**INTRODUCTION**

The Twin block was developed by Dr William J. Clark in 1977. Even though it’s a removable appliance requiring patient compliance, it’s still one of the most widely used functional correctors.

Twin-block appliance consists of upper and lower acrylic bite blocks with interlocking occlusal inclined planes at 70° angle, which functions to bring the mandible in its desired forward and downward position. It’s mainly indicated in actively growing Class II division I malocclusions.

Multiple authors have reported variable results with variable intensities till date. A recent systematic review reporting all the treatment effects of Twin Block was lacking.

The aim of this review is to assess the possible skeletal, dental and soft tissue treatment effects of the conventional Twin-block appliance compared to controls in Class II malocclusion individuals till date.

**MATERIALS AND METHODS**

**Information sources**

The electronic databases of Medline, PubMed and Cochrane library were systematically searched until September 2019. A limited grey-literature search was also done in Google Scholar.

**Search strategy**

Table 1 shows the terms used to carry out the search. Duplicate results were eliminated.

Inclusion criteria:

1. Human Cephalometric studies.
2. Use of conventional Twin-block appliance.
3. Cases treated with Non-extraction and Non-surgical approach to prevent introduction of any confounding factors.
4. Comparison with control group of untreated Class II malocclusion cases.
Selected abstracts were further subjected to scrutiny of the complete text. Also, when the abstracts were found to be unclear, the full text was obtained.

The 10 articles (FLOW CHART 1) which met all the inclusion criteria were finally included in the systematic review. Google Scholar did not reveal any different results than those from Pubmed/ Medline or Cochrane library. (FLOW CHART 2).

**Table 1: Search data and search strategies.**

| Database                        | Search strategy                                                                 | Number of Results |
|---------------------------------|---------------------------------------------------------------------------------|-------------------|
| Medline/PubMed: 1989 to present | (twin block OR twin-block OR twinblock) AND [(treatment outcome OR treatment effect$) OR (skeletal effect OR skeletal change) OR (dental effect OR dental change) OR (facial change or profile change or soft-tissue change)] | 251               |
| Cochrane library: 1989 to present |                                                                                | 70                |
| Google Scholar: 1989 to present |                                                                                | 14,800            |

**Study selection**

For each database search, first the titles and abstracts were evaluated. The articles that did not match the inclusion criteria, case reports, literature reviews, systematic reviews, editorial articles were all excluded. Articles including animal studies, modified twin block, non-cephalometric analysis were excluded.

**Electronic search - 321**
(Medline/PubMed, Cochrane library)

- From 321 Articles excluded by title -210
- From 111 Screening of abstracts
  - Exclusion of non-relevant studies- 81
- From 30 Screening of full text
  - Exclusion of non-relevant studies- 20
- Study selection complete (10)
  - (10 studies meeting all criteria selected)

**Flow Chart 1**

- **PUBMED/ MEDLINE SELECTION**
  - Total results: 251
  - Out of 251- Irrelevant: 167
  - Out of 84- Comparison with other functional appliance: 50
  - Out of 34- Not a study (case report/ review): 7
  - Out of 27- Investigation method other than cephalogram: 3
  - Out of 24- Not in english (chinese): 4
  - Out of 20- No control group: 4
  - Out of 16- Modified twin block used: 7
  - Out of 9- repetitive articles from same authour, less comprehensive excluded: 1
  - 8 articles selected

- **COCHRANE LIBRARY SELECTION**
  - Total results: 70
  - Out of 70- Irrelevant: 38
  - Out of 32- Comparison with other functional appliance: 21
  - Out of 11 – Modification of Twin Block used: 1
  - Out of 10- Similar studies by same authors, less comprehensive excluded: 2
  - 8 articles selected
  - Out of 8- duplicate from PUBMED: 6
  - 2 new articles

**Flow Chart 2**
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### Table 2: Methodological score used in the review.

