International Journal of Dentistry Scientific
Volume 1, Issue 2, Page 113-123, June 2024
p-ISSN: 3031-7142

CLEAR ALIGNER IN CLASS II MALOCLUSION
(Systematic Literature Review)

Ananda Hanny Savitri[1], **Rosada Sintya Dwi[2]***, Sekar Putri[3]

[1]Dentistry Program, Faculty of Medicine, Universitas Sriwijaya, Palembang-South Sumatera, Indonesia
[2,3]Dr.Mohammad Hoesin Government Hospital, Palembang-South Sumatera , Indonesia
*Correspondence author email: rosadasintyadwi@fk.unsri.ac.id

Article info: Received: 14-3-2023; Revised: 15-4-2023; Accepted: 12-6-2024; Publish: 30-6-2024

Abstract : Background: Malocclusion is an occlusion disorder of teeth and jaws that can interfere the function of the mouth. Class II angle malocclusion can be treated using removable orthodontic appliances, such as a clear aligner. The use of clear aligners causes less pain and discomfort compared to fixed orthodontic appliances. Clear aligner treatment aims to achieve dentofacial esthetics, functional and stable treatment results. Objective: The purpose of this study was to observe whether clear aligner treatment is effective to use in Angle class II malocclusion. Methods: This systematic literature review journals were selected through Google Scholar, PubMed, and Science Direct (2014-2023) databases which are published in English. Articles that met the inclusion and exclusion criteria were assessed using the CASP bias assessment, then summarized and analyzed to obtain the demographic data and changes that occurred based on cephalometric analysis. Results: This systematic literature review used ten journals consisting of case-control and case-report studies with low-bias research results in one journal and high-bias research in nine journals. All journals in this systematic literature review stated that there were dentoalveolar changes after the use of a clear aligner. Conclusion: There are corrected malocclusion changes in Angle class II malocclusion patients after the use of clear aligner treatment using auxiliary.

Keywords*: clear aligners, Angle class II malocclusion, cephalometry*

INTRODUCTION

Malocclusion is a deviation from normal occlusion of the teeth and jaw that can interfere with the function of the mouth, including the functions of speaking, swallowing, and chewing, and has an impact on dentofacial aesthetics.[1,2] According to the World Health Organization (WHO), malocclusion ranks third in the prevalence of dental and oral health diseases.[3] The causes of malocclusion can be genetic, environmental, or a combination of genetics and environment.[4]

According to Angle, the ideal occlusion exists when the mesiobuccal cusp of the maxillary first molar occludes with the sulcus located between the mesial and distal cusps of the mandibular first molar. Based on this position, Angle classified malocclusion into three, which are Angle class I, II, and III, with class II divided into two divisions.[2] When treating malocclusion, fixed or removable orthodontic

appliances can be used. Treatment using removable orthodontic appliances is easier, especially for children, because patients can easily maintain good oral hygiene and thus avoid caries.[5] One removable orthodontic device that can be used for the treatment is clear aligner. The use of a clear aligner results in better aesthetic, oral hygiene, and periodontal status and is reported to cause less pain and discomfort when compared to the use of fixed orthodontic appliances.[6]

Several researchers state that the use of clear aligner is effective in cases of moderate malocclusion. According to research by Dhanasekaran M et al. and Eshky RT, it is stated that the use of clear aligners in cases of Angle class II malocclusion provides satisfactory aesthetic and functional results.[7,8] Meanwhile, according to research by Patterson BD et al., the use of clear aligner in cases of Angle class II malocclusion did not provide any significant effect.[9] Based on the two different opinions, it is necessary to conduct further studies on the effectiveness of clear aligner in cases of Angle class II malocclusion.

METHODS

This research is a systematic literature review with qualitative analysis. The population studied is Angle class II malocclusion patients with various genders, races, and economic backgrounds in hospitals or other health facilities, and the exposure used was clear aligners. The journals used in this research were taken from three databases, such as Google Scholar, PubMed, and Science Direct over the last 15 years. The types of research used in this systematic literature review are case-control and case-report that meet the inclusion and exclusion criteria. The risk of bias assessment was the Critical Appraisal Skills Program (CASP).

