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An Overview of Class III Malocclusion (Prevalence, Etiology and Management)

Mohammad Jaradat[1*]

[1]*Department of Paedodontics and Orthodontics, Arab American University, Palestine.*

Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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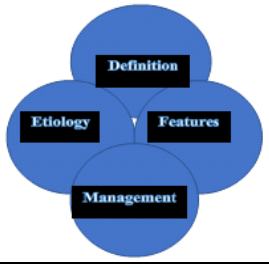
ABSTRACT

The prevalence of angle class III malocclusion varies greatly among and within populations, with the greatest incidence being seen among Asian people. The etiology of class III malocclusion is wide-ranging and complex, with both environmental and genetic contributions. A class III malocclusion can be of dental or skeletal origin, so it is crucial to classify the malocclusion accurately in order to manage it on a sound clinical basis. This article sheds the light on the best timing and management approach class III malocclusion that develops during the pre-pubertal and post-pubertal years.



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**Corresponding author: E-mail: mojaradat@hotmail.com;*

1. DEFINITION AND INCIDENCE OF CLASS III MALOCCLUSION

According to the British Standard Institute (BSI), the class III incisor relationship is defined as one in which the lower incisor edge lies anterior to the cingulum plateau of the upper incisors, with reduced or reversed overjet [1]. In terms of angle classification, a class III malocclusion is one in which the lower molar is mesially positioned relative to the upper molar, with no specifications with regard to the line of occlusion [2].

The prevalence of angle class III malocclusion varies greatly among and within populations (from 1% to more than 10%). The greatest incidence is found among Asian people [3]. Chinese and Malaysian populations show relatively higher prevalence of angle class III malocclusion (15.69% and 16.59%, respectively), while Indian populations show a relatively lower prevalence as compared to other races [4]. In the United States, the prevalence of class III malocclusion is only about 1% of the total population and only 5% of orthodontic patients [2].

2. ETIOLOGY OF CLASS III MALOCCLUSION

- The etiology of class III malocclusion is wide-ranging and complex. It is associated with both environmental and genetic factors, with a higher incidence being observed among the Asian population.

2. a Genetic factors: The most well-known example of inheritance is that of the Hapsburg royal family. The distinctive characteristics of this family included a prognathic lower jaw and hence a class III malocclusion. Out of the forty members of the family for whom records were available, thirtythree showed prognathic mandible and consequently a class III malocclusion [5]. Additionally, in 1970, Litton et al. studied the families of 51 individuals with class III anomalies. They concluded that class III characteristics were related to genetic inheritance in offspring and siblings [6].

2. b Environmental factors: A wide range of environmental factors have been suggested to contribute to the development of class III malocclusion. These include the ectopic eruption of the maxillary central incisor, enlarged tonsils, difficulty with nasal breathing, congenital anatomic defects, diseases of the pituitary gland (as in acromegaly) and the habit of protruding the mandible due to large tongue size or respiratory problems, which may lead to class III development [7,8].

3. FEATURES OF CLASS III MALOCCLUSION

ü *3.A- Sagittal dimension: Mandibular vs maxillary contribution*

Class III patients usually have a concave facial profile; this is due to the presence of either maxillary retrusion, mandibular protrusion or a combination of both problems. *Ellis and McNamara* found that a combination of maxillary retrusion and mandibular protrusion is the most common skeletal relationship (30%) found in class III patients, followed by maxillary retrusion and mandibular protrusion (19.5% and 19.1%), respectively [9].

Staudt & Killaridis (2009) found that 47.4% of class III patients had a purely mandibular contribution (either in position or size), while 19.3% had a purely maxillary contribution (either retruded position or size deficiency), and only 8.7% of the cases had contributions from both arches [10].

Baccetti, Reyes and McNamara studied gender differences among class III patients. They found that class III malocclusion was associated with a significant degree of sexual dimorphism in craniofacial parameters, especially from the age of thirteen onwards. Female subjects with class III malocclusion presented with significantly smaller linear dimensions in terms of the maxilla, mandible, and anterior facial heights as compared with male subjects during the circum-pubertal and post-pubertal periods [11].

