Review Article

Prognostic Factors for Successful Functional Appliance Therapy in Skeletal Class II Malocclusion- A Systematic Review

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ABSTRACT

AIM: To investigate clinical or cephalometric parameters that contribute to favourable outcomes with functional appliance therapy in skeletal class II malocclusion.

MATERIALS AND METHODS: Six electronic databases were searched PubMed, Ovid, Lilacs, Cochrane, Scopus, and Web of Science up to 25th February 2025. All study designs which evaluated factors associated with favourable and unfavourable outcome with functional appliance therapy for the treatment of skeletal class II malocclusion were included. The electronic search, initial screening, data extraction, risk of bias assessment was independently performed by the two reviewers. The collected data were analysed from the finally selected articles based on type of study, sample size, type of functional appliance used, and patient characteristics or factors studied which could be considered as positive predictive factors for functional appliance.

RESULTS: Seven retrospective studies and one prospective study were included. Prognostic factors like the Co-Go-Me angle, chin position, growth pattern and other occlusal factors such as overbite, overjet were evaluated in the selected studies. Four studies were rated very good with 9 points and four other studies were rated as satisfactory with 7 points using the Newcastle Ottawa Scale. Due to heterogeneity of the factors studied, a meta–analysis could not be conducted in this systematic review.

CONCLUSION: Two included studies reported Co- Go-Me angle as the single most important predictive factor for successful outcome. Cephalometric factors pointing to horizontal growth pattern or hypo divergence, chin position and occlusal variables like increased overbite and overjet were identified as positive predictive factors. However future studies with definitive comparison groups can strengthen the current evidence.

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INTRODUCTION

Angle's Class II division 1 malocclusion is a common malocclusion with a prevalence rate of 23% in children, 15% in youths, and 13% in adults in the American population.[1] Class II skeletal malocclusions are typically associated with a retrognathic mandible and a normally positioned, prognathic, or retrognathic maxilla in nearly 80% of children. A convex facial profile with a diminished chin projection is generally the result of the combination of these features.[2] Treatment of skeletal Class II malocclusion in children is done primarily through growth modification with a functional appliance.[3] The predicted favourable outcomes of functional appliance include improvement in mandibular growth and position, changes in maxillary growth characterized by the restriction of its forward growth, and should be accompanied by minimal proclination of mandibular incisors and mesial movement of mandibular posterior teeth.[4]

Studies have also shown that there is a variable response to treatment with functional appliance with some patients responding with better improvement in facial esthetics than others.[5] Apart from treatment timing and skeletal maturation, many factors have been found to influence the success of functional appliances which include both - clinical and cephalometric parameters. With the availability of numerous factors affecting the outcome of functional appliances for the treatment of class II skeletal malocclusion, it is important to explore and find the factor, which could be the strongest predictor of a successful outcome. Therefore, finding a predictive factor would help the clinician to produce the best possible outcome with functional jaw orthopaedics.

To the best of our knowledge, there is no systematic review that has evaluated the predictive/prognostic factors for functional appliance therapy. One previous systematic review has only mentioned the factors affecting sagittal stability after functional appliance therapy and found the evidences to be inconclusive. However, the review also did not highlight the characteristics that contribute to the success of functional appliance treatment.[6] Therefore, the aim of this systematic review is to identify the factors that predict or influence the favourable outcome of functional appliance therapy in the treatment of Class II skeletal malocclusion. It was primarily done to review the role and effectiveness of a particular parameter in success of functional appliance therapy in the available literature.

MATERIALS AND METHODS

Protocol and Registration:

This systematic review was conducted and reported in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). [7] The proposal was registered on the International Prospective Register of Systematic Reviews (Reg no: CRD42022312039).

ELIGIBILITY CRITERIA:

INCLUSION CRITERIA:

- Participants: Patients treated with functional appliance for correction of skeletal Class II malocclusion with favorable results

- Intervention: Functional appliance

- Comparator / Comparison: Patients with Class II skeletal malocclusion with unfavorable results & patients with class II skeletal malocclusion before or after treatment with functional appliance.

