Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

M--Effect of Orthodontic Facemask as a Treatment for Children in Growth and Development Period: A Systematic Review

Harun Achmad[1], Nurul Faizah[2]

[1]Lecturer department of Pediatric Dentistry, Faculty of Dentistry, Hasanuddin University, Indonesia

[2]Clinical Dental Student, Faculty of Dentistry, Hasanuddin University, Indonesia Hasanuddin University, Indonesia

E-mail Correspondence: harunachmader@gmail.com

ABSTRACT

Background: Different mixed dentition in treatment strategies, orthodontic facemask give the most satisfactory results in the shortest period of time. The orthodontic facemask is the general appliances of choice for the majority of class III patients who experience early and late mixed dental phases especially with maxillary retrognathism.**Aim:** To review an article on the effect of orthodonyic facemask treatment on a child's growth and developmental period.**Methods:**Data was collected by searching the literature on article search sites, namely Google search and Pubmed published from 2013-2020, the search was carried out in January 2021. The search for data was carried out systematically using the keywords *Facemask Orthodontics, Growth and Development, Children.***Results:**After eliminating duplicate articles, the titles and abstracts of each article were analyzed across 78 articles resulting in an exclusion of 84 articles. The full-text articles in the remaining 47 articles were re-analyzed and excluded 37 articles and produced 10 articles which were then entered into the analysis.**Conclusion:**Based on collected systematic review articles, with the excellent patient cooperation to treatment Class III malocclusion cases, orthodontic facemasks are the most appropriate and effective treatment during childrengrowth and development.

Keywords:*Orthodontic Facemask, Growth and Development, Children*

INTRODUCTION

In the era of globalization, the demand for and services for orthodontic care for children continues to increase from time to time. Originally, demand and services focused more on orthodontic curative action against malpositions of fixed teeth, but nowadays more demand and services have shifted to prevention (preventive) and orthodontic early treatment.[1,2,3]In the case of orthodontic services for children, it shows a different pattern of service handling; both in the preventive, interceptive and orthodontic curative service stages. In fact, the development of

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

orthodontic science in children, especially in the field of preventive and interceptic orthodontics, has been in line with the government's program in the field of dental and oral health services in a tiered and integrated manner; however, the implementation in the field is still a complex problem.[4,5]From the limitations and scope of orthodontics, it means that in the field of Pediatric Dentistry and Pediatric Dental Dentists have a considerable share and responsibility in developing the field of pediatric orthodontics, both in clinical and theoretical aspects.[6,7]

Of the different mixed dentitionin treatment strategies, orthodontic facemasks provide the most satisfactory results in the shortest period of time. The orthodontic facemask is the tool of choice for most of the class III patients who have mixed early and late dentition phases especially with maxillary retrognathism.[8]Class III malocclusion is usually growth-related and becomes more severe when growth is over. This is the main reason for the difficulty to manage in developing Class III cases.[9]It is imperative to take advantage of the patient's growth potential and facemask therapy during the maxillary growth period plays an important role in the successful correction of maxillary deficiency.[10]Therefore, the authors are interested in making a systematic review article on the effects of orthodontic facemask treatment on child’s growth and development.

METHODS

Data source

The data was collected by searching the literature on article search sites, namely google search and Pubmed which were published from 2013 to 2020, the search was carried out in January 2021. The search for data was carried out systematically using the keywords facemask orthodontics, growth and development, children.

KriteriaPenelitian

A. Inclusion criteria

1. Articles published from 2013-2020
2. Articles in English
3. Published scientific articles available online
4. An article that examines orthodontic facemask treatment during children’s growth and development.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

B. Exclusion criteria

1. Articles that cannot be accessed for free.
2. Articles that do not discuss the use of orthodontic facemasks during children's growth and development.

Data collection

The data that will be used in this research are secondary data. The data is obtained from articles that are searched for in the article database which will then be reviewed according to the research criteria set by the researcher.