Proff et al. found that mandibular length relative to anterior cranial base is increased in patients with class III skeletal growth patterns, while maxillary length is not consistently affected in those patients [12].

3.B- *Transverse dimension*

- Chen et al. analyzed the development of the dental arches and the skeletal mandibular-maxillary bases in untreated subjects withclass III malocclusions as compared with a class I control group. They measured the maxillary skeletal base width, biantegonial widths, and maxillary and mandibular inter-molar widths from cephalometric radiographs

at annual intervals between the ages of 10 and 14 years. They found that the maxillary skeletal base widths were statistically significantly smaller in the class III than in the class I group, while there were no statistically significant differences in biantegonial widths. However, the maxillary inter-molar widths were smaller in the class III group as compared with the class I group (statistically significant at all ages). The mandibular inter-molar widths showed no significant differences between the examined groups [13].

3. C- Vertical dimension

Regarding the vertical dimension of class III patients, *Staudt and Kiliaridis* found that that class III patients have more hyperdivergent vertical dimensions, with increased lower anterior facial heights [10].

Baccetti et al. found that increases in the vertical facial dimensions in class III subjects occurred not only at the pubertal growth spurt (corresponding with the eruption of the canines and premolars) but also at late developmental stages (corresponding with the complete eruption of the second and third molars) [14].

4. D Dental features

In skeletal class III patients, the teeth tend to compensate for the sagittal skeletal discrepancy between both arches. The maxillary incisors are proclined in 42.1% of cases, while the mandibular incisors are retroclined in 26.3%-68.4% of the cases [15,16].

4. MANAGEMENT OF CLASS III MALOCCLUSION

It is well-known that the accurate and thorough diagnosis of any malocclusion is critical in its management. Class III malocclusion can be of dental or skeletal origin, so it is crucial to classify the malocclusion accurately in order to manage it on a sound clinical basis.

4. a- *Pseudo class* III *malocclusion*

Pseudo-class III malocclusion is defined as an anterior crossbite resulting from a forward mandibular displacement [17]. *Giancotti* et al. found a 2-3% incidence of pseudo-class III among 7,096 Chinese children [18]. Usually, the upper incisors are retroclined, while the lower incisors are at a normal inclination. The sagittal relationship is usually class I or mild class III. The soft tissue profile is straight in terms of the centric relationship but concave when the mandible is habitually displaced anteriorly [19].

Pseudo-class III malocclusion can result from dental factors, such as an ectopic eruption of the maxillary permanent central incisors, or from functional factors, such as large tongue, tongue positioning and airway problems. Additionally, it can be the result of skeletal factors, such as the presence of minor transverse maxillary deficiency [19].

Early intervention is mandatory for many reasons, including the prevention of the traumatic occlusion of the lower incisors, which may lead to the development of periodontal problems; the prevention of true class III malocclusion and also providing enough space for the erupting permanent maxillary canines by proclining the upper incisors [19].

Fig. 1 shows a pseudo-class III malocclusion that was treated via a 2x4 fixed orthodontic appliance to obtain a class I incisor relationship and provide enough space for the crowded upper permanent canines.

The following figures (Figs. 2 and 3) shows a pseudo-class III malocclusion treated via an upper removable appliance with a double cantilever spring.

Fig. 4 shows a pseudo-class III malocclusion treated with a fixed orthodontic appliance.

4. b Mandibular prognathism (orthopedic management)

The chin cup, which is regarded as the oldest orthodontic appliance for the management of class III malocclusion, has been used in patients with mandibular prognathism prior to the occurrence of puberty. A complete and deep investigation of the literature revealed controversies regarding both its appropriate use and clinical effectiveness.

The ideal age for the use of a chip cup varies from 4 [20] to 14 [21] years. Patient sex should also be taken into consideration because females mature earlier than males. Force magnitude should be small in young patients [22,23] and be increased gradually. The suggested force at the center of the chin cup ranges from 150 grams [20] to 1,200 grams [24].