- Outcome: Role of factors that are associated with favorable results in patients treated with functional appliance for class II correction.

- Study design: Retrospective or Prospective or Randomized control trails

EXCLUSION CRITERIA:

- Patients who have undergone orthognathic surgery for correction of class II malocclusion

- Untreated control group

- Studies without any adequate follow-up

- Case Reports and Case Series

- Animal Studies

INFORMATION SOURCES, SEARCH STRATEGY AND STUDY SELECTION:

Electronic searches in MEDLINE (via PubMed), the Cochrane Library, Web of Science, Scopus, Ovid, and Lilacs were conducted. Search terms were based on both Medical Subject Headings (MESH) and free text with combinations and were prepared for MEDLINE via PubMed and adapted for Lilacs, Web of Science, Scopus, Ovid, and Cochrane electronic databases. Publications published in English were only searched. Grey literature and hand searching was also done.

The keywords and the search database summary are presented in Table 1.

TABLE 1 – SEARCH TERMS

KEYWORDS	DATABASE	NO OF ARTICLES
(Prediction) Or (Prognostic)) And (Factors)) Or (Determinants)) And (Success)) Or (Outcome)) Or (Favourable)) And (Functional Appliance)) Or (Myofunctional Appliance)) Or (Growth Modification)) And (Class II Malocclusion)	Pubmed	871
Prediction Or Prognostic And Factors Or Determinants And Success Or Outcome And Myofunctional Appliance And Class II Malocclusion	Cochrane	652
Predictive Or Prognostic Factors Or Determinants For The Success Or Favourable Of Myofunctional Appliance In Class II Malocclusion	Lilac	33
Prediction Or Prognostic And Factors Or Determinants And Success Or Outcome Or Favourable And Functional Or Myofunctional Appliance Or Growth And Modification And Class And II And Malocclusion	Scopus	183
Desired Factors And Success Or Favourable And Functional Appliance And Class II Malocclusion	Web Of Science	1903
Success Factors And Myofunctional Appliance And Class II Malocclusion	Ovid	1516
	Total	5158

STUDY RECORDS

The selection of studies was carried out in a step-by-step fashion**.** First, the articles are identified through a search in the databases. The initial screening of these articles involved independent screening of titles and abstracts, which is carried out by two reviewers based on the research question and against the inclusion and exclusion criteria. To assess for relevance, the full text was reviewed, when sufficient information could not be derived from the title and abstract. Full-text articles were fetched from the potentially eligible studies in the next stage. Moreover, hand searching was carried out from the reference lists of the eligible articles, thereby not missing any relevant articles.

DATA EXTRACTION

The extraction of relevant data was independently executed by the two reviewers. The following data were analyzed from the finally selected articles; author names, journal, year of publication, type of study, sample size, type of functional appliance used, and patient characteristics/ factors studied and associated with the outcome from the functional appliance. Each reviewer entered the extracted data individually into a Microsoft Word document and any disagreement on the same between the two reviewers (RR and BS) was resolved with further discussion with the other two reviewers (KV and VK). The extracted data was then shared with the other two reviewers (KV and VK) to streamline and conclude the process. The characteristics of the individual studies are included in Table 2.

TABLE 2- STUDY CHARACTERISTICS TABLE

TITLE	AUTHOR, AND JOURNAL	STUDY DESIGN, DEMOGRAPHIC DATA AND INTERVENTIONS	OUTCOME VARIABLES ASSESSED
Predicting the outcome of twin block functional appliance treatment	Caldwell et al, EJO	Prospective Study n=43 patients (20 males and 23 females) Pre-treatment and post-treatment cephalograms Twin Block	Overjet, overbite, molar relationship, SNA, SNB, ANB, upper incisor to palatal plane, lower incisors to mandibular plane, MMPA, and LFH
Cephalometric markers to consider in the treatment of class II division 1 malocclusion	Ahn et al, AJODO,	Retrospective Study n=76 patients Pre-treatment and post-treatment cephalograms Bionator	31 cephalometric parameters on 1. Growth Pattern – Saddle angle, Articular angle, Gonial angle, Palatal plane to mandibular plane angle, SN-Mandibular plane angle, Lower facial height ratio, Facial height ratio and FMA 2. Maxillo mandibular relationships – SNA, FMIA, U1 to facial plane, L1 to SNB, ANB, FH to palatal plane angle, N-Perpendicular to Pog, Go-Me/Na-S,AB to palatal plane angle, Ar-Pog, Facial convexity angle. 3. Dental Relationships – Interincisal angle, 4.Soft tissue Relationships.
Cephalometric determinant of successful	Patel et al, AO,	Retrospective Study n=72 patients (37 males & 35 females)	Cranial base variables, face height variables, anteroposterior variables, horizontal plane, mandibular variables,