| I. Study design (6√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A. Objective - objective clearly formulated (√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| B. Sample size - considered adequate and estimated before collection of data (√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| C. Baseline characteristics - similar baseline characteristics (√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| D. Co-interventions (√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| E. Randomization - random sampling (√); random allocation of treatment (√) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

### Table 2: Methodological scores for the selected articles.

| Article | Objective | Sample Size | Baseline | No Co-interventions | Random Sampling | Random Allocation | Measurement Method | Examiner | Statistician | Intra-rater | Inter-rater | Statistical Analysis | Confounders Included in Analysis | P value | Confidence Interval | Clinical Significance | Total Score (Out of 17) | Risk of Bias |
|---------|------------|-------------|----------|---------------------|-----------------|------------------|---------------------|----------|--------------|------------|-------------|-----------------------|-------------------------------|---------|---------------------|----------------------|------------------------|------------|
| 1) Illing et al. | √ | / | √ | √ | x | √ | √ | x | √ | x | √ | √ | √ | / | 14 | L |
| 2) Jena et al. | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 12 | M |
| 3) Lund & Sandler | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 12 | M |
| 4) Morris et al. | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 14 | L |
| 5) Varlik et al. | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 13 | L |
| 6) Dauvravu et al | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 9 | H |
| 7) Khoja et al | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 11 | H |
| 8) Baysal et al | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 10 | H |
| 9) Baysal et al | √ | / | √ | √ | x | x | x | x | x | x | x | x | x | / | 10 | H |
| 10) Tümer et al | √ | / | x | x | x | x | x | x | x | x | x | x | x | / | 9 | H |

Maximun number of √s = 17
√ = met; × = not met; / = partially met.
Data items and collection
Skeletal cephalometric findings denoting antero-posterior maxillary changes, mandibular changes, vertical changes, dental findings denoting effects on maxillary and mandibular molars and incisors, overjet and soft tissue findings such as the nasolabial angle, mentolabial sulcus and the position of upper and lower lip were collected.

Risk of bias in individual studies
Risk of bias was assessed through the evaluation of methodological quality study characteristics (Table 2).

Intra-rater reliability, interrater reliability, and blinding of examiner and/or statistician were considered. The studies were labeled as low risk, medium risk and high risk for bias. (Table 3).

Summary measures
Basic study characteristics for each of the 10 studies are mentioned in Table 4.

RESULT
Selection and study characteristics
A total of 10 articles meeting the inclusion criteria were selected as shown in Flow Chart 1 & 2.

Risk of Bias within Studies
Out of the 10 studies 3 studies have a low risk of bias, 5 studies have a high risk of bias and remaining studies have a medium risk of bias.

Antero-posterior effects on maxilla (Table 5)
Illing et al, Dauvravu et al, Baysal et al have reported a significant headgear effect. Whereas, Jena et al, Lund and Sandler, Khoja et al, Baysal et al have reported maxillary restrictive effect which were statistically insignificant. Varlik et al reported no maxillary restrictive effect.

Antero-posterior effects on mandible (Table 6)
All authors have reported statistically significant increase in mandible.

Vertical effects (Table 7)
Illing et al, Lund and Sandler, Khoja et al, Baysal et al and Tümer et al have stated statistically significant increase in the vertical height and Baysal et al have reported insignificant findings.

Effects on maxillary molar (TABLE 8)
Jena et al, Lund and Sandler, Dauvravu et al and Tümer et al have revealed statistically significant restrictive effect on the maxillary molars and, Baysal et al have reported otherwise.

Effect on mandibular molar (TABLE 9)
Lund and Sandler, Dauvravu et al and Tümer et al have reported statistically significant advancement of the mandibular molar. Baysal et al and Jena et al have reported statistically insignificant findings.

Effect on maxillary incisors (TABLE 10)
Except for Baysal et al and Baysal et al, all other studies have reported statistically significant decrease in maxillary incisors inclination.

