were assessed on clinical examination.

The data were analyzed using SPSS version 20 (IBM Corporation, SPSS Inc., Chicago, IL, USA).

**Surgical procedure**

The surgical management of all the cases of micrognathia was under general anesthesia with nasoendotracheal intubation. Risdon’s submandibular incision was mapped out with marking ink (Toluidine blue) [Figure 2]. The incision was placed 1.5 to 2 cm inferior to the mandible. The incision was placed parallel to the inferior border of the mandible. Layer-wise dissection was done and the periosteum was incised, and lateral surface of ramus and angle of mandible were exposed [Figure 3]. The osteotomy cut was placed at the angle to achieve a lengthening of both ramus and body [Figure 4]. The distraction device was placed obliquely
to achieve both ramus and mandibular lengthening [Figure 5]. The wound was closed layer wise using 3–0 Vicryl and 4–0 Prolene. The activating arm of the distraction device was exposed extraorally through a separate stab incision in one patient and intraorally in three patients.

All patients were extubated and recovery was uneventful. Postoperatively, all the patients were administered appropriate antibiotic and analgesics for 5 days. Sutures were removed on the 10th day. The following postoperative protocol was followed in all patients, a latency period of 7 days, the distraction rate was 1.5 mm with a rhythm of 0.75 mm twice a day, the distraction period was 10–15 days, the consolidation period was 6 weeks OR until a stable cortical outline is visible in the radiographs. Following the consolidation phase, the distractor device was removed under local anesthesia. Regular follow-up was carried out weekly for first 1 month and once in 2 weeks for 3 months and once in a month for next 2 months.
RESULTS

In three of four patients, micrognathia of the mandible was the result of postankylotic deformity, trauma being the cause of ankylosis in all patients. In one patient, micrognathia was attributed to hemifacial microsomia and 3 patients were male and one patient was a female with a mean age of $15.2 \pm 3.8$ years and the average mouth opening of the patients was $32.5 \pm 2.21$ mm [Table 1].

The ramus height was measured from condylion to gonion and the body length was measured from gonion to pogonion in lateral cephalogram. The mean increase in ramus height achieved was $9.2 \pm 2.17$ mm [Table 2] and the mandibular body length achieved was $10.4 \pm 1.67$ mm [Table 3]. There was an average increase in hyomental distance of $2.75$ cm $\pm 0.9$ cm postoperatively, showing a definitive improvement in the airway [Table 4]. The posterior pharyngeal space measured from the lateral cephalogram preoperatively ranged from 3 to 6 mm and postoperatively from 6 to 9 mm [Table 5]. In all patients, intraoral distraction device was placed with activating arm placed subcutaneously for convenience of activation.

Intraorally, there was a shift in occlusion to class I molar relation in three patients and there was posterior open bite in one patient. Marked correction of facial asymmetry was noticed in all cases both clinically [Figures 6a, b and 7a, b] and posteroanterior cephalogram [Figure 8a and b]. There was a restoration of dental as well as lip midline and improved lip competence.

### Table 1: Demographic data

| Serial number | Age  | Sex | Etiology of micrognathia | Mouth opening (mm) | Distraction side |
|---------------|------|-----|--------------------------|--------------------|------------------|
| 1             | 10   | Male| Ankylosis                | 30                 | Right            |
| 2             | 17   | Male| Hemifacial microsomia    | 35                 | Left             |
| 3             | 15   | Female| Ankylosis            | 32                 | Bilateral        |
| 4             | 19   | Male| Ankylosis                | 34                 | Left             |

### Table 2: Mandibular Ramus height

| Serial number | Ramus height (mm) | Preoperative | Postoperative | Mean (mm) | Preoperative | Postoperative | ± SD | P     |
|---------------|-------------------|--------------|---------------|-----------|--------------|---------------|------|-------|
| 1             | 33                | 41           |               | 40.6      | 49.8         |               | 6.10 | 0.001 |
| 2             | 40                | 52           |               | 40.6      | 52           |               | 6.49 |       |
| 3             | Left: 39          | Right: 41    | Right: 52     | Right: 52 |               |               |      |       |
| 4             | 50                | 58           |               | 50        | 58           |               | 58   |       |

Statistical analysis: Paired t-test. Strongly significant ($P \leq 0.001$), Significant ($P \leq 0.05$), SD=Standard deviation