		Experimental group- skeletal and control group- non skeletal group Twin block, Frankel 2 and activator	dentoalveolar variables, and soft-tissue variables.
Prediction of individual mandibular changes induced by functional jaw orthopaedics followed by fixed appliance in class II patients	Franchi et al, AO,	Retrospective Study n=51 patients (24 females & 27 males) Compared between pre-treatment and post-treatment cephalograms Twin block and Herbst appliance	Sagittal skeletal relationships: ANB, Co-Gn, and midfacial length, Co-A. Vertical skeletal relationships: Palatal plane to Frankfort horizontal; mandibular plane to Frankfort horizontal; palatal plane to mandibular plane. Morphologic and dimensional mandibular measurements: Co-Go-Me; B-Pg to Go-Me; ratio between Co-Go and S-Co; ratio between Go-Me and S-N.
Growth modulation using functional appliances- cephalometric predictors of successful response	Kumar et al, Orthodontics: The art and practice of dentofacial enhancement	Retrospective Study n=24 patients (11 male and 13 female) Pre-treatment and post-treatment cephalograms Twin block and Frankel appliance	Linear Parameters: S-N, S-Ar, UAFH, LAFH, Co-Go, Co-Gn, Go-Gn, overbite, and overjet Angular Parameters: N-S-Ar, S-Ar-Go, SNA, SNB, ANB, SN-MxP, SN-MnP, MxP-MnP, UI-MxP, LI-MnP in degrees, Jarabak ratio
Predictors of favourable soft tissue profile outcomes following class II twin-block treatment	Kim et al, KJO	Retrospective Study n=45 patients (35 boys and 10 girls) Pre-treatment and post-treatment cephalograms Twin block	Cranial Base Variables-S-Ar,S-N,Ba-N,N-S-Ar Face Height Variables-UAFH, LAFH, UPFH, LPFH, %LAFH, %LPFH, S-Ar-Go Anterior-Posterior Variables-SNA,SNB,ANB, VRP-Cd, VRP-ANS,VRP-ANS, VRP-A, VRP-B, VRP-Pog, B-Pog, S-N-Pog, Vertical Variables-SN-MxP, SN-MnP, MxP-MnP, FH-Occ Mandibular Dimensions- Cd-Go, Cd-Gn, Go-Gn, Ar-Gn, Ar-Go-Me, Symphysis inclination Dento-Alveolar Variables-OB, OJ, U1-MxP,L1-MnP,U1-Occ VRP-Ls, VRP-Li, VRP-sPog
Development of a prediction model for short-term success of functional appliance treatment in class II	Lombardo et al, International Journal of Environment Research and Public Health,	Retrospective Study n=39 patients (21 females,18 males) Pre-treatment and post-treatment cephalograms Twin Block appliance	SNA, SNB, Wits appraisal, SN to Palatal plane, SN to mandibular plane, Co-Go-Me, Co-Gn(mm), overjet, overbite, upper incisor to palatal plane, and lower incisor to mandibular plane, Pg-VL
Outcome quality of class II division 1 Herbst appliance treatment: influence of pre-treatment class II severity and skeletal maturity	Bock et al, EJO,	Retrospective Study n=526 patients (53% females and 47 % males) Pre-treatment and post-treatment cephalograms Herbst appliance	Age, skeletal severity, gender, and amount of sagittal molar and canine correction, Pre and post treatment rating scores (Peer Assessment Rating Index)

RISK OF BIAS / QUALITY ASSESSMENT

Evaluation of the methodological quality was performed using the Newcastle Ottawa Scale.[8] Two reviewers (RR and BS) independently assessed the risk of bias in included studies. The domains included for risk of bias assessment were representativeness of the sample, sample size, ascertainment of the exposure, comparability and assessment of the outcomes (Table 3). Any divergence in opinion on risk of bias between the reviewers (RR and BS) on particular studies was solved with the consensus of the two reviewers (KV and VK).