Research Procedures

1. Literature search was conducted on the online database google search and PubMed. In addition, a search for the list of references to articles that fall into the inclusion criteria was also carried out to find out whether there were other related studies that were relevant to this research.
2. Determination of the keywords carried out in the literature search, namely orthodontic facemasks, growth and development, children.
3. Eliminate duplicated literature.
4. Articles are filtered on the basis of title, abstract, and keywords.
5. Read complete or partial articles that have not been eliminated to determine whether the article meets the eligibility criteria.
6. Data collection was done manually by creating a research matrix containing: author's name, year, title, and conclusion.
7. Processing the data that has been obtained

The literature search was carried out on the online database, Pubmed, using keywords, namely orthodontic facemasks, growth and development, children.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

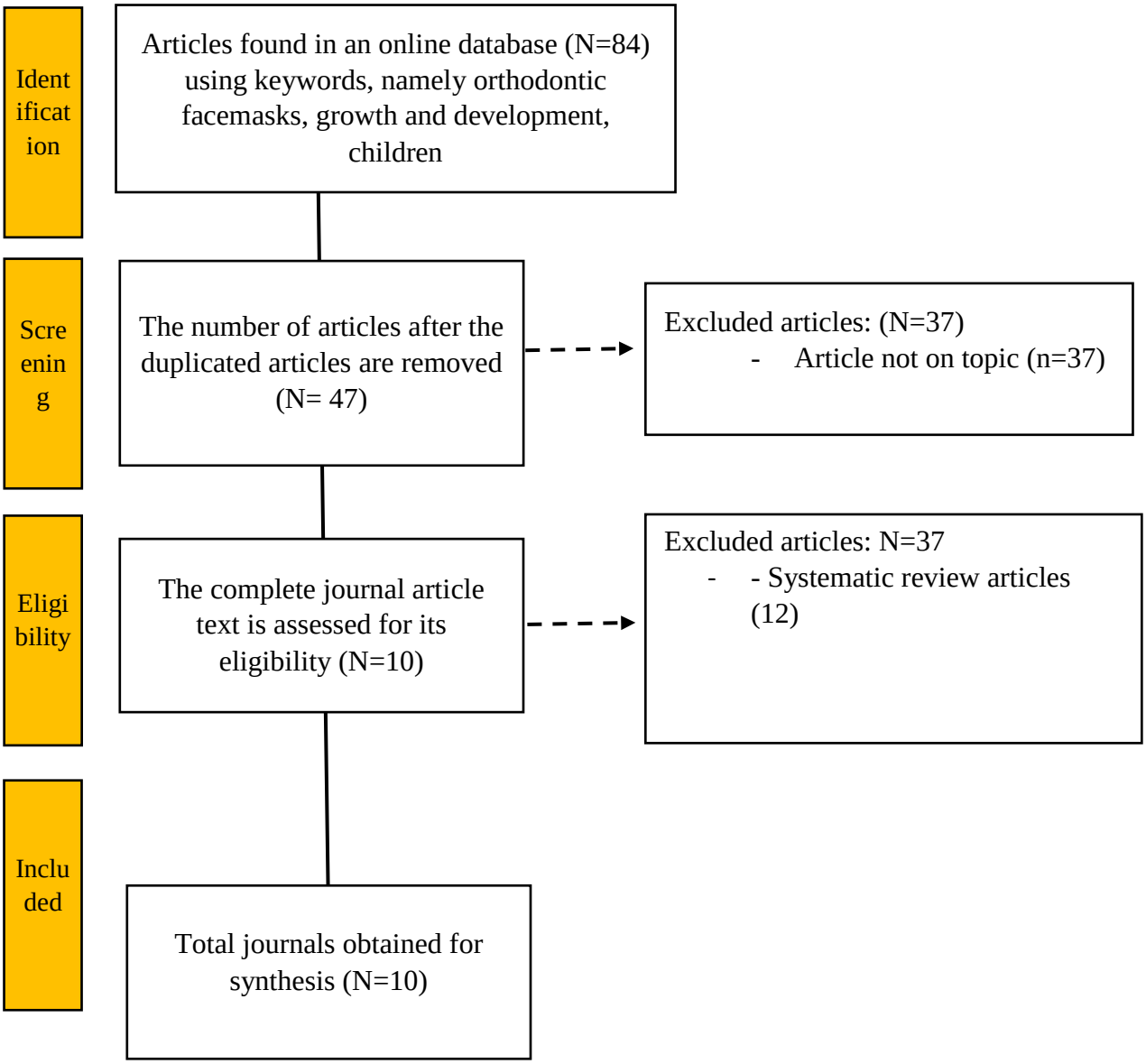

Figure 1.A diagram showing the selection of articles for review

The literature search was carried out on the online database, Pubmed, using keywords, namely orthodontic facemasks, growth and development, children.