### Table 3: Mandibular Body length

| Serial number | Body length (mm) | Preoperative | Postoperative | Mean | ± SD | P     |
|---------------|------------------|--------------|---------------|------|------|-------|
| 1             | 36               | 46           |               | 54.6 | 11.12| 0.000 |
| 2             | 64               | 75           |               | 11.12| 11.46|       |
| 3             | Left: 54         | Right: 57    | Right: 70     |      |      |       |
| 4             | 62               | 71           |               |      |      |       |

Statistical analysis: Paired t-test. Strongly significant ($P \leq 0.001$), Significant ($P \leq 0.05$), SD=Standard deviation

### Table 4: Distance between hyoid and menton

| Serial number | Hyomental distance (cm) | Preoperative | Postoperative | Mean | ± SD | P     |
|---------------|-------------------------|--------------|---------------|------|------|-------|
| 1             | 1                       | 4            |               | 2.0000| 1.41 | 0.010 |
| 2             | 4                       | 6            |               | 1.41 | 0.95 |       |
| 3             | 2                       | 4            |               |      |      |       |
| 4             | 1                       | 5            |               |      |      |       |

Statistical analysis: Paired t-test. Strongly significant ($P$ value $\leq 0.001$), Significant ($P \leq 0.05$), SD=Standard deviation
There was a significant improvement in chin projection and occlusal cant; however, further chin correction was needed in one case by means of advancement genioplasty [Table 6].

The intraoral distraction device was found to be well tolerated by all patients as they were able to perform their normal daily activities without great discomfort. The distraction process was uneventful in all cases without any infection or other major complications.

The formations of bone between the distracted ends were assessed by ultrasonogram, and panoramic radiographs taken 1 month of distraction demonstrated elongation of both ramus and body. The expanded area was filled with bone that was slightly less radiodense than the adjacent bone. OPGs and CT scans taken 3 months after the distraction showed complete bone regeneration between the distracted bone ends [Figures 9a-d and 10a and b].

There was transient paresthesia of the inferior alveolar nerve in one patient, but by the time the distraction device was removed, the patient had normal sensation. No sensory disturbances of lingual nerve were noted.

### Table 5: Posterior Pharyngeal space dimension

| Serial number | Posterior airway space (mm) | Mean | ± SD | $P$  |
|---------------|-----------------------------|------|-----|------|
|               | Preoperative | Postoperative | Preoperative | Postoperative | Preoperative | Postoperative |
| 1             | 3            | 6            | 4.75 | 7.75 | 1.5 | 1.25 | 0.005 |
| 2             | 6            | 9            |      |      |     |      |      |
| 3             | 4            | 8            |      |      |     |      |      |
| 4             | 6            | 8            |      |      |     |      |      |

Statistical analysis: Paired t-test, Strongly significant ($P \leq 0.001$), Significant ($P \leq 0.05$) SD = Standard deviation

### Table 6: Occlusion, midline shift, chin projection, facial symmetry

| Serial number | Occlusion | Midline shift | Chin projection | Facial symmetry |
|---------------|-----------|---------------|-----------------|-----------------|
|               | Preoperative | Postoperative | Preoperative | Postoperative | Preoperative | Postoperative |
| 1            | Class II | Classified | Right | No midline shift | Retrogenia | Chin prominent | Asymmetry present | Symmetrical |
| 2            | Class II | Classified | Left | No midline shift | Retrogenia | Chin prominent | Asymmetry present | Symmetrical |
| 3            | Class II | Classified | Right | No midline shift | Retrogenia | Chin prominent | Asymmetry present | Symmetrical |
| 4            | Class II | Posterior open bite | Left | No midline shift | Retrogenia | Chin prominent | Asymmetry present | Symmetrical |

There was a significant improvement in chin projection and occlusal cant; however, further chin correction was needed in one case by means of advancement genioplasty [Table 6].
During the active distraction period, one patient experienced strain on the TMJ; however, limited mouth opening was not seen. There were no signs of facial palsy of the mandibular branch of facial nerve.

**Discussion**

According to Ilizarov and other studies, bone formation is markedly increased during DO. The increased activity has been attributed to stimulatory effect on bone-forming cells by the tension produced.

Although it has not yet been proved, there are clinical reports that suggest an increase in the soft tissue mainly the muscles of mastication on distraction of the mandible. According to Moss and Salentijn, the explanation for this is that the functional matrix for development of craniofacial skeleton is influenced by the function of the attached neuromuscular tissue and associated spaces. Enlow and Harris also demonstrated that mandibular growth depends on the development of masticatory muscles and eruption of the teeth. There was an increase in soft tissue mainly muscles of mastication in the present study as a result of distraction.