TABLE 3: RISK OF BIAS ASSESSMENT

TITLE	AUTHOR	1	2	3	4	5	6	7	TOTAL SCORE
Predicting the outcome of twin block functional appliance treatment: A prospective study	Caldwell et al (1999)	a (*)	b	a (*)	a (**)	a (*)	b (**)	a (**)	Very Good study (9)
Cephalometric markers to consider in the treatment of class II division 1 malocclusion with the Bionator	Ahn et al (2001)	a (*)	b	c	a (**)	a (*)	b (**)	a (**)	Very Good study (9)
Cephalometric determinants of successful functional appliance therapy	Patel et al (2002)	a (*)	b	a (*)	a (**)	a (*)	b (**)	b	Satisfactory study (7)
Prediction of individual mandibular changes induced by functional jaw orthopaedics followed by fixed appliances in class II patients	Franchi et al (2005)	a (*)	b	a (*)	a (**)	a (*)	b (**)	b	Satisfactory study (7)
Growth modulation using functional appliances-cephalometric predictors of successful response	Kumar et al (2013)	a (*)	b	a (*)	a (**)	a & b (**)	b (**)	a (**)	Very Good study (10)
Predictors of favourable soft tissue profile outcomes following class II twin-block treatment	Kim et al (2017)	a (*)	a (*)	a (*)	a (**)	a (*)	C (*)	b	Satisfactory study (7)
Development of a prediction model for short-term success of functional treatment of class II malocclusion	Lombardo et al (2020)	a (*)	b · c		a (**)	a	b (**)	a (**)	Satisfactory study (7)
Outcome quality of class II division 1 Herbst-multibracket appliance treatment: influence of pre-treatment class II severity and skeletal maturity	Bock et al (2021)	a (*)	b	c	a (**)	a (*)	b (**)	a (**)	Very Good study (9)

Factor 1: Representativeness Of Sample, Factor 2: Sample Size, Factor 3: Non - Respondents, Factor 4: Ascertainment Of Exposure (Risk Factor), Factor 5: Comparability On The Basis Of Study Design Or Analysis. Confounding Factors Are Controlled, Factor 6: Outcome Assessment, Factor 7: Statistical Test

EFFECT MEASURES

Effect measures included in this review were the mean difference of the clinical and cephalometric variables evaluated in the selected studies.

RESULTS:

STUDY SELECTION

The PRISMA flowchart portrays the actual search selection process (Figure 1). The initial search was carried out and 5158 records were obtained across six databases. Removal of duplicates resulted in 4702 articles, out of which 4679 records were eliminated based on the information derived from the titles and abstracts. Then, inclusion and exclusion criteria were applied to the resultant 23 full-text documents. Seventeen studies from the 23 full-text documents were excluded resulting in 6 articles. The PRISMA flowchart (Figure 1) mentions the reasons for exclusion. Later, hand search for documents that were cited in any of the six selected studies were carried out and two articles were selected, resulting in eight studies finally being included in the review.
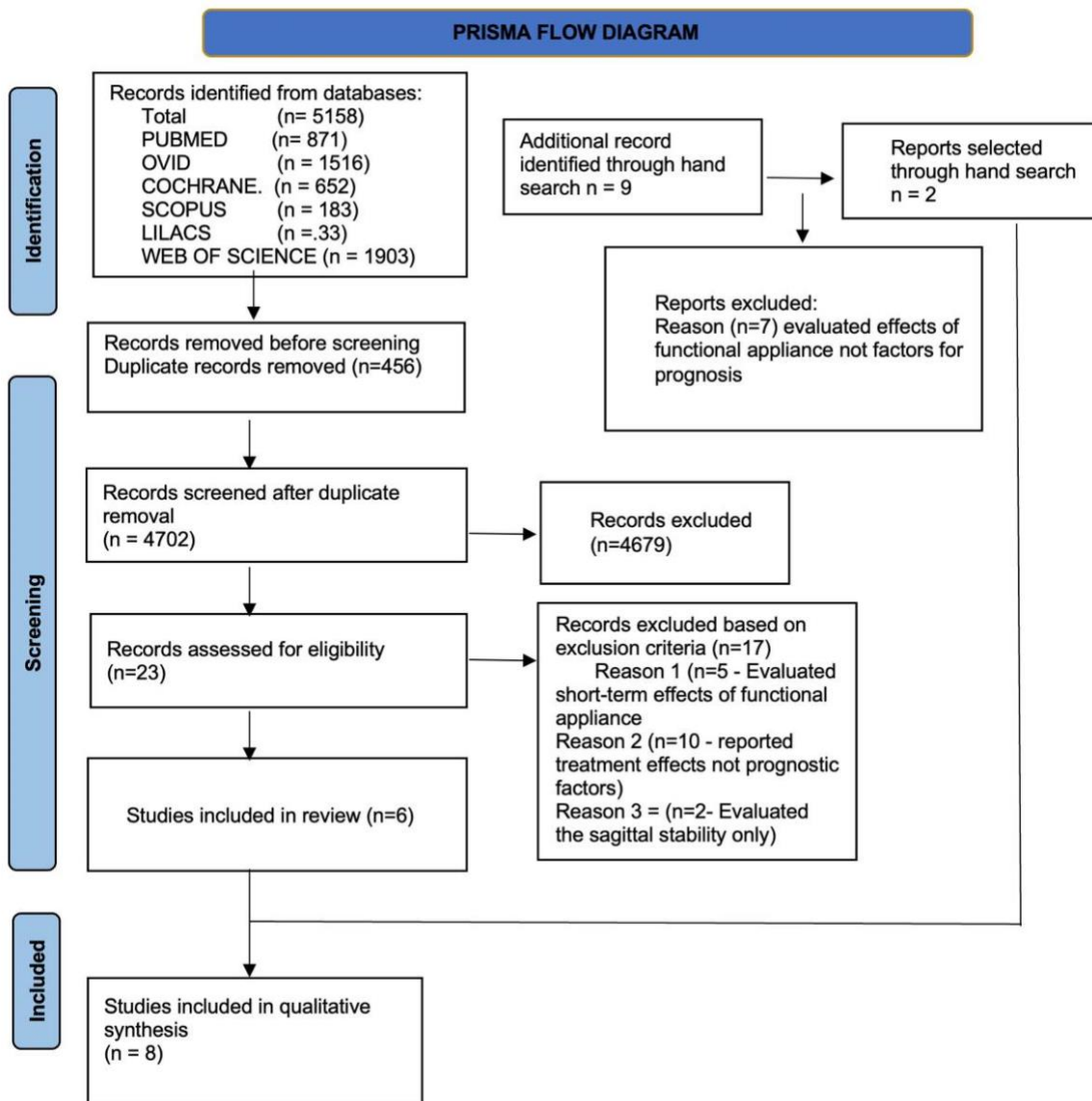
Figure 1: PRISMA Flowchart

STUDY CHARACTERISTICS

Out of the eight studies that were included in the review, seven were retrospective and one study was prospective. All the included studies evaluated prognostic factors for the success of functional appliances and the results from the individual studies are shown in Table 4.