RESULTS

The literature search began on December 15, 2022 – June 2023 in three databases: Google Scholar, PubMed, and Science Direct. The review was conducted by PRISMA (Preferred Reporting Item for Systematic Review and Meta-Analysis) guidelines. The PRISMA diagram shows that 168 journals have been extracted through the specified search strategy, with 9 journals being duplicates. Journals were selected according to the inclusion criteria and 138 journals were not included because they were not relevant to the research and did not meet the inclusion criteria. Out of all the 21 articles obtained, 11 articles did not include cephalometric analysis and were excluded, leaving 10 journals. The 10 journals included were synthesized qualitatively and assessed independently using the Critical Appraisal Skills Program (CASP) bias assessment.

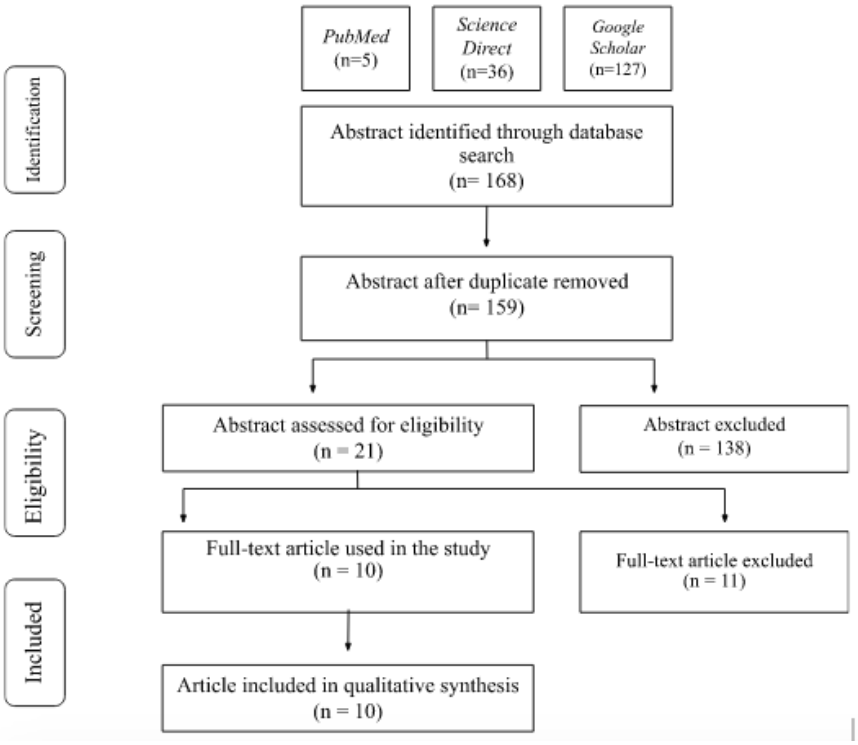

Figure 1. PRISMA flow diagram

Table 1 and Table 2 show changes that occur in patients with class II Angle malocclusion based on six cephalometric analysis that are used. The total subjects from all the journals that have been analyzed are 46 patients. All journals obtained showed the same result, which is the correction of malocclusion in Angle class II malocclusion patients.

Table 1. Data Before Treatment

Researcher, Year Published	Types of Research	Demographic Data			*Pre-treatment*					
		Group	Average Age (years)	Gender (M, W)	SNA (°)	SNB (°)	ANB (°)	U1-PP (°)	IMPA (°)	Wits (mm)
Lombardo *et al*, 2023[29]	*Case-control*	M	11.2	9,12	82.2± 2.6	76.0 ±2.0	5.4 ±1.4	112.0 ±9.6	100.2 ±9.0	2.7 ±1.8
		C	10.9	4,11	81.7± 2.7	75.5± 2.5	6.0± 1.4	112.2 ±6.1	97.1± 7.3	2.7 ±2.7
Lombardo *et al*, 2022[30]	*Case-report*	M	14	1,0	84.5	79.0	5.4	107.7	96.3	1.3
Lombardo *et al*, 2018 [26]	*Case-report*	M	18	1,0	79.0	72.0	7.0	118.0	92.5	4.7
Arreghini *et al*, 2014 [31]	*Case-report*	M	11	1,0	79.8	73.6	6.3	103.6	97.7	3.6

