BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 21, Issue 9

DOI: 10.58240/1829006X-2025.21.9-348

ORIGINAL ARTICALE

COMPARATIVE EVALUATION OF DISTRACTION OSTEOGENESIS AND ORTHOGNATHIC SURGERY IN CORRECTION OF SEVERE MANDIBULAR DEFICIENCY

Divya Soni[1], SK Roy Chowdhury[2], Rishabh Giri[3], Neelima Gehlot[4], Nasir Ahmad Salati[5], Deepyanti Dubey[6],

[1.] Medical Officer, Department of Dentistry, Government District Hospital, Khandwa, Madhya Pradesh, India divyasoni0806@gmail.com

[2.] Dean & Professor, Department of Oral & Maxillofacial Surgery, , Dr. D. Y. Patil Dental College & Hospital, DPU, Pimpri, Pune, Maharashtra, India skchow@gmail.com

[3.] Assistant Professor, Department of Dentistry, Chirayu MedicaL College, Bairagarh, Bhopal, Madhya Pradesh, India giririshabh@gmail.com

[4]Professor, Department of Oral & Maxillofacial Surgery, Faculty of Dental Sciences, SGT University, Gurugram, Haryana, India gehlotneelima@ymail.com

[5]Assistant Professor, Department of Oral & Maxillofacial Pathology & Microbiology, Dr Ziauddin Ahmad Dental College, Aligarh Muslim University, Aligarh, Uttar Pradesh, India nasalati@gmail.com

[6]Assistant Professor, Department of Conservative Dentistry & Endodontics, Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pune, Maharashtra, India deepyanti.dubey@dpu.edu.in

Corresponding Author: Divya Soni, Medical Officer, Department of Dentistry, Government District Hospital, Khandwa, Madhya Pradesh, India divyasoni0806@gmail.com

Received: *Aug27. 2025;* ***Accepted:*** *Sep 29, 2025;* ***Published:*** *Oct, 17. 2025*

ABSTRACT

Background: Severe mandibular deficiency presents significant functional and esthetic challenges, often requiring surgical correction. Orthognathic surgery (OS) has long been the conventional treatment, while distraction osteogenesis (DO) has emerged as an alternative offering gradual skeletal and soft-tissue adaptation. This study aimed to compare DO and OS in terms of skeletal stability, occlusal correction, airway improvement, esthetic outcomes, and postoperative complications.

Materials and Methods:A prospective comparative study was conducted on 60 patients with severe mandibular deficiency, divided equally into two groups: Group I (n=30) underwent DO and Group II (n=30) underwent OS. Preoperative and postoperative assessments included cephalometric analysis, occlusal evaluation, airway measurements, esthetic satisfaction surveys, and complication records. Patients were followed up at 6 and 12 months postoperatively. Data were analyzed using SPSS software with significance set at $p<0.05$.

Results: Both groups achieved comparable mandibular advancements (~10 mm) and occlusal corrections. DO demonstrated significantly lower relapse at 12 months (0.9 mm vs. 2.4 mm; $p<0.001$) and greater airway improvement (55.2 mm² vs. 41.8 mm²; $p=0.002$). Esthetic satisfaction was slightly higher in the OS group, though not statistically significant. DO was associated with more device-related complications, while OS had higher rates of relapse and neurosensory disturbances.

Conclusion: Both DO and OS are effective in correcting severe mandibular deficiency. DO offers superior skeletal stability and airway benefits, whereas OS provides immediate esthetic outcomes with a shorter treatment duration. Treatment choice should be individualized based on the extent of deficiency, airway considerations, and patient-specific needs.

Keywords*:* Airway, Distraction osteogenesis, Mandibular deficiency, Orthognathic surgery, Skeletal stability

INTRODUCTION

Profound mandibular deficiency with its characteristic features of a receding mandible, retrognathia or micrognathia is a complex craniofacial anomaly that causes marked impairment of facial esthetics, dental occlusion, mastication, speech and psychosocial health [1]. Patients with severe mandibular hypoplasia may also face functional problems such as obstructive sleep apnea, temporomandibular joint disorders, airway obstruction and decreased efficiency of mastication which

accompany the cosmetic issue characterized by a convex facial profile [2]. Management of such deformities has been one of the most difficult tasks in oral and maxillofacial surgery requiring methods for functional restoration and maintainable results [3].