RESULTS

Table 1. The Effect of Orthodontic Facemask Treatment on Children's Growth and Development

No.	Authors	Years	Titles	Methods	Conclusion

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

1.	Manuel Nienkemper, Benedict Wilmes, Alexander Pauls, Dieter Drescher[11]	2013	Maxillary protraction using a hybrid hyrax-facemask combination	Treatment of 16 children (mean age 9.5 ± 1.3 years) was investigated clinically and by means of pre- and post-treatment cephalograms.Changes in sagittal and vertical, and dental and skeletal values were evaluated andtested for statistically significant differences.	The hybrid hyrax-facemask combination seems to be effective for orthopaedic treatment ingrowing class III patients. Unwanted maxillary dental movements can be avoided due to stable skeletal anchorage.
2.	Gregory W. Jackson, Neal D. Kravitz[12]	2014	Expansion/Facemask Treatment of an AdultClass III Malocclusion	A 19-year-1-month-old Caucasian female presented with achief complaint of "I do not like my underbite." Her medical history was noncontributory. She had a symmetrical, mesofacial face and a concave soft tissue profile. Herupper lip was slightly retruded. She presented with maxillaryhypoplasia and flat malar eminences. She had a permanentdentition with class III malocclusion in both molars andcanines.The maxillary arch was tapered withmoderate crowding and the mandibular arch was ovoid withmoderate crowding.	This case demonstrates that, given excellent patient cooperation,it is possible to treat an adult class III malocclusion with maxillary expansion and a protraction facemask.
3.	Dr. SaibaliniPani, Dr. SnigdhaPattanaik, Dr. Subhrajeet Narayan Sahoo[13]	2017	Reverse Pull Headgear	For treating skeletal Class III malocclusion with a retrusivemaxilla and a hypodivergent growth pattern.presenting initially with some degree of anterior mandibular shift and a moderate overbite have an improved treatment prognosis.Correcting the anterior crossbite usually results in a downward and backward rotation of the mandible thatdiminishes its prognathism.	In many of the mild to moderate and some rather severe ClassIII problems facemask therapy produces a pronounced occlusal change within a relatively short period. When used withcaution this type of treatment has proven extremely rewarding in a wide variety of Class III conditions.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

4.	Aby Abraham, Elbe Peter, Koshi Philip, Mukundan V, Jinu George, R. Sreevatsan[14]	2013	Early management of class III malocclusion with bonded maxillary expansion and facemask therapy - A case report	A 10 year old girl came with the chief complaint of anterior cross bite to Orthodontic department. Patient had no relevant medical and dental history. On extraoral examination, the facial profile was concave, anterior divergent face and acute nasolabial angle	Patient was treated for a period of six months with rapid maxillary expansion and facemask. Significant improvements were obtained in facial profile and anterior cross bite correction was achieved.
5.	Dennyson Brito Holder da Silva, Ariane Salgado Gonzaga[15]	2020	Importance of orthodontic intervention of the Class III malocclusion in mixed dentition	Upon extraoralexamination, the patient's face revealed typical characteristics of Class III malocclusion, with a deficiency of the middle third of the face, without zygomatic projection, showing the sclera in the lower part of the iris and active lip sealing. In frontal view, there was a slight facial asymmetry with mandibular deviation to the right, while in lateral view it showed a concave profile, with a chin-neck line apparently adequate to the face size.	The intervention and supervision of skeletal Class III performed in patients before the growth spurt, associated with the interception of deleterious oral habits and effective and efficient orthodontic mechanics are decisive factors for the success of orthodontic treatment of this malocclusion.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