TABLE 4- RESULT TABLE

AUTHOR	VARIABLES ASSESSED	RESULTS	CONCLUSION
Caldwell et al (1999)	Overjet, Overbite, Molar relationship, SNA angle, SNB angle, ANB angle, Upper incisors to maxillary plane, Lower incisors to mandibular plane, Lower facial height, MMPA	Multiple regression analysis with coefficient of determination was used. Deep overbite and SNB angle in combination with overjet were identified as important parameters.	Deep overbite, Decreased SNB angle was the important pre-treatment parameter for the success of functional appliances.
Ahn et al (2001)	31 parameters on Growth Pattern, Maxillo mandibular relationships, Dental Relationships, Soft tissue Relationships.	Statistically significant parameters were Articular angle, ANB angle, Facial convexity angle, FMIA, L1 to A-Pog, U1to Facial plane, L1 to facial plane, Upper lip thickness (E-line), Lower lip thickness (E-line), Lower lip thickness (Sn-Pog'). Articular angle and FMIA angle had greater discriminant value in multiple regression analysis	Horizontal growth pattern, normal anteroposterior relationship of maxilla and mandible, retrusive mandibular incisor and retrusive lower lip were important predictors for the success of functional appliances.
Patel et al (2002)	Cranial base variables, Face height, antero-posterior, Horizontal planes, Mandibular variables, dento-alveolar variables, soft tissue variables, cranial base variables	Parameters statistically significant in Group 1(pre-treatment) After pre and post treatment comparison> 1.LAFH is increased and it was statistically significant (P= <0.02) 2.SNB angle become average and it was statistically significant (P= <0.000) 3.ANB angle is reduced after treatment and it was statistically significant (P=<0.000) 4.SN-MnP angle was reduced and it is statistically significant P= <0.010 5.Cd-Go length was increased and it is statistically significant (P=<0.041) 6.Cd-Gn length was increased and it is statically significant (P=<0.002) Group 2 (post treatment) Parameters were not statistically significant (P>0.05)	Smaller and retrusive mandible & smaller anterior and posterior face heights are favourable response for functional appliance.
Franchi et al (2006)	Sagittal skeletal relationship, Vertical skeletal relationship, Dimensional and Morphological mandibular measurements	1.Critical score -value dividing the good responders from bad responders 2.Critical score is 0.249 3.Each new patient with Class II malocclusion at CS 3 that will show an individual score smaller than critical score responded favourably	Class II malocclusion patient in skeletal maturation at stage three with a pre-treatment value for Co-Go-Me angle

		to treatment greater than critical score respond unfavourably to treatment 4.Stepwise discriminant analysis identified Co-Go- Me angle in patients at CS 3 stage to be a variable providing most efficient separation between good and bad responders. Power of selected variable -80.4 Co-Go-Me angle >125.5- poor responders Co-Go-Me angle< 125.5- good responders.	smaller than 125.5° is expected to respond favourably to treatment.
Kumar et al (2013)	Linear parameters, Angular parameters, Percentage parameters	Parameters statistically significant in Group 1 after pre and post treatment comparison: 1.Co-Go length is increased with (P value <0.05) 2.Overjet is reduced (p value <0.05) 3.SNB angle increased (p value <0.001) 4.ANB angle is decreased (P-value 0.001) 5.Jarabak ratio becomes average with (P-value <0.01) Group 2 post treatment parameters are not statistically significant.	Low mandibular plane angle, Low basal plane angle and High Jarabak ratio are the pre-treatment parameters related to a success of functional appliance.
Kim et al, (2017)	Linear parameters, Angular parameters	Significant cephalometric changes seen in post treatment parameter such as gonial angle, Distance from vertical reference plane to B point and Vertical reference plane to pogonion. 1.L1 to pogonion with coefficient determination of 0.473 effective predictor. 2.IMPA and Gonial angle with coefficient of determination of 0.719 most strongly related variables. 3.In combination with L1 to pogonion the coefficient of determination 0.751and it is increased to 0.818 when combined with vertical factor SN to MxP.	Small symphysis inclination, IMPA, L1 to Pogonion, ANB, SN to MxP, SN to MnP and gonial angle and large L1 to Occ are the pre-treatment cephalometric parameters for the favourable soft tissue profile outcomes.
Lombardo et al (2020)	Sagittal skeletal relationship, Vertical skeletal relationship, Dimensional and Morphological mandibular measurements	Step wise linear regression model found. Co-Go-Me angle as single predictive variable – Correlation coefficient -0.563. And it is statistically significant(p=0.000).	Smaller Pre-treatment value of Co-Go-Me angle produces greater advancement of soft tissue chin on profile.
Bock et al (2021)	Parameters used in Peer Assessment rating Index and correlated with skeletal maturity and severity of class II molar relation.	Occlusal severity was statistically significant and Skeletal maturity not be a determinative factor for outcome quality. 1.Skeletal maturity (p=<0.82) 2.Occlusal severity(p=<0.019)	The Herbst appliance was effective irrespective of the pre-treatment skeletal maturity but was dependent on occlusal severity to some extent for favourable outcome.