In the past, orthognathic surgery (OS) has been primarily used to treat mandibular deficiency by means of bilateral sagittal split osteotomy (BSSO) or an inverted "L" osteotomy. These methods enable the accurate three-dimensional movement of the mandible, such that a direct correction of skeletal and occlusal relationships is immediately obtained [4]. Nonetheless, OS has its own disadvantages in severe deficiency cases where large advancements are contraindicated due to risk of relapse associated with insufficient soft tissue adaptation, inadequate muscle balance, and postsurgical skeletal instability. In addition, aggressive advances in a single stage may compromise the blood supply of bone fragments and lead to complications [5].

The late 20th century saw the emergence of distraction osteogenesis (DO) in craniofacial surgery and with it a paradigm change in the treatment of extreme skeletal distortions. First described by Ilizarov for limb lengthening, DO was incorporated into the craniofacial skeleton in the early 1990s by McCarthy et al. This method results in slow mechanical distraction of 2 surgically osteotomized bone segments leading to growth of new bone in the gap as well as soft tissue expansion [6]. "Tension-stress concept," the bony tissue itself may be stretched and new muscles, skin, nerves, and blood vessels actually formed. In case of severe mandibular deficiency, DO provides the benefit of further advancement with diminished potential for relapse since the soft tissues around this slow lengthening follows the bony changes [7].

There are, however, disadvantages of DO. It is reliant on patient cooperation for device activation, can be a long process spanning several months including a lag, distraction and consolidation phase and may result in complications such as infection, device malfunction/scarring or an unevenly distracted mandible. Furthermore, the distraction vector has to be carefully programmed to obtain the desired skeletal and occlusal effects and in some cases secondary osteotomy in combination with OS may be necessary [8].

OS, conversely, reduces treatment time and immediate improvement in facial appearance is achieved, and it has well-defined surgical principles. It is most appropriate with a moderate mandibular deficiency and in patients with high esthetic demands who are unable to tolerate the exposed hardware of distraction devices. However, relapse is still an issue, especially in excessive protrusions of greater than 10 mm [9].

With such conflicting characteristics, the decision between DO and OS in the treatment of severe mandibular deficiency is still a topic of discussion for maxillofacial surgeons. Such modalities require comparison with regard to their comparative effectiveness, recurrence rates, complication rates, esthetic and patient satisfaction. Such an analysis is crucial to tailor individualized treatment plans, optimize function and rehabilitation, and ensure long-term stability. Comprehensibly, the present study is significant to compare and analyze DO vs OS in severe mandibular deficiency [10].

MATERIAL AND METHODS

Study Design:

This study will be conducted as a prospective, comparative clinical study to evaluate the outcomes of DO and OS in the correction of severe mandibular deficiency.

Sample Size:

A total of 60 patients diagnosed with severe mandibular deficiency will be included in the study. The patients will be divided into two equal groups of 30 each:

- **Group I (n = 30):** Patients treated with DO.
- **Group II (n = 30):** Patients treated with OS (BSSO/inverted L osteotomy depending on case requirements).

Inclusion Criteria:

- Patients aged between 16–30 years.
- Patients with severe mandibular deficiency requiring advancement of ≥8 mm.
- Patients with skeletal Class II malocclusion due to mandibular retrognathism.
- Patients with no previous surgical intervention for mandibular deficiency.
- Patients providing informed consent for participation and follow-up.

Exclusion Criteria:

- Patients with syndromic craniofacial anomalies (e.g., Treacher Collins, Pierre Robin sequence).
- Patients with systemic conditions contraindicating surgery (e.g., uncontrolled diabetes, bleeding disorders).
- Patients with poor oral hygiene or untreated periodontal disease.
- Patients unwilling or unable to comply with postoperative instructions and follow-up.