6.	SemaYüksel, Tuba TortopÜçem, Alaaddin Keykubat[16]	2013	Early and late facemask therapy	The materialconsisted of lateral cephalometric radiographs of 34 subjects with Class III malocclusionstreated with a Delaire type facemask. Two groups of 17 patients each were formed: an early(six girls, 11 boys) and a late treatment group (eight girls, nine boys). At the beginning of treatment, the mean ages were 9 years 8 months for the early treatment group and 12 years6 months for the late treatment group. The average treatment time was 7 months for bothgroups. A control group consisting of 17 children with a mean age of 9 years 5 months wasformed that matched only the early treatment group according to age, and sagittal dentaland skeletal relationships. To differentiate the orthodontic and total effects of the Delairetype facemask, superimpositions were made.	In both age groups, significant forward movementof the maxilla was observed at the end oftreatment.Evaluation of the superimpositions showedthat in both age groups there was a significantforward movement of the upper incisor and molars.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

7.	Sourabh Agrawal, Roopak D. Naik, Anand K Patil, Harshavardhan Kidiyoor[17]	2015	Customized petit type facemask for class III correction	Under these conditions custom made petit facemask for increased patient compliance, ease of adjustment and cost effectiveness is a viable alternative.	In this era of customization where even orthodontic brackets are customised and treatment modalities like Invisalign are gaining popularity, the orthodontist has to strive for efficient appliance with perfect adaptation. Custom made appliances using 3-D printing utilizing data from cone beam computer tomography may be the answer. The current idea of customization of facemask for patient comfort is a good beginning in this direction.
8.	Cordasco G, Matarese G, Rustico L, Fastuca S, Caprioglio A, *Lindauer SJ, Nucera R*[18]	2014	Efficacy of orthopedic treatment with protraction facemask on skeletal Class III malocclusion: a systematic review and meta-analysis	Inclusion criteria – randomized controlled trials (RCTs) of orthodontic treatments to correct Class IIImalocclusions in children and adolescentsDatabases searched – CENTRAL, MEDLINE, and EMBASEDates searched – 1966 to January 2013 as appropriateOther sources of evidence – hand searching of reference listsLanguage restrictions – none.	Population – patients with skeletal Class III malocclusion Intervention – orthopedic protraction facemask treatment Comparison – untreated patients with skeletal Class III Outcome – the following cephalometric angles: ANB, SNA, SNB, SN-mandibular plane and SN-palatal plane were evaluated.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

9.	Bhatnagar A[19]	2020	Correction of Class III Malocclusion in a Growing Child: A Case Report	A 8 year old healthy female patient reported with the chief complaint of forward placement of lower front teeth as compared to upper front teeth with large lower jaw. On extra oral examination, patient's facial profile was concave, anterior divergent face and obtuse nasolabial angle. Lower lip was positioned ahead of the upper lip.	The case focuses on early management of class III malocclusion, thus providing normal skeletal, dental development along with psychological development, in later ages. Combination of maxillary expansion with the use of protraction appliance will increase the amount of skeletal effect.
10.	Simon Watkinson[20]	2014	Orthodontic Treatment for Prominent Lower Front Teeth (Class III Incisors) in Children: A Cochrane Systematic Review	The following databases were searched up to 7th January 2013: Cochrane Oral Health Group Trials Register, Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE via OVID, EMBASE via OVID. *Selection criteria:* All randomised controlled trials of orthodontic treatments to correct Class III incisors. Trials were eligible for inclusion in the review if they recruited children and/or adolescents (aged 16 or less) receiving orthodontic treatment to correct Class III incisors. Trials including patients with a cleft lip and/or palate or other cranio-facial deformity/syndrome were excluded as were trials that had recruited less than 80% children or adolescents or patients who had previously received surgical orthognathic treatment. Active interventions included: orthodontic braces, chin cups, facemasks, reverse headgear, bone-anchored appliances or any other intra or extra-oral appliance aiming to correct Class III incisors	There is some evidence that the use of a facemask, to correct prominent lower front teeth in children, is effective when compared to no treatment on a short term basis. However, in view of the general poor quality of the included trials, these results should be interpreted with caution. Further randomised controlled trials, with long follow-up, are required.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