Ilizarov reported that the rhythm of distraction has a significant influence on the bony regeneration. The rate of distraction was 1.5 mm/day in the present study since animal studies have shown that a distraction rate of 2 mm/day resulted in delayed union or nonunion in the distracted area. On the contrary, a slow distraction rate of 0.3–0.5 mm/day produced premature consolidation; hence, the distraction rate in the current study was 1.5 mm/day and there was biologically favorable bone formation in all the cases.

During the age of mixed dentition in patients with hemifacial microsomia and a hypoplastic mandible, the unerupted molar buds are located high in the retromolar region and can be damaged by an osteotomy cut in this region. Moreover, the ramus is wider in the retromolar region than superiorly; therefore, an oblique osteotomy results in more bony surfaces on both sides of the osteotomy for regeneration of bone. A recent experimental study in tibial bone by Richards et al. had demonstrated that when the osteotomies were created at a 300 angle to the bony axis, there were changes in the distribution of gap strain, which caused increased shear on the osteoblasts resulting in deposition of more osteoid and mineralized bone.

One of the important phases in DO is determination of vector of distraction. Placement of the device parallel to inferior border of mandible will result in an anterior open bite. Posterior placement of device can achieve elongation of ramus with slight anterior movement. Keeping this principle in mind, since a vertical elongation and forward advancement of mandible was needed, an oblique osteotomy was made in the angle of mandible and the device was placed obliquely to achieve a simultaneous increase in ramus height and body length in all patients in the present study, and since the device was oriented parallel to occlusal plane, there was no evidence of anterior open bite.

In the mandible, it is better to perform an osteotomy rather than corticotomy to allow better movement of the segments and increased control of the planned vector of elongation because the intraoral devices are not rigid enough to move the segment in the planned direction without an osteotomy. The osteotomy should be completed at the posterior border of ramus to allow downward distraction and to prevent an open bite. Hence, in the current study, since an intraoral device was used, osteotomy was done rather than a corticotomy.

A study performed by Williams et al demonstrates expansion of mandibular framework with advancement of base of tongue that leads to increased pharyngeal airway. This is determined on the basis of cephalometric study where the advancement of hyoid bone along the axis of mandibular body is measured after distraction.

A study by Rachmiel et al supports that the distraction of the micrognathic mandible increases the volume of upper airway, increases the mandibular volume, and advances the hyoid bone, thereby improving the glossoptosis and airway obstruction eliminating symptoms of OSA. A study by Miloro suggests a 12 mm increase in posterior airway space. Even though none of our patients had OSA as polysomnography was done in all patients, there has been a definitive increase in the posterior pharyngeal airway space and hyomental distance, suggesting an improvement in airway similar to the above-mentioned studies.

A study by Tuzuner-Oncul and Kisinisci shows that they were able to obtain a linear increase in length of 13 mm in ramus height measured in lateral cephalometric radiographs and 18 mm in PA cephalometric radiographs and this increase was maintained over the period of the study and no skeletal relapse in 24 months postconsolidation.

In another study on intraoral DO by Sadakah et al., there was a total mandibular elongation from 17 to 25 mm (20.7 mm) and occlusal canting decreased to Zero degree in 7 patients and 10 in 2 patients (mean 0.20). In a study by El-Bialy et al. on bilateral mandibular DO using an intraoral tooth borne device, the total mandibular length and corpus length increase achieved were 5 mm and 4.6 mm, respectively. This amount of distraction is less than bone–borne studies. In another study by Miloro on mandibular DO for pediatric airway management, there was a mean increase in mandibular length of 15 mm.

In a study by Padwa et al. on simultaneous maxillary and mandibular DO with a semi-buried device, a mean increase of 10 mm of mandibular body length was achieved. In a study by van Strijen et al., the mean lengthening of the mandible achieved was 7.6 mm (range: 8–10 mm). In a study by Jansma et al., the mean increase in ramus length was 13 mm (range: 10–16).

Similar to these studies, in the present case series, there was a mean increase of 10.4 mm in mandibular body length and 9.2 mm increase in ramus height.

In a study on long bones, it has been emphasized that an intact intramedullary blood circulation with overlying periosteam
is essential to allow bone regeneration after lengthening. Karaharju et al.\textsuperscript{[23]} have reported from their study on sheep that the cutting of the intramedullary blood vessels or overlying periosteum does not affect bone healing. In the present study, the inferior alveolar nerve was kept intact at all times and periosteum was not stripped extensively to preserve mandibular bone volume and maintain the integrity of the inferior alveolar nerve.