Various protocols regarding daily wearing time have been suggested, ranging between 8 [20]

and 18 hours [25]. The clinical results of the chin cup are a subject of debate. Some authors have suggested the retardation or restriction of mandibular growth, [26,23,27] while many other orthodontists have questioned such effects. [22,21,28,29] Most recently, *De clerck and Proffit* found that the catch-up growth of the mandible after early chin cup treatment tended to reverse any improvement gained during the pre-pubertal treatment phase [30].

Fig. 1-A. Pseudo-class III malocclusion

Fig. 1-B. 2x4 fixed orthodontic appliance

Fig. 1-C, D. Space has been created for the permanent canines

Fig. 2-A. pretreatment photographs **Fig. 2-B. post treatment photograph**

Fig. 3-A. lateral profile view

Fig. 3-B. Frontal view

Fig. 3-C. Intraoral right-side view (class I molar)

Fig. 3.D. Intraoral left side view (class I molar)

Fig. 3-E. post treatment frontal photograph

Fig. 4- A. pretreatment photographs

Fig. 4-B. during treatment photograph

Fig. 5-A. Pretreatment photographs

Fig. 5-B. Patient wearing the chin cup

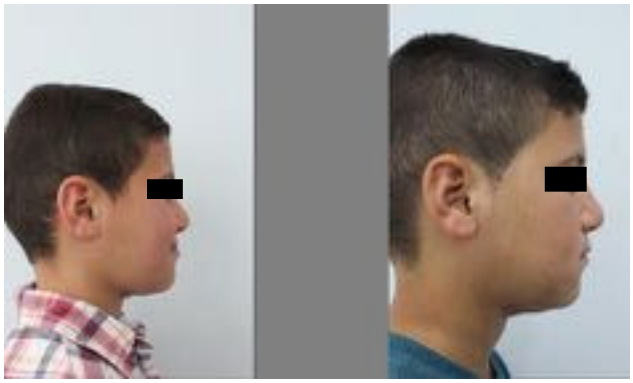

Fig. 5-C. Post treatment photograph

Fig. 6-A. Lateral view of a class III patient with retrognathic maxilla

Fig. 6-B. Frontal photograph of the patient

Fig. 6-C. Pretreatment lateral cephalometric view

Fig. 6-D. Reverse-pull headgear

Fig 6-E. Post-treatment occlusion

Fig. 6- F. Post-treatment profile

Chatzoudi et al. found that there was an increase in the vertical growth pattern, anterior face height and/or the posterior rotation of the mandible following the use of a chin cup appliance [31]. Fig. 5 shows a class III patient with mandibular prognathism who was treated via a chin cup appliance.

Regarding the effect of the chin cup on the temporomandibular joint, Wendl et al. recently found that early chin cup treatment was not observed to have an adverse impact on the temporomandibular joints [32].

Fig. 7-A. Pretreatment photograph

Fig. 7-B. Post-treatment photograph

4.C Maxillary deficiency (early orthopedic management)

Patients with retrognathic maxilla are best treated with reverse-pull headgear at an eary age. Guyer et al. reported that about 57% of white children with either a normal or a prognathic mandible showed a deficiency in the maxillary arch [33]. Regarding the ideal treatment timing, *Merwin* et al. suggested that a similar skeletal response can be obtained when maxillary protraction was begun either before the age of 8 (5 to 8 years) or after the age of 8 years (8 to 12 years) [34]. In contrast, *Kim* et al. and *Wells et al.* found that protraction headgear was less effective in patients older than 10 years of age [35,36].

Regarding the stability of the results, *Wells* et al. found that when reverse-pull headgear treatment was used in early mixed dentition, a positive overjet was maintained in the long term in 70%-75% of the treated cases, while 25%-30% of cases relapsed into reverse overjet, mostly due to the late horizontal growth of the mandible. These researchers also found that up to the age of 10 years, the time at which RPHG therapy began did not appear to be a major factor in determining long-term success [36]. Fig. 6 shows an 8-years-old class III patient with maxillary deficiency who was successfully treated with a reverse-pull headgear appliance.