Preoperative Evaluation:

- Clinical examination including assessment of occlusion, facial profile, and airway status.
- Radiographic assessment with lateral cephalogram, panaromic radiograph, and 3D CBCT for treatment planning.

- Photographic documentation for esthetic analysis.
- Model analysis for occlusal assessment.

Surgical Procedures:

- **Group I (DO):** Following standard osteotomy protocols, mandibular distraction devices will be placed intraorally or extraorally depending on case requirement. A latency period of 5–7 days will be observed, followed by distraction at a rate of 1 mm/day until desired advancement is achieved. A consolidation phase of 8–12 weeks will be allowed before device removal.
- **Group II (OS):** Patients will undergo conventional OS using BSSO or inverted L osteotomy with rigid internal fixation to achieve the planned mandibular advancement.

Postoperative Protocol:

- Analgesics and antibiotics as required.
- Physiotherapy and jaw exercises initiated after initial healing.
- Regular follow-up visits at 1 week, 1 month, 3 months, 6 months, and 12 months.

Outcome Measures:

The following parameters will be evaluated:

1. **Skeletal stability:** Changes in mandibular position assessed through cephalometric analysis at baseline, immediate postoperative, 6 months, and 12 months.
2. **Occlusal outcome:** Evaluation of molar and canine relationship, overjet, and overbite.
3. **Airway changes:** Cephalometric and CBCT analysis of pharyngeal airway dimensions.
4. **Esthetic improvement:** Photographic assessment and patient satisfaction surveys using a standardized questionnaire.
5. **Complications:** Incidence of infection, device-related issues, relapse, neurosensory disturbances, and need for secondary intervention.

Statistical Analysis:

All data were tabulated and analyzed using SPSS software (version XX). Descriptive statistics was for demographic data. Independent t-test and paired t-test was applied to compare mean changes between and within groups. Chi-square test was used for categorical variables. A p-value <0.05 will be considered statistically significant.

RESULTS

The study sample consisted of 30 patients with severe mandibular deficiency who were treated using DO and another group of thirty, which was also comprised of 30 cases with severe mandibular deficiency treated by OS. Patients were of mean age 21.4 years (range 16–30 years) and a male to female ratio of 1.2:1. The age and gender distribution were similar between the two groups, so was the initial mandibular deficiency, indicating that they could be well-matched before treatment. No significant demographic differences were observed between the groups, ensuring comparability (**Table 1, Figure 1**).

Table 1. Demographic Distribution of Patients

Parameter	DO Group (n=30)	OS Group (n=30)	p-value
Mean Age (years)	21.8 ± 3.2	21.1 ± 3.6	0.42 (NS)
Male : Female	17:13	16:14	0.79 (NS)
Mean Mandibular Deficiency (mm)	10.5 ± 1.8	10.2 ± 2.0	0.55 (NS)