Palone *et al*, 2021[32]	*Case-report*	M	27	0,1	79.2	73.8	5.5	118.3	97.0	2.1
Palone *et al*, 2022[33]	*Case-report*	M	12	0,1	82.5	77.8	4.7	109.0	94.1	6.3
		M	40	0,1	79.1	74.6	3.7	105.4	95.0	2.5
Gudhimella *et al*, 2022[34]	*Case-report 1*	M	26	0,1	84.0	76.2	7.9	102.4	96.6	4.7
Palone *et al*, 2022 [35]	*Case-report*	M	34	0,1	78.0	67.1	10.9	116.7	96.6	11.5
Cassetta *et al*, 2020[36]	*Case-report*	M	13	1,0	87.7	81.1	6.7	103.0	89.9	5.6
Palone *et al*, 2022[37]	*Case-report*	M	22	0,1	82.1	81.3	0.9	101.2	99.9	1.5

M: Angle class II malocclusion, C: Control, M: Man. W: Woman

Table 2. Data After Treatment

Researcher, Year Published	**Types of Research**	**Demographic Data**			***Post-treatment***					
		Group	**Average Age (years)**	**Gender (M, W)**	**SNA (°)**	**SNB (°)**	**ANB (°)**	**U1-PP (°)**	**IMPA (°)**	**Wits (mm)**
Lombardo *et al*, 2023[29]	*Case-control*	M	11.2	9,12	81.8±2.6	77.4±3.2	3.9±1.5	111,6±2.6	101.4±3.2	1.9±2.4
		C	10.9	4,11	81±3.2	75.9±1.1	6.2±0.3	111.5±1.5	97.5±1.1	2.3±2.3
Lombardo *et al*, 2022[30]	*Case-report*	M	14	1,0	84.5	80.8	3.6	108	99.9	1.4
Lombardo *et al*, 2018 [26]	*Case-report*	M	18	1,0	81	74.8	6.2	111	96.5	4
Arreghini *et al*, 2014 [31]	*Case-report*	M	11	1,0	78	74.1	3.8	101.9	105.6	-1.6
Palone *et al*, 2021[32]	*Case-report*	M	27	0,1	70.3	73.7	5.7	106	96.2	4.8
Palone *et al*, 2022[33]	*Case-report*	M	12	0,1	82.9	80.2	2.7	117	95	-1.3
		M	40	0,1	79.7	75.3	4.4	100.2	105.6	3.3

Gudhimella *et al*, 2022[34]	*Case-report 1*	M	26	0,1	83.4	76.8	6.6	97.7	100.4	0.8
Palone *et al*, 2022[35]	*Case-report*	M	34	0,1	76.1	67.8	8.3	100.8	104.2	8.7
Cassetta *et al*, 2020[36]	*Case-report*	M	13	1,0	87.1	81.3	5.8	98.6	95.6	2.1
Palone *et al*, 2022[37]	*Case-report*	M	22	0,1	82.7	81	1.7	104.2	102.4	1.4

M: Class II Angle malocclusion, C: Control, M: Man. W: Woman

DISCUSSION

All the journals used in this study show that correction of malocclusion occurs in class II Angle malocclusion patients with the use of clear aligner. As time goes by, the scope of the use of clear aligners is expanding. Limitations of tooth movement such as extrusion, correction of severe tooth rotation, molar transition, post-extraction space closure, and other complex cases can be achieved with the use of assistive devices in the clear aligner system.[11] All journals discussed in this literature review have research methods using attachments and devices. The tools used are class II elastics, buttons, mini-screws, and NiTi wire. Apart from the use of assistive devices, one journal reported clear aligner treatment that was preceded by a surgical procedure using the piezocision technique, and two journals reported clear aligner treatment that was preceded by treatment using assistive devices before treatment using clear aligners.[21,24,25]