Effect on mandibular incisors (TABLE 11)
Except for Baysal et al and Baysal et al, all

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Table 4: Summary of selected articles.

| Study Type* | Total | Twin Block | Control | Mean age of combined groups at T1 (years) | Skeletal maturity indicators | Treatment duration (months) |
|-------------|-------|------------|---------|------------------------------------------|-----------------------------|----------------------------|
| 1) Illing et al | P | 36 | 16 | 20 | 11.2 | - | 9 |
| 2) Jena et al | P | 35 | 25 | 10 | 11.4 | - | 12.78 |
| 3) Lund and Sandler | P | 63 | 36 | 27 | 12.4 | - | 14.4 |
| 4) Morris et al | P | 36 | 16 | 20 | 11.2 | - | 9 |
| 5) Varlik et al | P | 50 | 25 | 25 | 11.9 | MP3 H stage | 8 |
| 6) Dauvravu et al | P | 28 | 17 | 11 | 10-14 years | CVMI- III and IV MP3-H stage | 11.5 |
| 7) Khoja et al | P | 113 | 53 | 60 | 11.3 | CVMI- II, III, IV | 8-12 |
| 8) Baysal et al | P | 40 | 20 | 20 | 12.58 | MP3 S and H2 stage | 15.89 |
| 9) Baysal et al | P | 40 | 20 | 20 | 12.58 | MP3 S and H2 stage | 15.89 |
| 10) Tümer et al | P | 26 | 13 | 13 | 13 | - | 7-14 |

*P= prospective, R= retrospective; - =not mentioned

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Table 5: Skeletal antero-posterior effects on maxilla.

| Study          | Parameter                           | Changes Reported | P Value | Significance |
|----------------|-------------------------------------|------------------|---------|--------------|
| 1) Illing et al.⁷ | SNA                                 | 0.3              | -1.4    | p<0.01       | S             |
| 2) Jena et al⁹  | -                                   | 2.04             | -1.64   | p=0.259      | NS            |
| 3) Lund and Sandler⁷ | SNA                                 | 0.3              | -0.1    | p>0.05       | NS            |
| 4) Varlik et al¹¹ | Point A to Y axis (Se to ptm)      | 0.2              | 1.2     | p<0.05       | NS            |
| 5) Dauvravu et al¹² | Ss/rlp (Pancherz analysis)     | -                | -0.67   | p=0.022      | S             |
| 6) Khoja et al¹³ | SNA                                 | 0.04±0.10        | -0.19±1.10 | p=0.168      | NS            |
| 7) Baysal et al¹⁴ |                        | 1.35             | -0.45   | p<0.05       | NS            |
| 8) Baysal et al¹⁵ |                        | 0.20             | -0.75   | p=0.004      | S             |
| 9) Tümer et al¹⁶ |                        | 0.05             | -0.23   | p>0.05       | NS            |

S= significant, NS= not significant

Table 6: Skeletal antero-posterior effects on mandible.

| Study          | Parameter                           | Changes Reported | P Value | Significance |
|----------------|-------------------------------------|------------------|---------|--------------|
| 1) Illing et al.⁷ | Ar to Gn                            | 1                | 3.2     | (p<0.05)     | S             |
| 2) Jena et al⁹  | -                                   | 3.54mm           | 5.52mm  | (p<0.01)     | S             |
| 3) Lund and Sandler⁷ | SNB                                | 0.4              | 1.9     | (p=0.001)    | S             |
| 4) Varlik et al¹¹ | B to Y axis (Se to ptm)            | 0.4              | 4.2     | (p=0.001)    | S             |
| 5) Dauvravu et al¹² | pg/OLp (Pancherz analysis)     | -                | 4.88mm  | (p=0.000)    | S             |
| 6) Khoja et al¹³ | SNB                                 | 0.17±1.03        | 1.73±1.22 | (p<0.001)    | S             |
| 7) Baysal et al¹⁴ | pg/OLp (Pancherz analysis)      | 2.12             | 4.62    | (p=0.009)    | S             |
| 8) Baysal et al¹⁵ |                        | 0.45             | 2.07    | (p=0.001)    | S             |
| 9) Tümer et al¹⁶ |                        | 0.31             | 1.77    | (p<0.01)     | S             |