- **Use of titanium miniplates in cases of maxillary deficiency**

Recently, miniplates have been used in the orthopedic management of class III patients with maxillary deficiency. The aim of using these miniplates in maxillary deficiency cases is to permit equivalent, favorable skeletal changes without the unwanted dento-alveolar effects (proclination of maxillary incisors and retroclination of mandibular incisors) [37].

The success rate of miniplates depends on the surgical procedure used and the thickness and quality of the bone. Because the thickness and the density of the bone in the infrazygomatic crest may be insufficient for the mechanical retention of the osteosynthesis screws, the most stable skeletal anchorage can be obtained in children at least 11 years old.

The failure rate in the mandible is lower than in the maxilla because the density and thickness of the external cortical bone are higher than those of the infrazygomatic crest [30].

De clerck et al. studied the dento-facial effects of bone-anchored maxillary protraction and found that both the overjet and molar relationship were improved significantly, without any significant change in maxillary incisor inclination. There was significant improvementin the soft tissue variables, by about 4 mm as compared to untreated controls [37].

Sar et al. found that miniplate protraction with either a facemask or class III elastics had significant effects as compared with an untreated control group. They found that the maxilla moved forward by 3.11 mm in the facemask group and by 3.82 mm in the class III group. Regarding the counterclockwise rotation of the maxilla, this was significantly less in the facemask group as compared with the class III elastics group, which means that the miniplate-with-facemask protocol is indicated in patients with severe maxillary deficiency and a high-angle vertical pattern, while miniplates with Class III elastics are indicated in patients with a decreased or normal vertical dimension and retroclined lower incisors [38]. Similar effects were found by Al Naggar et al. with greater skeletal advancement of the maxilla (4.87 mm in the facemask group and 5.81 mm in the class III elastics group) [39].

4.D Camouflage treatment approach for class III malocclusion

Fully grown class III patients can be treated via either orthognathic surgery or camouflage approaches. Patients with mild skeletal class III malocclusion can benefit from orthodontic camouflage with class III elastics. This treatment is usually suitable for patients with a deep overbite and a low mandibular plane angle because the class III elastics (running from the lower canine to the upper first permanent molar) extrude the upper molars, resulting in the clockwise rotation of the mandible and thus an increased lower anterior face height. Additionally, these elastics procline the maxillary incisors and retrocline the mandibular incisors [40]. Fig. 7 shows the case of a class III malocclusion that was treated on a non-extraction basis, with space closure and the retraction of the lower incisors into a class I relationship.

Patients with a moderate class III skeletal relationship may benefit from the extraction of mandibular teeth. The extraction pattern may involve the lower premolars or incisors. The extraction of a mandibular incisor is occasionally indicated for patients with an anterior cross-bite or an edge-to-edge incisor relationship. The factors that determine the extraction choice include the amount of negative overjet and the degree of crowding in the lower arch [41]. Fig. 8 shows a class III malocclusion case with moderate crowding that was treated with a two-unit extraction (lower first premolars) approach.

Faerovig and Zachrisson studied the effects of lower incisor extraction on anterior occlusion in adult class III patients. They found that the lower incisors tipped lingually by about 6 degrees, which resulted in increased overjet. Overbite was also increased by about 0.6 mm for both the central and lateral incisors. Lower incisor extraction resulted in a decrease in the inter-canine width by about 3.3 mm (SD, 2.0 mm), while no change was found in inter-molar width following extraction therapy [42].

4.E- Orthognathic surgery

Non-growing patients with severe skeletal class III malocclusion are best treated with a combined orthodontic and surgical approach. Accurate patient selection is the major issue in diagnosis and treatment planning. *Kerr et al.* attempted to establish some cephalometric yardsticks in adult patients with class III malocclusion and thus determine objective criteria for the various treatment options. These researchers suggested that surgery should be performed for patients with the following characteristics:

- An ANB angle of less than -4 degrees,
- a maxillary/mandibular (M/M) ratio of 84%,
- an inclination of the lower incisors to the mandibular plane of 83 degrees
- and a Holdaway angle of 3.5 degrees [43].