DISCUSSION

In recent years, facemask therapy with and without associated palatal expansion has become a common technique used to correct hypoplastic maxillary class III malocclusion.[21]Maxillary expansion has been recommended as a routine part of Class III treatment due to maxillary deficiency, however, the critical evaluation of expansion with respect to maxillary protraction has been limited. Therefore, the aim of this study was to examine the bone, tooth and soft tissue effects of facemask therapy with and without associated maxillary expansion. The results of this study indicated that facemask therapy with and without RME caused significant bone and dentoalveolar changes in adolescent Class III patients.[22,23]

Fixed device therapy after facemask use is required in this case to treat occlusion. The ideal age for facemask therapy is generally for the initial case of mixed teeth. But if the patient also presents with late mixed teeth, the ideal treatment for class III due to maxillary deficiency is a facemask of RME.[25,26]If facemask therapy is used at the start of mixed teeth, considerable time may elapse before the final phase of fixed appliance treatment can begin. Several stages of orthodontic intervention may be required, and therefore this patient should be monitored until all major facial growths have been completed (Figure 2 and Table 1).[14]

Figure 2. Use of Orthodontic Facemasks

Source: Abraham A, Peter E, Philip K, Mukundan V, George J, Sreevatsan R. Early management of class III malocclusion with bonded maxillary expansion and facemask therapy

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

- A case report. International Dental Journal of Students Research;4(4):202-206.[14]

Table 1. Optimal time to start facemask therapy

Authors	Optimum time to start facemask therapy
Bacetti, Mc Gill, Franchi, McNamara[11]	Early mixed dentition.
Baik[12]	Face mask/expansion therapy in younger children was not significantly different from older children
Kim, Viana, Graber[13]	Before the patient is 10 years of age.
Takada[14]	Pre and mid pubertal group showed significant increase in SNA and maxillary length, while late pubertal group showed only a less significant increase in SNA.
Kapust[15]	4 to 7 and 7-10 age group responded better to treatment than 10-14 age group.
Franchi, Bacetti[16]	Early mixed or late deciduous dentition produces significant favourable modifications in both maxillary and mandibular structures, whereas late

Source: Abraham A, Peter E, Philip K, Mukundan V, George J, Sreevatsan R. Early management of class III malocclusion with bonded maxillary expansion and facemask therapy - A case report. International Dental Journal of Students Research;4(4):202-206.[14]

According toNienkemper et al[11]that significant skeletal repair of the sagittal plane can be achieved, as demonstrated by changes in SNA and WITS assessments. A meta-analysis of the treatment effects achieved with conventional and facemask RME showed an increase in SNA of 1,4°.[11,24]The results of the current investigation indicated a higher effectiveness associated with the maxillary anterior case.[27,28,29,30]

The decision for maxillary protraction is evidenced by the literature that Class III facemask treatment is the most preferred choice for retrognatic maxillary correction.[31,32,33,34]The study showed significant favorable results in correction of dental variables, such as positive changes in the Wits analysis index and correction of patient overjet.[35,36,37,38,39,40]These previously reported characteristics corroborate the outcome of this clinical case culminating in an increase in the Wits analysis value from -4 mm before treatment to +1 mm after treatment, and adequate overjet and overbite. In addition, differences in chin size between men and women as well as between different population groups make the adjustment of prefabricated face masks for different populations difficult. The custom-made facemask presented here are perfect for the patient at a very economical price.[41,42,43,44,45]

They can be made with minimal laboratory support without the need for repeated visits, as in the case of custom facemasks. The downward and backward movements of the chin expressed in this

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1658 - 1672
Received 20 January 2021; Accepted 08 February 2021.

patient have been described by Migliaccioet al.[46]andKamatchi et al.[47]with protraction of the maxilla and chin, and Suresh[48] andBuwembo[49] andusing palatal expansion with facemask. Various soft tissue changes are combined to enhance the class III profile of the patient. The profile becomes more convex due to the forward movement of the upper lip and the retraction of the lower lip, the soft tissue pogonion moves backward and the menton moves downward as described byWinnier et al.[50,51,52,53,54,55]

CONCLUSION

Based on collected systematic review articles, with the excellent patient cooperation in treatment of Class III malocclusion cases, orthodontic facemasks are the most appropriate and effective treatment during children's growth and development.