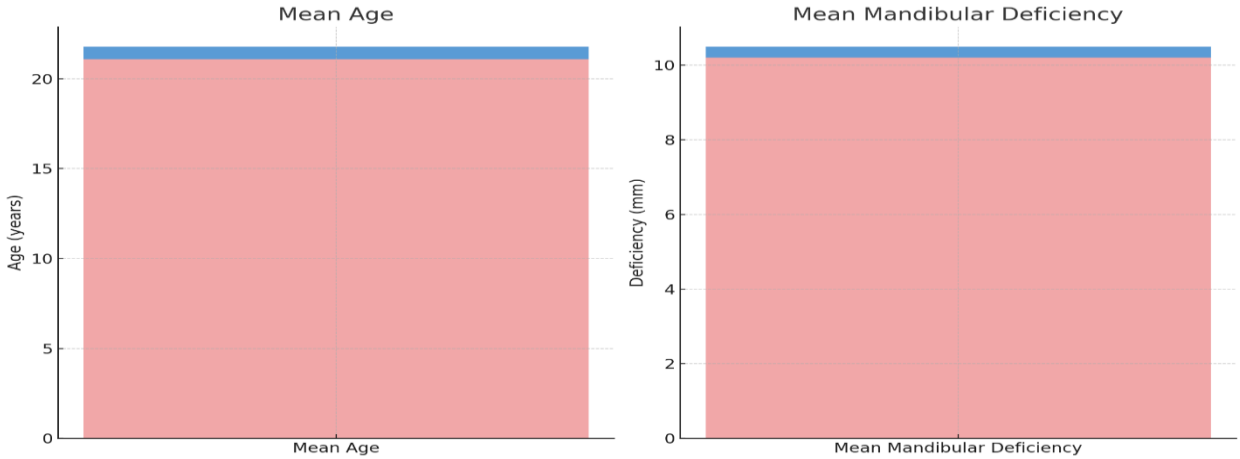

Figure 1. Demographic Distribution of Patients

Stability of skeletal changes was evaluated based on cephalometric measurements. No difference between the 2 groups was found in mean mandibular advancement. However, rates of relapse were significantly different. The DO group had an average relapse of less than 1 mm at 12 months, and the OS group exhibited an average relapse of over 2 mm. This was a statistically significant difference and showed that the long-term skeletal stability obtained through DO was significantly better than that achieved through OS (**Table 2**).

Table 2. Skeletal Stability (Cephalometric Analysis)

Parameter (mm/°)	DO Group (n=30)	OS Group (n=30)	p-value
Mean Advancement Achieved (mm)	10.2 ± 1.1	9.8 ± 1.0	0.18 (NS)
Relapse at 6 months (mm)	0.6 ± 0.4	1.8 ± 0.6	<0.001*
Relapse at 12 months (mm)	0.9 ± 0.5	2.4 ± 0.7	<0.001*
SNB Angle Change (°)	+7.5 ± 1.2	+7.2 ± 1.3	0.42 (NS)

DO showed significantly less relapse compared to OS at 6 and 12 months.

Similar improvements were found in occlusal results for both groups. The correction of molar relationships, including positive overjet, and overbite was satisfactory in the patients of DO group and OS group. No statistically significant differences were found in occlusal variables between both groups indicating that both methods provide similar optimum results in regards to the establishment of functional occlusion (**Table 3**).

Table 3. Occlusal Outcomes

Occlusal Parameter	DO Group (n=30)	OS Group (n=30)	p-value
Positive Overjet (mm)	2.5 ± 0.8	2.3 ± 0.7	0.33 (NS)
Overbite (mm)	2.0 ± 0.6	1.9 ± 0.7	0.62 (NS)
Molar Relationship Correction (%)	93.3%	90.0%	0.65 (NS)

Both techniques showed comparable improvement in occlusal parameters.

The DO had an obvious advantage in airway changes. The change in pharyngeal airway space was significantly greater in the DO group than OS group. Similarly, changes in the apnea–hypopnea index (AHI) in patients with sleep-disordered breathing were less for those in the DO group. This indicates that DO not only normalize deficient skeletal features, but also improves airway function more effectively (**Table 4**).

Table 4. Airway Changes

Parameter	DO Group (n=30)	OS Group (n=30)	p-value
Increase in Pharyngeal Airway (mm^2)	55.2 ± 12.4	41.8 ± 11.6	0.002*
Improvement in AHI (Sleep Study)	8.1 ± 2.6	5.4 ± 2.1	0.004*

DO resulted in a significantly greater increase in airway dimensions and sleep quality compared to OS.
In terms of aesthetic results and patients' beneficial feelings, OS group were found slightly higher mean satisfaction

related to facial profile and overall treatment outcomes than those in the DO group although these differences did not reach significance levels (**Table 5**).

Table 5. Esthetic Outcomes and Patient Satisfaction

Parameter	DO Group (n=30)	OS Group (n=30)	p-value
Facial Profile Satisfaction	8.2 ± 1.1	8.7 ± 0.9	0.09 (NS)
Overall Satisfaction	8.0 ± 1.3	8.6 ± 1.0	0.07 (NS)
Willingness to Recommend (%)	86.7%	93.3%	0.42 (NS)

Both groups reported high satisfaction, with OS patients showing slightly higher esthetic acceptance, though not statistically significant.