Stellzig-Eisenhauer et al. (2002) found that the WIT's appraisal was the most decisive factor in discriminating between the surgical and non-surgical class III groups, with the surgical group having a WIT appraisal value of (-12.2 ± 4.3 mm) and the non-surgical group having a WIT appraisal value of (-4.6 ± 1.7 mm) [44].

Regarding the timing of surgery, *Battagel* found that the maximum change in facial characteristics occurred between the average ages of eleven and twelve years but that these changes continued after the age of fifteen years in females. On the other hand, class III male faces showed their greatest increments of growth between the ages of fourteen and seventeen years [45].

Fig. 8-A. Pretreatment photograph

Fig. 8-B. Photo taken during treatment

Fig. 8-C. Post-treatment photograph

Common surgical movements include maxillary advancement and mandibular setback or combination of both movements in cases of severe class III malocclusion with a huge negative overjet. *Kitagawa* et al. suggested that patients in whom significant mandibular setback surgery was performed would have a higher risk of breathing problems while asleep [46]. Currently, the two-jaw-surgery approach is becoming more popular than the single-jaw-surgery approach because facial appearance is improved if concurrent maxillary advancement allows for smaller mandibular setback [47,48, 49].

Regarding the stability of surgical movements, *Proffit* et al. stated that in order to minimize relapse, the amount of mandibular setback should be reduced because of simultaneous maxillary advancement [50]. Jakobson et al. found that mandibular setback was not as important as maxillary stability [51].

5. CONCLUSION

ü The thorough examination and diagnosis of class III malocclusion patients are mandatory for its management. Patient gender, age, complaints and malocclusion severity are key factors in determining the best treatment modality.

ü Variations are present in the long-term stability of the various growth modification approaches to class III malocclusion.

ü The use of titanium miniplates permitted equivalent, favourable skeletal changes, without unwanted dento-alveolar effects.