Among the 8 included studies, Ahn et al [9] used Bionator as an intervention in his study, Bock et al [10] used Herbst appliance as a functional appliance in their study, and in six studies Kumar et al [11], Franchi et al [12], Lombardo et al [13], Patel et al [14], Caldwell et al [15], Kim et al [16] the functional appliance used was twin block.

Types of Parameters Assessed:

Out of the eight included studies Kumar et al [11], Franchi et al [12], Lombardo et al [13] and Kim et al [16] included only cephalometric variables. Patel et al [14], Ahn et al, [9] Bock et al [10] and Caldwell et al [15] included Clinical and Cephalometric variables.

The clinical and cephalometric variables that were found to be significant in the included studies were soft tissue pogonion, lower lip position, Lower lip thickness, Upper lip thickness, Lower lip thickness (Sn-Pog), overjet, overbite, ANB angle, SNB angle, Co-Go-Me angle(L), Co-Gn length, Co-Go length, Lower posterior facial height, VRP-B, VRP-Pog, S-N-Pog, facial convexity angle, articular angle and Jarabak ratio.

RISK OF BIAS

Most of the studies selected in this review were retrospective, except the study by Caldwell et al which was prospective. The Newcastle Ottawa scale was used to assess the risk of bias for each of the included studies.[8] The following domains such as the representativeness of the sample, sample size, ascertainment of the exposure, comparability, assessment of the outcome and the statistical test used was assessed. Four studies were rated as "VERY GOOD" study with 9 points based on representativeness of the sample, sample size, ascertainment of the exposure, comparability, assessment of the outcome and the statistical test used. Four studies were rated as "SATISFACTORY" study with 7 points based on representativeness of the sample, ascertainment of the exposure, comparability assessment of the outcome and the statistical test used. The result of the risk of bias assessment is included in TABLE 3.

DISCUSSION

One of the important criteria for growth modification therapy with functional appliance is proper selection of patient. Hence it is important is selection of patients who possess certain characteristics or features to get the desired outcome from functional appliance therapy.

The primary aim of the study was to evaluate the factors that predict or influence the success of functional appliance therapy in treatment of Class II skeletal malocclusion. All the studies included in this review were retrospective in nature except one study. Evaluation of risk of bias of the 8 selected articles, done by two authors using the Modified Newcastle Ottawa Scale reported four studies rated as "VERY GOOD" study with 9 points. Four studies were rated as "SATISFACTORY" study with 7 points based on representativeness of the sample, ascertainment of the exposure, comparability, assessment of the outcome and the statistical test used.[13] One systematic review given by Bock et al and another review by Wins et al were excluded in this review as the authors described the factors for stability of results with functional appliance which was particularly related to the sagittal dimension.[6,18]

From qualitative review of the eight selected articles, smaller Co-Go-Me angle, decreased SNB angle, increased ANB angle, smaller articular angle, low basal plane angle, smaller upper and lower facial heights, low mandibular

plane angle, small symphysis inclination, small IMPA, small SN to MxP & SN to MnP, small L1 to Pog and high Jarabak ratio are the cephalometric variables that were identified as determinants for a successful outcome from functional appliance therapy. In addition, some clinical variables like soft tissue pogonion, lower lip position, increased overjet and overbite were also found to be reported to be important prognostic factors that influence the outcome from functional appliance treatment.