Contrary to the study by Whitesides and Meyer,\textsuperscript{[26]} temporary hypothesis was not encountered in all the patients in the present study.

There has been some controversy as to when distraction should begin after the osteotomy procedure. For long bones, Ilizarov recommended a 5–7-day delay before starting gradual distraction.\textsuperscript{[6]} With mandibular distraction, Snyder et al.\textsuperscript{[27]} indicated a period of 1 week while Karp et al.\textsuperscript{[28]} and Costantino and Friedman\textsuperscript{[29]} all waited for 10 days. Considering the healing capacity of mandibles and relatively young age of the patients in this study, a waiting period of 5–7 days was applied and was found to be optimal.

The disadvantage of the extraoral distractors is that they leave scars along the cheek; possibility of a fall may result in loosening of the pins or breakage of the device. On the contrary, these disadvantages do not occur with intraoral distractors.\textsuperscript{[17]} Hence, we favored intraoral distractors for all patients in the present study. However, these devices do not allow for multidirectional lengthening with adjustments during the distraction period.

In a study by Jansma et al.,\textsuperscript{[24]} the mean increase in ramus length was 13 mm (range 10–16) similar to our study.

In a study by Jansma et al.,\textsuperscript{[24]} the chin was brought into facial midline analogous to this; even in the current study, there was definite increase in chin projection and the midline shift was corrected; although over correction is often advised, this was not possible in this study because the developing opposite crossbite became the limiting factor.

Similar to the studies by Rubio-Bueno et al.,\textsuperscript{[30]} good occlusion was achieved after lengthening the ramus and corpus with DO with intraoral device in this study.

In agreement with recommendation of Mommaerts and Nagy,\textsuperscript{[31]} DO was performed in all patients in the second stage of dental development.

The least predictable feature in the case series was the posterior open bite. It is assumed that unilateral lengthening of ramus leads to a transverse shift of the mandible to the opposite side, unfortunately minimizing the vertical effect in the molar region on the distraction side. This mandibular shift to the opposite side was also described by Diner et al.\textsuperscript{[32]} They stated that this Mandibular shift often masks the vertical lengthening of ramus and prevents the creation of the desired unilateral open bite on the distracted side. An open bite was present only in one of the cases; the use of an intraoral device could be the reason for this lack of getting a desired open bite on the distracted side which could favor the downward growth of maxilla. Jansma et al.\textsuperscript{[25]} suggest placement of an orthodontic bite block on the opposite side either pre- or post-operatively if an intraoral distraction device is used.

There have been no long-term studies on stability after treatment of hemifacial microsomia by DO. Kusnoto et al.\textsuperscript{[33]} found 1 mm shortening of the mandibular ramus after DO. 5%–8% overcorrection and concluded that the settling of the regenerate could be the cause for the shortening of the ramus found. And also reported 2% more growth of the mandibular body occurred on the distracted side than on the opposite side.

However, in the current study, the follow-up period is just 3 months and a longer follow-up period is necessary to assess the relapse rate.

During the distraction period, forces tend to push the condyle up into the glenoid fossa. This could explain the pain in the ipsilateral TMJ in two cases during early distraction period.

Rubio-Bueno et al.\textsuperscript{[30]} reported anterior rotation of the condylar segment immediately after the surgery in extraoral distraction device because of rotation of bony segment around the single external screw probably due to pull of the temporalis muscle but in view of the fact that an intraoral device with four screws were fixed on each side of the osteotomy, this complication was not encountered in the current study.

From the patients’ point of view, the distraction period was not an uncomfortable experience. No major discomfort was noted at the distraction site. The only disadvantage of DO using intraoral distraction device seems to be the necessity of two operations under general anesthesia and frequent visits to the clinic during the activation period.

**Conclusion**

Young patients with mandibular hypoplasia who are resistant to functional orthodontic therapy can be treated effectively by means of DO to lengthen the mandible. The advantages of intraoral devices are higher quality distraction due to proximity between the bone and frame, possibility of using implants as both distraction and prosthetic pillars and unaltered social life for the patient. A definite improvement in all parameters such as body length, ramus height, chin projection, and occlusal cant was observed in all patients. Moreover, the patients were subjectively satisfied with the outcome of the results. DO is definitely a boon to the oral and maxillofacial surgeons in treating large deficiencies of mandible in terms of stability.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/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.
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Conflicts of interest
There are no conflicts of interest.

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