ü Non-growing patients with severe skeletal class III malocclusion are best treated with combined orthodontic and surgical intervention.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. British Standards Institute. Glossary of Dental Terms (BS 4492). London: BSI; 1983.
2. Graber TM, Vanarsdall RL, Vig KWL. Orthodontics. Current Principles and Techniques,4rth ed. St Louis: Mosby. 2005;565.
3. Ideshi Ishii, Shuichi Morita, Yutaka Takeuchi, Shinji Nakamura. Treatment effect of combined maxillary protraction and chincap appliance in severe skeletal Class III cases. A AmJ Orthod Dentofacial Orthop. October. 1987;92(4):304–312.
4. Soh J, Sandham A, Chan YH. Occlusal status in Asian male adults: Prevalence and ethnic variation. Angle Orthod. 2005; 75:814-820.
5. Jacobson A, Evans WG, Preston CB, Sadowsky PL. Mandibular prognathism. Am J Orthod. 1974;66:140-71.
6. Litton SF, Ackermann LV, Isaacson RJ, Shapiro BL. A genetic study of class 3 malocclusion. Am J Orthod. 1970;58:565-77.
7. Akosi T, Schilli W. Class III anomalies: A coordinated approach to skeletal, dental, and soft tissue problems. J Oral Surg. 1981;39:860-70.
8. Proffit, William R, Henry W. Fields, David M. Sarver. Contemporary orthodontics. 6th ed. St. Louis, Mo: Elsevier/Mosby; 2013.
9. Ellis E, McNamara JA Jr. Components of adult class III malocclusion. J Oral Maxillofac Surg. 1984;42(5):295-305.
10. Staudt CB, Kiliaridis S. Different skeletal types underlying Class III malocclusion in a random population. Am J Orthod Dentofacial Orthop. 2009;136(5):715-721.
11. Baccetti T, Reyes BC, McNamara JA Jr. Gender differences in class III malocclusion. Angle Orthod. 2005;75(4): 510-20.
12. Proff P, Will F, Bokan I, Fanghänel J, Gedrange T. Cranial base features in skeletal class III patients. Angle Orthod. 2008;78(3):433-9.
13. Chen F, Terada K, Yang L, Saito I. Dental arch widths and mandibular-maxillary base widths in class III malocclusions from ages 10 to 14 . Am J Orthod Dentofacial Orthop. 2008;133(1):65-9.
14. Baccetti T, Reyes BC, McNamara JA Jr. Craniofacial changes in class III malocclusion as related to skeletal and dental maturation. Am J Orthod Dentofacial Orthop. 2007;132(2):171.
15. Bhatia SN, Leighton BC. A manual of facial growth. A computer analysis of longitudinal cephalometric growth data. Oxford, United Kingdom: Oxford University Press; 1993.
16. Behrents RG. An atlas of growth in the aging craniofacial skeleton. Monograph 18. Craniofacial Growth Series. Ann Arbor: Center for Human Growth and Development, University of Michigan; 1985.
17. Rabie AB, Gu Y. Diagnostic criteria for pseudo-class III malocclusion. Am J Orthod Dentofacial Orthop. 2000;117(1):1-9.
18. Giancotti A, Maselli A, Mampiere G, Spano E. Pseudo-class III malocclusion treatment with Balters' Bionator. Journal of Orthodontics. 2003;30:203-21.
19. Kumar SA, Shetty KS, Prakash AT. Pseudo class III diagnosis and simplistic treatment. Journal of Indian Orthodontic Society. 2011;45(4):198-201.
20. Barrett AA, Baccetti T, McNamara JA. Treatment effects of the light-force chincup. Am J Orthod Dentofacial Orthop. 2010;138:468–76.
21. Sugawara J. Clinical practice guidelines for developing class III malocclusion. In: Nanda R, editor. Biomechanics and Esthetic Strategies in Clinical Orthodontics. US: Saunders. 2005;211–63.
22. McNamara JA. Treatment of patients in the mixed dentition. In: Graber TM, Vanarsdall RL, Vig KWL, editors. Orthodontics: Current Principles and Techniques. China: CV Mosby. 2005;543–77.
23. Ngan P. Treatment of class III malocclusion in the primary and mixed dentitions. In: Bishara ES, editor. Textbook

of Orthodontics. US: Saunders. 2001;375–414.