Out of the eight studies included in the review only two studies were able to proclaim one cephalometric parameter the Co-Go- Me angle as the single most predictor for favourable outcome with functional appliances given during peak of pubertal growth spurt in cervical vertebral maturation stage 3.[21,14] Both the authors suggested that smaller the Co-Go-Me angle, greater was the advancement of the soft tissue chin. In the study by Lombardo et al [13] the correlation coefficient for Co-Go-Me angle was 0.563 and it was highly statistically significant($p=<0.05$) and a cut off value of 125.5° was given by Franchi et al [12]. Patients with Co-Go-Me angle lesser than 125.5° were considered to be good responders and vice versa. In both the above -mentioned studies the conclusions were based on either the increase in soft tissue chin projection or the increase in total mandibular length. Majority of the studies included in this review suggested many parameters or a group of parameters either cephalometric or dentoalveolar variables as good predictors of outcome with functional appliance therapy.

Some of them reported parameters related to horizontal growth pattern of the mandible or hypodivergency like basal plane angle, Jarabak ratio, articular angle, decreased lower anterior facial height, small gonial angle, SN-mandibular plane angle as good predictors for favourable outcomes with functional appliance therapy.

Six articles evaluated the role of ANB in predicting favourable outcome with functional appliances and the results were found to be equivocal. Three studies mentioned ANB to be good predictor [9,12,15] whereas three other studies found it to be statistically insignificant.[11,14,16]. Apart from the above-mentioned cephalometric parameters the study by Kim et al, [16] reported small maxillary plane angle and smaller symphysis inclination to be positive predictors for functional appliance therapy.

In addition to the skeletal parameters, dental parameters like increased overjet and overbite, and the angle between long axis of lower incisor to pogonion to be important predictive factors for functional appliance therapy.[11,9,14] Both overjet and overbite were reported as two important factors related solely to favourable outcome with functional appliance by Caldwell et al,[15] but they were only correlated to the amount of overjet reduction actually an outcome of both skeletal and dentoalveolar change but not reflecting true skeletal response which is more desired as a favourable outcome with any functional appliance. Only one study has reported lower lip protrusion to favourable outcome with functional appliances but it was reported as one of the many other factors identified as favourable cephalometric parameters.

Majority of the studies included in this review suggested many parameters or a group of parameters either cephalometric or dentoalveolar variables as good predictors of outcome with functional appliance therapy. Two studies like Lombardo et al,[13] and Franchi et al,[12] suggested a single most predictor the Co-Go-Me angle for successful functional appliance therapy. This angle, between the condylar axis (Co-Go) to the mandibular base (Go- Me) was considered by the authors to be a representation of the morphological characteristic of mandible and also directly related to changes in the mandible produced by functional appliances at the tissue level.[19,20] This angle was also found to be positively correlated to mandibular plane inclination which is an important

determinant factor in selecting a case for functional appliance. A meta-analysis could not be planned for this parameter as it was reported by only two studies and a cut off value was given for this angle in only one of the article [14] and the other article did not provide a mean value for the same.

Most of the included studies in this review used the pre-treatment sample as the control group and in only one study the control group was patients with unfavourable outcomes, in such case the latter scenario would be more ideal than the former. Future research should be directed towards testing the validity of the identified factors in predicting the outcome of treatment with functional appliances.

CLINICAL SIGNIFICANCE & LIMITATION:

Prognostic factors help in identifying the patient who will benefit the most from any treatment modality. This systematic review has identified some factors which could predict a favourable outcome with functional appliance therapy in skeletal class II malocclusion which in turn can be used to select patients for functional appliance therapy. Though the level of evidence obtained from this systematic review is low to moderate, the findings could propel further advanced research focussing on these parameters to delineate specific predictive factors for class II growth modification.

CONCLUSION

 Based on the qualitative review of seven selected articles the following conclusions were drawn

1. Four articles were of very good quality and four articles were found to be of satisfactory as per Modified New Castle Ottawa Scale.
2. Factors related to horizontal growth pattern were favourable predictors.
3. Smaller Co- Go-Me angle was identified as a single most important predictive factor for successful outcome with functional appliances by two included studies.
4. Further studies are required to validate specific cephalometric or clinical factors to arrive at a single predictor for favourable outcome with functional appliance.

CONFLICT OF INTEREST DISCLOSURE

FUNDING

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Figure Legends:

Figure 1- Prisma Flow Diagram depicting search results.