S= significant, NS= not significant

Table 7: Vertical skeletal effects

| Study          | Parameter                           | Changes Reported | P Value | Significance |
|----------------|-------------------------------------|------------------|---------|--------------|
| 1) Illing et al.⁷ | Lower anterior facial height        | -0.3             | +2.7    | (p<0.01)     | S             |
| 2) Lund and Sandler⁷ | Total anterior facial height       | 2.3              | 4.9     | (p=0.001)    | S             |
| 3) Khoja et al¹³ | Sn-GoGn                            | -0.19±1.09       | 0.60±2.45 | (p=0.029)    | S             |
| 4) Baysal et al¹⁴ | Lower anterior facial height        | 2.05             | 3.85    | (p=0.022)    | S             |
| 5) Baysal et al¹⁵ | Sn-GoGn                            | -0.62            | -0.25   | (p=0.05)     | NS            |
| 6) Tümer et al¹⁶ | Ar-Go-M                            | -0.73            | 2.31    | (p<0.01)     | S             |

S= significant, NS= not significant

Table 8: Effects on maxillary molar

| Study          | Parameter                           | Changes Reported | P Value | Significance |
|----------------|-------------------------------------|------------------|---------|--------------|
| 1) Jena et al⁸  | -                                   | -0.36mm          | -1.36mm | (p<0.05)     | S             |
| 2) Lund and Sandler⁷ | U6 -horizontal                    | 0.9              | -0.7    | (p=0.05-0.01) | S             |
| 3) Dauvravu et al¹² | (mi/RLp by Pancherz analysis)      | -                | -0.133±1.245mm | (p=0.014)    | S             |
| 4) Baysal et al¹⁴ | mi/OLp-pg/OLp (Pancherz analysis)  | 0.27             | -0.52   | (p<0.05)     | NS            |
| 5) Tümer et al¹⁶ | U6 to Ptv                          | 1.50             | -0.54   | (p<0.01)     | S             |

S= significant, NS= not significant
Table 9: Effects on mandibular molar

| Study          | Parameter                                                                 | Changes Reported | P Value     | Significance |
|----------------|---------------------------------------------------------------------------|------------------|-------------|--------------|
| Jena et al³    | L6- horizontal                                                           | 0.27mm-1.53mm    | (p>0.01)    | NS           |
| Lund and Sandler⁴ | mi/RLp(d) minus pg/RLp(d) (Pancherz analysis)                        | -0.666±1.496mm   | (p>0.01)    | S            |
| Baysal et al⁴  | L6/Plv                                                                   | 2.04-4.89mm      | (p<0.01)    | S            |

S= significant, NS= not significant

Table 10: Effects on maxillary incisor

| Study          | Parameter                                                                 | Changes Reported | P Value     | Significance |
|----------------|---------------------------------------------------------------------------|------------------|-------------|--------------|
| Illing et al⁷  | U1 to maxillary plane                                                     | -1.9-9.1         | (p<0.01)    | S            |
| Jena et al³    | -                                                                         | -0.53mm-1.43mm   | (p<0.001)   | S            |
| Lund and Sandler⁴ | U1 to maxillary plane                                                  | -0.2-11          | (p<0.001)   | S            |
| Morris et al¹⁰ | U1- SN                                                                    | 0.2-2.6          | (p<0.001)   | S            |
| Varlik et al¹¹ | is/RLp (Pancherz analysis)                                               | 0.866±1.125mm    | (p=0.054)   | S            |
| Khoja et al¹³  | U1- SN                                                                    | 1.12 ± 4.19-4.66 ± 5.44 | (p<0.001)   | S            |
| Baysal et al¹⁴ | U1- SN                                                                    | 1.62-1.47        | (p<0.001)   | S            |
| Tümer et al¹⁴  | U1/Plv                                                                    | 1.58-1.50        | (p<0.001)   | S            |