The use of a removable clear aligner is affected and depends on patient motivation and compliance. For the device to be effective, the use of a clear aligner must be done for 22 hours per day.[12] This systematic literature review focuses on corrected class II Angle malocclusion as assessed using cephalometric measurements. In all journals, there are six variables that will be used to determine the results, which are SNA, SNB, ANB angle, Wits analysis, U1-PP, and IMPA. The SNA, SNB, and ANB angles are used to measure skeletal angles, Wits analysis is used to measure linear distances of skeletal relationships, while U1-PP and IMPA are used to measure dental and the relationship between the teeth of the upper and lower jaw.[10,15]

The SNA angle evaluates the position of the maxilla to the anterior cranial base.[10,15] A total of six journals showed a decrease in the SNA angle value, three journals showed an increase in the SNA angle value, and one journal showed a constant SNA angle value. The average decrease in the SNA angle value that occurred in the clear aligner group was -0.8°, while in the control group, which did not receive treatment, it was -0.7°. Historically, clear aligners did not have the

potential to correct the SNA angle and required pretreatment such as headgear, bionator, twin-block, or Herbst.[29] The changes that occur in the SNA angle are the impact of dental changes, this is in accordance with research by Caruso et al., where changes occur due to a reduction in torque movement on the upper anterior teeth, which allows optimization of the maxilla.[27] The increase in the SNA angle value occurs because the SNA angle value is in the normal range, which is close to the normal value. In journals with SNA angle values that do not change, it is explained in the research of Lombardo et al. that patients with class II skeletal malocclusion have maxillary growth that can only be inhibited and cannot be reduced.[16,18,19,20,28]

The SNB angle is used to indicate the position of the mandible to the anterior cranial base.[10] A total of seven journals showed an increase in the SNB angle value, and two journals showed a decrease in the SNB angle value. The average increase in the SNB angle value that occurred in the clear aligner group was quite significant, namely +1.7°, while in the control group, where no treatment was carried out, it was -0.4°. Treatment with clear aligner uses the principle of mechanical inclination to guide mandibular advancement. This is supported by the research conducted by Lombardo et al. and Ravera et al., which state that the mechanism of the clear aligner allows a force to move the mandible anteriorly.[17,31,32] This statement is also in accordance with research by Caruso et al., which states that the inclination plane mechanism in the clear aligner pushes the mandible to move forward, which causes correction of mandibular retrusion.[26] The decrease in the SNB angle value occurred because patients did not fully comply with the protocol for using class II elastics.[25] The use of class II elastics plays a role in increasing the biomechanical efficiency of treatment with clear aligners and is recommended to be used full-time from the start of treatment.[30]

The ANB angle is the difference between the SNA angle and the SNB angle.[26] A total of eight cases showed a decrease in the ANB angle value, and three cases showed an increase in the ANB angle value. The average decrease in the ANB angle value in the clear aligner group was quite significant, which is -1.6°, while in the control group, where no treatment was carried out, it was -0.2°. In research conducted by Lombardo et al., the decrease in ANB angle shows the effectiveness of clear aligners in pushing the mandible to an anterior position.[17] Apart from that, the decrease in the ANB angle is also influenced by point A and point B which form the ANB angle.[34] Based on research conducted by Sun et al., clear aligner can control the torque of the maxillary anterior teeth, thereby encouraging backward movement of point A.[32] In cases with an increase in the ANB angle stated by Palone et al. in their research, an increase in the ANB angle value occurred due to a lack of patient compliance in carrying out the treatment protocol using class II elastics.[25]

U1 to palatal plane represents the angle formed by the relationship of the maxillary incisor to the palatal plane (ANS to PNS) of the maxilla.[16] A total of eight journals showed a decrease in the U1-PP angle value, and two journals showed an increase in the U1-PP angle value. The average decrease in the U1-PP that occurred

in the clear aligner group was quite significant, namely -5.45°, while in the control group, which did not receive treatment, it was -0.7°. This is explained in the research of Caruso et al., who stated that clear aligners have a biomechanical function to control the inclination of the maxillary incisors because of their structure surrounding the surface of the tooth crown when compared with the control group.[28] A change in the inclination of the maxillary anterior teeth at the U1-PP angle allows a change in the SNA angle. Journals that show an increase in the value of the U1-PP angle have an inclination angle below the normal range that is close to the normal range.[18]