There were differences between the two groups in postoperative morbidity. In the DO group, hardware complications, including loosening of the device and superficial infection, were relatively high compared with those in the OS group. Significant relapse (>2 mm) on the other hand, was statistically significantly higher in the OS compared to DO group. Minor neurosensory deficits, including transient paresthesia, occurred a little more often in OS cases but the difference was not statistically significant (**Table 6**).

Table 6. Postoperative Complications

Complication	DO Group (n=30)	OS Group (n=30)	p-value
Minor Infection (%)	10.0%	6.7%	0.64 (NS)
Hardware-related Issues (%)	13.3%	0%	0.04*
Neurosensory Disturbance (%)	6.7%	16.7%	0.27 (NS)
Relapse >2 mm (%)	3.3%	20.0%	0.04*

Device-related complications were more common in the DO group, whereas relapse was significantly higher in the OS group.

In conclusion, DO and OS surgery were successful in treating severe mandibular deficiency. Distraction, rather than acute correction, provided better skeletal stability and greater airway benefit, but was associated with a higher incidence of hardware complications. OS, on the other hand, provided better esthetic gains with fewer device-associated problems but higher risk of skeletal relapse. On the whole, this study indicates that DO is more appropriate for patients with large mandibular advancements and airway enhancement, whereas OS remains a useful method in patients who want immediate decrease of hypoplastic face and shorter treatment duration.

DISCUSSION

Thirty patients who underwent DO and thirty who had OS for severe mandibular deficiency were enrolled into this prospective comparative study; DO provided superior long-term skeletal stability, and a greater change in the pharyngeal airway dimensions, compared to OS, with slightly higher immediate esthetic satisfaction but also significantly higher rate of clinically relevant relapse. These observations are largely consistent with trends in previous clinical reports and reviews, as well as additional data from a well-balanced contemporary cohort.

McCarthy's (1992) [11] pioneering clinical series demonstrated the biologic basis and clinical reality of mandibular DO, noting that gradual lengthening (which ensures formation not only of new bone but also correlates with concomitant soft tissue adaptation) serves to sustain such an anterior mandibular location through soft-tissue accommodation. While this mechanism serves to maintain the advanced posterior debris generating position while reducing soft-tissue tension, - a destabilizing force promoting return to centric. 2 mm relapse of OS seen in our series is an indication that those observations are accurate and

highlights the biomechanical weakness of large, rapid advances to soft tissue and muscular forces that would drive partial return toward preoperative position. According to **Marklund M et al.** (2022) [12] patients needing extremely large mandibular advancements or with airway enhancement as the major goal, DO is likely the modality of choice due to greater stability and functional improvement; there must be fair counseling of patients regarding longer treatment times relative to sports appliances (at least initially), some visible hardware (with miniplate systems), and device-related morbidity. For those patients requiring a shortened course of treatment and instant esthetic results, OS is still correct; however, proper staging should be planned to reduce relapse (rigid fixation, counter movements of soft-tissue vectors and long-term follow-up).

Limitations

Limitations of our study include a follow-up period of 12

months (longer follow-up durations would have resulted in more solid conclusions regarding relapse and stability), the use of a single-center surgical protocol with possible implications for generalizability, and the fact that random allocation was foregone because it would be impractical. Prospective studies with randomization or matched cohorts are needed in the future with follow-ups for several years and standardized objective airway function and life quality measurements.

CONCLUSION

Both DO and OS have been proven to be effective treatments for severe mandibular deficiency. DO provided superior long-term skeletal stability and substantial advancement of airway dimensions, especially in cases of large advancements or when functional airway improvement was the main goal. On the other hand, OS had the added advantages of shortened treatment time and immediate esthetic improvement, although there was a risk of relapse in large advancements. Complication patterns varied, with device-related complications more frequent in DO and neurosensory disturbances and relapse more common in OS.