24. Abdelnaby YL, Nassar EA. Chin cup effects using two different force magnitudes in the management of class III malocclusions. Angle Orthod. 2010;80: 957–62.
25. Gökalp H, Kurt G. Magnetic resonance imaging of the condylar growth pattern and disk position after chin cup therapy: A preliminary study. Angle Orthod. 2005;75: 568–75.
26. Deguchi T, McNamara JA. Craniofacial adaptations induced by chin cup therapy in class III patients. Am J Orthod Dentofacial Orthop. 1999;115:175–82.
27. Tuncer BB, Kaygisiz E, Tuncer C, Yüksel S. Pharyngeal airway dimensions after chin cup treatment in class III malocclusion subjects. J Oral Rehabil. 2009;36:110–17.
28. Oppenheim A. A possibility for physiologic orthodontic movement. Am J Orthod OralSurg. 1944;30:345–6.
29. Thilander B. Chin-cap treatment for angle class III malocclusion. Report of the congress. European Orthodontic Society. 1965;41:311–27.
30. De Clerck HJ, Proffit WR. Growth modification of the face: A current perspective with emphasis on Class III treatment. Am J Orthod Dentofacial Orthop. 2015;148(1):37-46.
31. Chatzoudi MI, Marathiotou II, Papadopoulos MA. Clinical effectiveness of chin cup treatment for the management of class III malocclusion in pre-pubertal patients: A systematic review and meta-analysis. Prog Orthod. 2014;15(1):62.
32. Wendl B, Stampfl M, Muchitsch AP, Droschl H, Winsauer H, Walter A, Wendl M, Wendl T. Long-term skeletal and dental effects of facemask versus chincup treatment in class III patients: A retrospective study. J Orofac Orthop. 2017; 78(4):293-299.
33. Guyer EC, Ellis EE, McNamara JA Jr, Behrents RG. Compo- nents of class III malocclusion in juveniles and adolescents. Angle Orthod. 1986;56:7-30.
34. Merwin D, Ngan P, Hagg U, Yiu C, Wei SH. Timing for effective application of anteriorly directed orthopedic force to the maxilla. Am J Orthod Dentofacial Orthop. 1997;112(3):292-9.
35. Kim JH, Viana MA, Graber TM, Omerza FF, BeGole EA. The effectiveness of protraction face mask therapy: A meta-analysis. Am J Orthod Dentofacial Orthop. 1999;115(6):675-85.
36. Wells AP, Sarverb DM, Proffitc WR. Long-term efficacy of reverse pull headgear therapy. Angle Orthodontist. 2006;76(6).
37. De Clerck H, Cevidanes L, Baccetti T. Dentofacial effects of bone-anchored maxillary protraction: A controlled study of consecutively treated class III patients. Am J Orthod Dentofacial Orthop. 2010;138(5): 577-81.
38. Sar C, Sahinoğlu Z, Özçirpici AA, Uçkan S. Dentofacial effects of skeletal anchored treatment modalities for the correction of maxillary retrognathia. Am J Orthod Dentofacial Orthop. 2014;145(1):41-54.
39. Elnagar MH, Elshourbagy E, Ghobashy S, Khedr M, Kusnoto B, Evans CA. Three-dimensional assessment of soft tissue changes associated with bone anchored maxillary protraction protocols. Am J Orthod Dentofacial Orthop. 2017; 152(3):336-347.
40. Park JH, Joseph Yu, and Ryan Bullen. Camouflage treatment of skeletal class III malocclusion with conventional orthodontic therapy. Am J Orthod Dentofacial Orthop. 2017;151:804-11.
41. Ngan P, Moon W. Evolution of class III treatment in orthodontics. Am J Orthod Dentofacial Orthop. 2015;148(1):22-36.
42. Faerovig E, Zachrisson BU. Effects of mandibular incisor extraction on anterior occlusion in adults with Class III malocclusion and reduced overbite. Am J Orthod Dentofacial Orthop. 1999;115(2): 113-24.
43. Kerr WJ, Miller S, Dawber JE. Class III malocclusion: Surgery or orthodontics? Br J Orthod. 1992;19:21-24.
44. Stellzig-Eisenhauer A, Lux CJ, Schuster G. Treatment decision in adult patients with class III malocclusion: Orthodontic therapy or orthognathic surgery? Am J Orthod Dentofacial Orthop. 2002;122(1):27-37.
45. Battagel. The etiological factors in class III. Eur J ortho.1993;15:347-370.
46. Kitagawara K, Kobayashi T, Goto H, Yokobayashi T, Kitamura N, Saito C. Effects of mandibular setback surgery on oropharyngeal airway and arterial oxygen saturation. Int J Oral Maxillofac Surg. 2008;37:328-33.
47. Bailey LJ, Proffit WR, White RP Jr. Trends in surgical treatment of class III

skeletal relationships. Int J Adult Orthod Orthognath Surg. 1995;10: 108-18.
48. Johnston C, Burden D, Kennedy D, Harradine N, Stevenson M. Class III surgical-orthodontic treatment: A cephalometric study. Am J Orthod Dentofacial Orthop. 2006;130:300-9.
49. Proffit WR, White RP Jr. Surgical-orthodontic treatment. St Louis: Mosby; 1991.
50. Proffit WR, Phillips C, Turvey TA. Stability after mandibular setback: Mandible-only versus 2-jaw surgery. J Oral Maxillofac Surg. 2012;70:e408-14.
51. Jakobsone G, Stenvik A, Sandvik L, Espeland L. Three-year follow- up of bimaxillary surgery to correct skeletal Class III malocclusion: Stability and risk factors for relapse. Am J Orthod Dentofacial Orthop. 2011;139:80-9.

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