Incisor Mandibular Plane Angle (IMPA) determines the position of the mandibular incisor to the mandibular plane.[14] All the journals studied showed an increase in IMPA angle values after using clear aligners. The average increase in the IMPA angle value that occurred in the clear aligner group was quite significant, namely 4.6°, while in the group without treatment it was 0.4°. In the research of Lombardo et al., it is stated that the clear aligner produces good control over the inclination of the mandibular incisors, where the clear aligner is able to correct the correct inclination of the incisor teeth, thereby reducing overjet.[17,29] In their research, Lombardo et al. explained that the IMPA angle value increased due to good anchorage control of the clear aligner, followed by patient compliance in carrying out the treatment protocol.[18]

Wits analysis is a measurement used to see the relationship of the maxilla and mandible in the anteroposterior plane.[14] A total of nine cases showed a decrease in the Wits analysis value, and two cases showed an increase in the Wits analysis value. The average decrease in the Wits analysis value that occurred in the clear aligner group was quite significant, namely -2.3°, while in the control group, where no treatment was carried out, it was -0.4°. The decrease in the value of Wits analysis occurs due to the working mechanism of mandibular advancement in the clear aligner, which allows point B to be moved anteriorly, thus improving the position of the mandible relative to the cranial base. This was stated in research conducted by Gurgel et al. and Ravera et al., namely that there is a decrease in the Wits analysis related to point B that moved anteriorly.[31,33] In the research of Lombardo et al., an increase in the Wits analysis value occurs because the patient has a normal Wits analysis value that is close to the normal range.[18,20]

The posttreatment outcomes indicate the response that occurs. The changes showed the same results, namely dentoalveolar and skeletal correction in patients with Angle class II malocclusion. Dentoalveolar changes, such as retroclination of the maxillary incisors and proclination of the mandible incisors, are the most important changes that occur as an effect of clear aligner in patients with Angle class II malocclusion. The results of the study by Lombardo et al. state that the movement caused is mostly dentoalveolar in nature, which then causes a slight decrease in the SNA angle, a slight increase in the IMPA angle, and retroclination of the maxillary incisors.[16] According to research done by Gudhimella et al.,

dentoalveolar changes can cause a decrease in mandibular plane, a decrease in lower facial height, and an increase in the SNB angle.[22] The skeletal changes that occur are changes in the SNB angle and point B which affect the changes in the ANB angle and Wits analysis. Treatment with clear aligner allows mandibular advancement to occur, where the position of the mandible moves forward with the help of auxiliary, such as class II elastics. Finally, according to research by Sun et al. clear aligner treatment not only corrects mandibular advancement but also gradually corrects the inclination of the anterior teeth and slightly aligns the anterior teeth.[32]

Arreghini et al. state that greater skeletal changes can be achieved if treatment is carried out during the patient's peak pubertal growth period.[18] Apart from that, it is also stated that skeletal correction can be achieved with the use of auxiliary, for example class II elastics. Also, Kim-Berman et al. reported that the mandible can move forward due to the use of elastics that are worn full-time.[27]

CONCLUSION

Clear aligner is effective in treating in class II malocclusion cases. Using the right attachments and devices can improve the effectiveness of aligner therapy.

RECOMMENDATIONS

1. Further research with a larger sample of class II malocclusion is necessary.
2. Further research is needed regarding the effectiveness of using clear aligners in class II malocclusion.
3. For class II malocclusion patient who are interested in using clear aligners, hopefully this study can be taken into consideration when selecting the orthodontic treatment by paying attention to the weaknesses and limitations of this study.