REFERENCES

1. IwaSutardjo RS. Considerations and Problems of Early Use of Orthodontic Interseptic Devices in Developmental Children. Journal Stomatognatic of Jember University. 2011. 8(1): 1-10.
2. Araújo EA, Buschang PH. Recognizing and correcting developing malocclusions: a problem-oriented approach to orthodontics. New Jersey: Wiley Brackwell; 2016. p. 255.
3. de Almeida MR, de Almeida RR, Oltramari-Navarro PVP, Conti ACCF, Navarro RL, Camacho JGDD. Early treatment of Class III malocclusion:10-year clinical follow-up. J Appl Oral Sci. 2011 Aug;19(4):431-9.
4. Mandall N, Cousley R, DiBiase A, Dyer F, Littlewood S, Mattick R, et al. Early Class III protraction facemask treatment reduces the need for orthognathic surgery: a multi-centre, two-arm parallel randomized, controlled trial. J Orthod. 2016 Sept;43(3):164-75.
5. Nardoni DN, Siqueira DF, Cardoso MA, CapelozzaFilho L. Cephalometric variables used to predict the success of interceptive treatment with rapid maxillary expansion and face mask. A longitudinal study. Dental Press J Orthod. 2015 Jan-Feb;20(1):85-96.
6. Clemente R, Contardo L, Greco C, Di Lenarda R, Perinetti G. Class III treatment with skeletal and dental anchorage: a review of comparative effects. Biomed Res Int. 2018 July 2;2018:7946019.
7. Watkinson S, Harrison JE, Furness S, Worthington HV. Orthodontic treatment for prominent lower front teeth (Class III malocclusion) in children. Cochrane Database Syst Rev. 2013 Sept;30(9):CD003451.
8. Nascimento MHA, de Araújo TM, Machado AW. Severe anterior open bite during mixed dentition treated with palatal spurs. J ClinPediatr Dent.2016;40(3):247-50.
9. Woon SC, Thiruvenkatachari B. Early orthodontic treatment for Class III malocclusion: a systematic review and meta-analysis. Am J OrthodDentofacialOrthop. 2017 Jan;151(1):28-52.
10. Ugolini A, Cerruto C, Di Vece L, Ghislanzoni LH, Sforza C, Doldo T, et al. Dental arch response to Haas-type rapid maxillary expansion anchored to deciduous vs permanent molars: a multicentric randomized controlled trial. Angle Orthod. 2015 July;85(4):570-6.
11. Nienkemper et al.: Maxillary protraction using a hybrid hyrax-facemask combination. Progress in Orthodontics 2013 14:5.