S= significant, NS= not significant

Table 11: Effects on mandibular incisor

| Study          | Parameter                                                                 | Changes Reported | P Value     | Significance |
|----------------|---------------------------------------------------------------------------|------------------|-------------|--------------|
| Illing et al⁷  | Lower incisor to mandibular plane                                         | -0.7+2           | (p<0.001)   | S            |
| Jena et al³    | -                                                                         | -0.59mm+1.44mm   | (p<0.001)   | S            |
| Lund and Sandler⁴ | Li- mandibular plane                                                    | 0.9-4.4         | (p<0.001)   | S            |
| Varlik et al¹¹ | IMPA                                                                      | No change 1.3    | (p<0.001)   | S            |
| Dauvravu et al¹² | li/rlp                                                                    | 1.40±1.638mm     | (p=0.012)   | S            |
| Khoja et al¹³  | IMPA                                                                      | 1.05 ± 3.45-4.30 ± 3.91 | (p=0.001)   | S            |
| Baysal et al¹⁴ | li/olp- pg/olp                                                           | -0.40-0.15      | (p<0.05)    | NS           |
| Baysal et al¹⁵ | IMPA                                                                      | 0.57-0.92        | (p<0.05)    | NS           |
| Tümer et al¹⁴  | L1/Plv                                                                    | 1.19-5.73       | (p<0.01)    | S            |

S= significant, NS= not significant

other authors have reported statistically significant proclination of mandibular incisors.

Effects on the Overjet (Table 12)

All studies have reported a statistically significant decrease in the overjet.

Soft tissue effects of Twin Block (Table 13)

Morris et al,¹⁰ Varlik et al,¹¹ Khoja et al¹³ and Baysal et al¹⁴ have reported statistically significant retrusive upper lip effect with a significant increase in nasolabial angle, whereas insignificant findings were reported by Morris et al¹⁰ and Baysal et al.¹⁴ Morris et al,¹⁰ Khoja et al¹³ and Baysal et al¹⁵ have narrated a statistically significant lower lip protrusion, whereas, Varlik et al¹¹ reported otherwise. Of these four studies, Morris et al¹⁰ revealed insignificant change whereas Varlik et al¹¹ and Baysal et al¹³ reported statistically significant increase in the mentolabial sulcus depth.
Table 12: Effects on the overjet

| Study          | Parameter | Changes Reported | P Value | Significance |
|---------------|-----------|------------------|---------|--------------|
|               |           | Control group    | Treatment group |   |             |
| 1) Illing et al² | Overjet   | 0.8              | -5.7    | (p<0.01)     | $S$ |
| 2) Jena et al⁸  | Overjet   | 0.37mm           | -6.75mm | (p<0.001)    | $S$ |
| 3) Lund and Sandler⁹ | Overjet | -0.3             | -7.9    | (p<0.001)    | $S$ |
| 4) Dauvravu et al¹² | is/RLp-II/RLp | -6.54±1.12mm    | (p<0.000) | $S$ |
| 5) Khoja et al¹³ | Overjet   | -0.30 ± 1.25     | -6.50 ± 2.46 | (p<0.001)    | $S$ |
| 6) Baysal et al¹⁴ | is/OLp-II/OLp | 0.38             | -4.48   | (p=0.000)    | $S$ |
| 7) Türmer et al¹⁶ | Overjet   | 0.27             | -7.46   | (p<0.01)     | $S$ |