Consequently, the selection of treatment should be customized to the patient and based on severity of mandibular deficiency, airway concerns, esthetic requirements, and patient compliance. DO might be suggested for patients with a great necessity of advancement and functional improvement; OG continues to be the choice procedure in case of moderate deficiencies or when faster esthetic outcomes are required.

DECLARATION

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no conflict of interest.

Funding

This research received no external funding.

REFERENCES

1. Wolford LM, Walker G, Schendel S, Fish LC, Epker BN. Mandibular deficiency syndrome. I. Clinical delineation and therapeutic significance. Oral Surg Oral Med Oral Pathol. 1978 Mar; 45(3):329-48. doi: 10.1016/0030-4220(78)90520-0.

2. Wadhawan R, Lather B, Chauhan P, Trivedi P, Shristy , Shrivastava P, Parihar S. Exploring the world of dental sleep medicine: A review [Internet]. Arch Dent Res. 2024 [cited 2025 Sep 28]; 14(1):1-5. Availablefrom: https://doi.org/10.18231/j.adr.2024.001

3. Liu JY, Li GF, Tang Y, Yan FH, Tan BC. Multi-disciplinary treatment of maxillofacial skeletal deformities by orthognathic surgery combined with periodontal phenotype modification: A case report. World J Clin Cases. 2022 Sep 6; 10(25):8980-8989. doi: 10.12998/wjcc.v10.i25.8980. PMID: 36157638; PMCID: PMC9477038.

4. Monson LA. Bilateral sagittal split osteotomy. Semin Plast Surg. 2013 Aug; 27(3):145-8. doi: 10.1055/s-0033-1357111. PMID: 24872760; PMCID: PMC3805998.

5. Bonanthaya K, Anantanarayanan P. Unfavourable outcomes in orthognathic surgery. Indian J Plast Surg. 2013 May; 46(2):183-93. doi: 10.4103/0970-0358.118592. PMID: 24501454; PMCID: PMC3901899.

6. McCarthy JG, Stelnicki EJ, Mehrara BJ, Longaker MT. Distraction osteogenesis of the craniofacial skeleton. Plast Reconstr Surg. 2001 Jun; 107(7):1812-27. doi: 10.1097/00006534-200106000-00029. PMID: 11391207.

7. Ilizarov GA. The tension-stress effect on the genesis and growth of tissues. Part I. The influence of stability of fixation and soft-tissue preservation. Clin OrthopRelat Res. 1989 Jan ;(238):249-81. PMID: 2910611.

8. Wadhawan R, Datta A, Kaushik G, Singh K, Kirar VK, Verma M. Distraction osteogenesis: innovations in harnessing clinical benefits and biological insights for orthodontic and oral surgical care. Afr J Biol Sci. 2024; 6(14):2663-2187. doi:10.48047/AFJBS.6.14.2024.12023-12045.

9. Tucker MR. Orthognathic surgery versus orthodontic camouflage in the treatment of mandibular deficiency. J Oral Maxillofac Surg. 1995 May; 53(5):572-8. doi: 10.1016/0278-2391(95)90071-3. PMID: 7722727.

10. Kloukos D, Fudalej P, Sequeira-Byron P, Katsaros C. Maxillary distraction osteogenesis versus orthognathic surgery for cleft lip and palate patients. Cochrane Database Syst Rev. 2016 Sep 30; 9(9):CD010403. doi: 10.1002/14651858.CD010403.pub2. Update in: Cochrane Database Syst Rev. 2018 Aug 10; 8:CD010403. doi: 10.1002/14651858.CD010403.pub3. PMID: 30095853; PMCID: PMC6513261.

11. McCarthy JG, Schreiber J, Karp N, Thorne CH, Grayson BH. Lengthening the human mandible by gradual distraction. Plast Reconstr Surg. 1992 Jan; 89(1):1-8; discussion 9-10. PMID: 1727238.

12. Marklund M. Starting Mandibular Advancement Device Therapy in Patients with Good Protrusive Capacity: A Randomized Pilot Study. Turk J Orthod. 2023 Sep 29; 36(3):158-164. doi: 10.4274/TurkJOrthod.2022.2022.54.