12. Gregory W. Jackson, Neal D. Kravitz. Expansion/Facemask Treatment of an Adult Class III Malocclusion. Hindawi Publishing Corporation Case Reports in Dentistry Volume 2014, Article ID 270257, 6 pages http://dx.doi.org/10.1155/2014/270257.
13. Dr. SaibaliniPani, Dr. SnigdhaPattanaik and Dr. Subhrajeet Narayan Sahoo. 2017. Reverse pull headgear. International Journal of Current. Research, 9, (06), 5327453278.
14. Abraham A, Peter E, Philip K, Mukundan V, George J, Sreevatsan R. Early management of class III malocclusion with bonded maxillary expansion and facemask therapy - A case report. International Dental Journal of Students Research;4(4):202-206.
15. Silva DBH, Gonzaga AS. Importance of orthodontic intervention of the Class III malocclusion in mixed dentition. Dental Press J Orthod. 2020 Sept-Oct;25(5):57-65. DOI: https://doi.org/10.1590/2177-6709.25.5.057-065.bbo.
16. SemaYüksel, Tuba TortopÜçem, AlaaddinKeykubat. Early and late facemask therapy. *European Journal of Orthodontics* 23 (2013) 559–568.
17. Agarawal S, Naik D R, Patil A K, Kidiyoor H. Customized petit type facemask for class III correction. JOADMS 2015;1(2):3-8. Source of Support: Nil.
18. Cordasco G, Matarese G, Rustico L, Fastuca S, Caprioglio A, Lindauer SJ, Nucera R. Efficacy of orthopedic treatment with protraction facemask on skeletal Class III malocclusion: a systematic review and meta-analysis. R.* OrthodCraniofac Res 2014;17:133–143.
19. Bhatnagar A. Correction of Class III Malocclusion in a Growing Child: A Case Report. J Dent & Oral Disord. 2020; 6(2): 1126.
20. Watkinson S. Orthodontic Treatment for Prominent Lower Front Teeth (Class III Incisors) in Children: A Cochrane Systematic Review. 2014. University of Liverpool, for the degree of Doctorate of Dental Science.
21. Rédua RB. Different approaches to the treatment of skeletal Class II malocclusion during growth: Bionator versus extraoral appliance Dental Press J Orthod. 2020 Mar-Apr;25(2):69-85.
22. Liu W, Zhou Y, Wang X, Liu D, Zhou S. Effect of maxillary protraction with alternating rapid palatal expansion and constriction vs expansion alone in maxillary retrusive patients: a single-center, randomized controlled trial. Am J OrthodDentofacialOrthop. 2015 Oct;148(4):641-51.
23. Graber, Vanarsdall, Vig. Orthodontics- Current principles and management, Elsevier, 5th edition, 2012:505.
24. Foersch M, Jacobs C, Wriedt S, Hechtner M, Wehrbein H. 2015. Effectiveness of maxillary protraction using facemask with or without maxillary expansion: A systematic review and metaanalysis. *Clin Oral Investig*.,19:118192.
25. Harrington C, Gallagher JR, BorzabadiFarahani. 2015. A retrospective analysis of dentofacial deformities and orthognathic surgeries using the index of orthognathic functional treatment need (IOFTN). *Int J PediatrOtorhinolaryngol*., 79:10636.
26. De Baets, E.; Lambrechts, H.; Lemiere, J.; Diya, L.; Willems, G. Impact of self-esteem on the relationship between orthodontic treatment need and oral health-related quality of life in 11–16-year-old children. Eur. J. Orthod. 2012, 34, 731–737.
27. Imani, M.M.; Jalali, A.; Dinmohammadi, M.; Nouri, P. The E_ect of Orthodontic Intervention on Mental Health and Body Image. Open Access Maced. J. Med. Sci. 2018, 17, 1132–1137.
28. Meeran, N.A. Iatrogenic possibilities of orthodontic treatment and modalities of prevention. J. Orthod. Sci.2013, 2, 73–86.
29. Karkhanechi, M.; Chow, D.; Sipkin, J.; Sherman, D.; Boylan, R.J.; Norman, R.G.; Craig, R.G.; Cisneros, G.J. Periodontal status of adult patients treated with fixed buccal appliances