S= significant, NS= not significant

Table 13: Soft tissue effects

| Study          | Parameter | Changes Reported | P Value | Significance |
|---------------|-----------|------------------|---------|--------------|
|               |           | Control group    | Treatment group |   |             |
| 1) Morris et al¹⁰ | 1. Upper lip to E line | 0.7              | -1.4    | p<0.01       | $S$ |
|               | 2. Lower lip to E line | 0.8              | 3.8     | p<0.05       | $S$ |
|               | 3. NLA:   | 6                | 3.8     | p<0.05       | NS |
|               | 4. MLS:   | 12.1             | -0.6    | p>0.05       | NS |
| 2) Varlik et al¹¹ | 1. Upper lip: Ls to Y Line | 0.03             | -2.23   | P< 0.001     | $S$ |
|               | 2. Lower lip: Li to Y axis | 0.23             | 3.10    | p<0.001      | $S$ |
|               | 3. NLA:   | 0.10             | 6.23    | p<0.05       | $S$ |
|               | 4. MLS:   | 0.50             | 16.35   | p>0.001      | $S$ |
| 3) Khoja et al¹³ | 1. Upper lip to E-line | -0.62 ± 3.47     | -0.81± 2.41 | p=0.015     | $S$ |
|               | 2. Lower lip to E-line | -0.55 ± 4.24     | 0.37 ± 1.57 | p=0.082     | NS |
|               | 3. NLA:   | -3.72± 14.17     | 3.64 ± 9.83 | p=0.001     | $S$ |
|               | 4. MLS:   | -                | -       | -            | -            |
| 4) Baysal et al¹⁵ | 1. Upper lip to E line | 0.22             | -2.72   | p<0.001      | $S$ |
|               | 2. Lower lip to E line change | -0.32             | -0.9    | p<0.001      | $S$ |
|               | 3. NLA:   | 2.35             | -0.35   | p>0.05       | NS |
|               | 4. MLS:   | -10              | 22.6    | p<0.001      | $S$ |

S= significant, NS= not significant

**DISCUSSION**

According to the results, restrictive maxillary effects of Twin block were reported by a few studies,⁷,¹²,¹⁵ whereas most studies reported no restrictive maxillary effect ⁸,⁹,¹¹,¹³,¹⁴,¹⁶ All the studies reported a significant increase in the mandibular jaw base.⁷⁻¹⁶

Out of the 10 studies, only 6 studies have registered vertical skeletal changes. All have found statistically significant increase in vertical dimensions ⁷⁻¹⁶ except for one study which gave insignificant results.⁹

Out of the studies that reported maxillary molar and mandibular molar changes only one study 14 reported insignificant changes while others showed a statistically significant maxillary molar restrictive effect and a mandibular molar advancement.⁸,⁹,¹²,¹⁶

Except for Two studies¹⁴,¹⁵ all other studies reported a significant decrease in the inclination of the maxillary incisors.⁷⁻⁹,¹¹⁻¹³,¹⁶ Most of the studies reported a significant mesial mandibular incisor movement.⁸,⁹,¹¹⁻¹³,¹⁶ Some studies have reported insignificant mandibular incisor change.⁷⁻¹⁴,¹⁵

Except for the 3 studies that did not report changes in the overjet ¹⁰,¹¹,¹⁵ all have reported a significant decrease in the overjet.⁷⁻⁹,¹²⁻¹⁴,¹⁶
Studies reporting soft tissue parameters were only four.\textsuperscript{10,11,13,15} Equal number of studies found significant\textsuperscript{11,13} and insignificant\textsuperscript{10,15} changes in the Nasolabial angle. Two studies found significant\textsuperscript{11,15} change in the Mentolabial sulcus whereas one study found an insignificant result.\textsuperscript{10} All studies found a significant posterior positioning of the Upper lip,\textsuperscript{10,11,13,15} and anterior positioning of the Lower lip position,\textsuperscript{10,11,15} except for one.\textsuperscript{13}

**CONCLUSION**

This systematic review has aimed to find out the dental, skeletal and soft tissue effects of the conventional Twin Block appliance as compared with the control. From this systematic review it can be safely concluded that the conventional Twin Block appliance is indicated for individuals diagnosed with a Class II malocclusion with a horizontal growth pattern and a frank mandibular retrognathism. The use of this appliance is contraindicated in the cases of maxillary prognathism. Effective and favourable soft tissue changes are seen. However, some inevitable dental changes mainly lower anterior proclination are strongly reported which need to be timely addressed.

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