REFERENCES

1. Nelson, JS. Wheeler's Dental Anatomy, Physiology, and Occlusion. 10th Ed. Philadelphia: Sanders Elsevier; 2014. p. 74.
2. Cobourne, M. T., DiBiase, A. T. Handbook of orthodontics. 2nd Ed. Elsevier Science; 2015. p. 2-4, 209.
3. Lombardo, G, Vena F, Negri P, Pagano S, Barilotti C, Paglia L, et al. Worldwide Prevalence of Malocclusion in The Different Stages of Dentition: A Systematic Review and Meta-analysis. Eur J Paediatr Dent. 2020;21(2):115–122.
4. Anthony SN, Zimba K, Subramanian B. Impact of Malocclusions on the Oral Health-Related Quality of Life of Early Adolescents in Ndola, Zambia. Int J Dent. 2018.
5. Damaryanti E, Indrawati E, Firdausi A. Gambaran tingkat keparahan maloklusi pada pasien orthodonti antara tahun 2012-2015 dan 2015-2018 di RS Universitas Brawijaya menggunakan indeks ICON. E-Prodenta J Dent. 2019;3(2):240–8.

6. Ho C-T, Chao C-W, Kao C-T. Clinical Use of Contemporary Clear Aligner Therapy. Taiwan J Orthod. 2018;30(3):163–70.
7. Dhanasekaran D, Mani D, Thirunavukkarasu D, Tamizhmani D, Prasanth D, Rakshethaa D. Case report-An esthetic approach to treat class II subdivision malocclusion using clear aligners. Eur J Mol Clin Med. 2021;08(03).
8. Eshky RT. Orthodontic Correction of Class II Skeletal Malocclusion Complicated by Deep Bite Using Clear Aligners: A case report. J Taibah Univ Med Sci [Internet]. 2022;(xxxx):1-7. Available from: https://doi.org/10.1016/j.jtumed.2022.04.002
9. Patterson BD, Foley PF, Ueno H, Mason SA, Schneider PP, Kim KB. Class II malocclusion correction with Invisalign: Is it possible?. Am J Orthod Dentofac Orthop. 2021;159(1):41–8.
10. Premkumar S. Textbook of Orthodontics. New Delhi:Reed Elsevier;2015. p. 150-161, 175-190, 274-83.
11. Tamer I, Öztas E, Marsan G. Orthodontic treatment with clear aligners and the scientific reality behind their marketing: A literature review. Turkish J Orthod. 2019;32(4):241–6.
12. Kundal S. Aligners: The Science of Clear Orthodontics. Int J Dent Med Spec. 2020;7(1)
13. Nazir DSZ, Mushtaq DM. Incisor Mandibular plane Angle (IMPA), Frankfort Mandibular Plane Angle (FMA) and Lower Incisor to A-pog distance, and their relation in Different Skeletal Classes. Int J Appl Res. 2020;6(12):309–14.
14. Bhalaji SI. Orthodontics: The Art and Science. 5th Ed. New Delhi: Arya (MEDI) Publishing House; 2015. p.197-208.
15. Alam MK, Kassab M, Alroudhan IE, Alabid IAI, Alruwaili MF, NafeaAlsharari K, et al. Cephalometrics For Orthognathic Surgery (Cogs) Analysis For Saudi Arabian Adults. Eur J Mol Clin Med. 2020;7(6):2048–67.
16. Lombardo L, Colonna A, Carlucci A, Oliverio T, Siciliani G. Class II subdivision correction with clear aligners using intermaxilary elastics. Prog Orthod. 2018;19(1).
17. Lombardo EC, Lione R, Franchi L, Gaffuri F, Maspero C, Cozza P, et al. Dentoskeletal effects of clear aligner vs twin block—a short-term study of functional appliances. J Orofac Orthop. 2023.
18. Lombardo L, Cremonini F, Oliverio T, Cervinara F, Siciliani G. Class II correction with Carriere Motion 3D Appliance and clear aligner therapy. J Clin Orthod. 2022 Mar;56(3) 187-193. PMID: 35706151.
19. Arreghini A, Carletti I, Ceccarelli MC, Lombardo L, Siciliani G. Class II treatment with the Runner in adolescent patients: Combining Twin Block efficiency with aligner aesthetics. J World Fed Orthod [Internet]. 2014;3(2):e71–9. Available from: http://dx.doi.org/10.1016/j.ejwf.2014.02.002
20. Palone M, Cervinara F, Casella S, Siciliani G, Lombardo L. Resolution of a complex malocclusion using a hybrid aligner approach. J Clin Orthod. 2021;55(6):343–53.
21. Palone M, Cremonini F, Guiducci D, Lombardo L. Combined use of F22 aligners and intermaxillary elastics in mild skeletal Class II: Two case reports.