and removable aligners over one year of active orthodontic therapy. Angle Orthod. 2013, 83, 146–151.
30. Chhibber, A.; Agarwal, S.; Yadav, S.; Kuo, C.L.; Upadhyay, M. Which orthodontic appliance is best for oral hygiene? A randomized clinical trial. Am. J. OrthodDentofac. Orthop. 2018, 153, 175–183.
31. Zhang W., Qu H. C., Yu M., Zhang Y. Theeffects of maxillary protraction with or withoutrapid maxillary expansion and age factorsin treating Class III maloclusion: A metaanalysis.Plos One. 2015; 10 (6): e0130096.
32. Solano-Mendoza B., Iglesias-Linares A.,Yañez-Vico R. M., Mendoza-Mendoza A.,Alió-Sanz J. J., Solano-Reina E. Maxillaryprotraction at early ages. The revolutionof new bone anchorage appliances. J ClinPediatr Dent. 2012; 37 (2): 219-29.
33. Karthi M., Gobichettipalayam J. A.,Bhandari P. K.. Early correction of Class IIImalocclusion with rapid maxillary expansionand face mask therapy. J Pharm Bioallied Sci.2013; 5 (Suppl 2): S169-72.
34. Al-Khalifa H. N. Orthopedic correctionof Class III malocclusion during mixeddentition. Open J Stomatol. 2014; 4: 372-80.
35. Abraham A., Peter E., Philip K., Mukundan V.,Geoge J., Sreevatsan R. Early management ofClass III malocclusion with bonded maxillaryexpansion and facemask therapy. A casereport. Int Den J Stud Res. 2016; 4 (4): 202-6.
36. Sarver D. M. The face as the determinant of treatment choice. From Frontiers of dental and facial esthetics. Craniofacial Growth Series, 38. McNamara & Kelly Eds. 2013.
37. Grabowski R, Kundt G, Stahl F. Interrelation between occlusal findings and orofacial myofunctional status in primary and mixed dentition. Part III: interrelation between malocclusions and orofacial dysfunctions. J OrofacOrthop 2007;68:462-76.
38. Grabowski R, Stall F, Gaebel M, Kundt G. Relationship between occlusal findings and orofacial myofunctional status in primary and mixed dentitions. Part I: prevalence of malocclusions. J OrofacOrthop 2007;68:26-37.
39. Kavanagh C, Kavanagh D. Maxillary midline diastema –aetiology and orthodontic treatment. J of Irrish Dent Assoc.2010;50(1):14-9.
40. Mulligan TF. Diastema Closure and Long-term stability. J Clinical Orthodontics. 2010; 1: 560-74.
41. Proffit WR. Contemporary orthodontics. 2008; 5: 82.
42. Rodrigues de Almeida R. Early treatment protocol for skeletal class III maloclussion. *Brazilian Dental Journal*. 2013; 24: 2
43. Musich D, Busch MJ. Early orthodontic treatment: Current clinical perspectives. *Alpha Omegan*. 2007; 100: 17-24.
44. Harrison JE. Orthodontic treatment for prominent upper front teeth in children. *The Cochrane database of systematic reviews*. 2011; **18**: CD003452.
45. Wilson B, Joseph J, Bharadwaj P, Kaushik PC. Space Management in Paediatric Dentistry. J dent. Panacea. 2014, 1(2).
46. Migliaccio S, Aprile V, Zicari S, Grenci A. Eruption guidance appliance: a review. Eur J Paediatr Dent. 2014; 15(2):163-6.
47. Kamatchi D, Vasanthan P, Kumar SS. Orthodontic challenges in mixed dentition. SRM J Res Dent Sci. 2015; 6(1):22.
48. Suresh M, Ratnaditya A, Kattimani VS, Karpe S. One phase versus two phase treatment in mixed dentition: a critical review. Int J Oral Dent Health: JIOH. 2015; 7(8):144.
49. Buwembo W, Luboga S. Moyer's method of mixed dentition analysis: a meta-analysis. Afr.

Health Sci. 2004; 4(1):63-6.

50. Winnier JJ, Rupesh S, Nayak UA. Treatment options for management of mandibular anterior crowding in mixed dentition. J Evidence Based Med Hlthcare. 2014; 15(1):1937-46.
51. Achmad H, Djais AJ, Petrenko EG, Larisa V, Putra AP. 3-d printing as a tool for applying biotechnologies in modern medicine. International Journal of Pharmaceutical Research, 2020. 12(4), pp. 3454-3463.
52. Achmad H, Djais AI, Jannah M, Huldani, Putra AP. Antibacterial chitosan of milkfish scales (Chanoschanos) on bacteria porphyromonasgingivalis and agregatibacteractinomycetescommitans. Systematic Reviewa In Pharmacy, 2020. 11(6), pp. 836-841.
53. Achmad H, Djais AI, Syahrir S, Fitri A, Ramadhany YF. A literature us regarding the use of herbal medicines in pediatric dentistry. International Journal of Pharmaceutical Research. 2020. 12,PP. 881-897.
54. Achmad H, Djais AI, Syahrir S, Fitria A, Ramadhany YF. Impact Covid-19 in pediatric dentistry: A literature review. International Journal of Pharmaceutical Research, 2020. 12,p.830-840.
55. Djais AI, Achmad H, Dewiayu D, Sukmana BI, Huldani. Effect of Combination of Demineralization Freeze Dentin Matrix (DFDDM/0 and Moringaoleifera lam osteoprotegerin (OPG) and receptor activator of nuclear factor kappa Bligand (RANKL) as a marker of bone remodeling. Systematic Reviews in Pharmacy. 2020. 11(6), pp.771-779.