Journal of Orthodontics. 2023;50(1):77-85. doi:10.1177/14653125221122054
22. Gudhimella S, Gandhi V, et al. Management of Anterior Open Bite and Skeletal Class II Hyperdivergent Patient with Clear Aligner Therapy. Turkish J Orthod. 2022;139–49.
23. Palone M, Brucculeri L, Cremonini F, Albertini P, Lombardo L. Treatment of severe Class II skeletal malocclusion in a hyperdivergent adult patient via hybrid clear aligner approach: A case report. Journal of Orthodontics. 2023;50(2):205-214. doi:10.1177/14653125221138588
24. Cassetta M, Guarnieri R, Altieri F. The combined use of clear aligners and computer-guided piezocision: a case report with a 2-year follow-up. Int J Comput Dent [Internet]. 2020;23(1):57–71. Available from: http://www.ncbi.nlm.nih.gov/pubmed/32207462
25. Palone M, Baciliero M, Cervinara F, Maino GB, Paoletto E, Cremonini F, et al. Class II treatment of transverse maxillary deficiency with a single bone-borne appliance and hybrid clear aligner approach in an adult patient: A case report. J World Fed Orthod [Internet]. 2022;11(2):80–94. Available from: https://doi.org/10.1016/j.ejwf.2021.12.004
26. Bokhari F, Asad S. Sagittal pattern and severity of skeletal discrepancy in Class II Div 1 malocclusion. Poj. 2010;2(2):66–71.
27. Kim-Berman H, McNamara JA, Lints JP, McMullen C, Franchi L. Treatment effects of the CarriereR Motion 2DTM appliance for the correction of Class II malocclusion in adolescents. Angle Orthod. 2019;89(6):839–46.
28. Caruso S, Nota A, Severino M, Meuli S. Mandibular advancement with clear aligners in the treatment of skeletal Class II . A retrospective controlled study. 2021;(March).
29. Tai, S. Clear Aligner Technique. USA: Quintessence Publishing; 2018. p. 131-78.
30. Nanda R, Castrofrolio T, Garino F, Ojima K. Principles and Biomechanics of Aligner Treatment. 1st Ed. Philadelphia: Sanders Elsevier; 2022. p. 66-82.
31. Ravera S, Castroflorio T, Galati F, Cugliari G, Garino F, Deregibus A, et al. Short term dentoskeletal effects of mandibular advancement clear aligners in Class II growing patients. A prospective controlled study according to STROBE Guidelines. Eur J Paediatr Dent. 2021;22(2):119–24.
32. Sun Z, Pan Y, Lin T , Lu H, Ai H, Mai Z. Comparison of cephalometric measurements of the Twin Block and A6 appliances in the treatment of Class II malocclusion: a retrospective comparative cohort study. Ann Transl Med Vol 10, No 16 (August 31, 2022) Ann Transl Med [Internet]. 2022; Available from: https://atm.amegroups.org/article/view/99891
33. Gurgel ML, de Oliveira Ruellas AC, Bianchi J, McNamara JA Jr, Tai S, Franchi L, Deleat-Besson R, Le C, Logan C, Turkestani NA, Massaro C, Del Castillo AA, Arruda KEM, Benavides E, Yatabe M, Cevidanes L. Clear aligner mandibular advancement in growing patients with Class II malocclusion. AJO DO Clin Companion. 2023 Apr;3(2):93-109. doi: 10.1016/j.xaor.2023.01.003. Epub 2023 Jan 25. PMID: 37636594; PMCID: PMC10454533.
34. Fountoulaki G, Thurzo A. Change in the Constricted Airway in Patients after Clear Aligner Treatment: A Retrospective Study. Diagnostics (Basel). 2022

Sep 11;12(9):2201. doi: 10.3390/diagnostics12092201. PMID: 36140602; PMCID: PMC9498122.