

C. Maspero, G. Galbiati, L. Giannini, G. Guenza,
M. Farronato

Department of Orthodontics, Fondazione IRCCS cà Granda
Ospedale Maggiore Policlinico. University of Milan, Italy

e-mail: cinzia.maspero@gmail.com

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Class II division 1 malocclusions: comparisons between one- and two-step treatment

ABSTRACT

Aim The aim of this study consists in comparing the two-step treatment with that performed in a single-step in adolescent patients.

Material and methods Study design: This paper is a critical review of the literature with a systematic approach. The search for scientific articles was performed on the US National Library of Medicine database using the PubMed service. Keywords set: "Early treatment Class II OR 1-phase orthodontics OR orthodontic timing Class II". From the initial screening 20 articles were selected of which the full text has been researched and evaluated.

Results The selected articles were reviewed and evaluated by two independent operators, who both excluded two papers. Ultimately 13 articles were selected that refer to four major working groups, respectively from Manchester, North Carolina, Florida and Queen Mary University of London..

Conclusions We can assume that both the one- and two-step treatment are effective in correcting Class II malocclusion, with no significant difference of outcome, except for the incidence of incisor trauma, which was significantly lower for the early treatment group.

Keywords Early Class II treatment; 1-phase 2-phase orthodontics; Timing of Class II treatment.

Introduction

Class II malocclusions represent a significant percentage of orthodontic cases treated in clinical practice. Ast et al. [1965] tried to assess the prevalence of Class II malocclusion in a study in which they examined 1.413 adolescents aged between 15 and 18 years. According to this study, Class II malocclusion occurs in about one third of the examined children. In some studies, Class II malocclusion has been associated with a higher prevalence of muscles strain problems, but there is a clear lack of association with strictly joint issues (click, lock joint, dislocations): it is therefore impossible to make any forecast of proper development of TMD on the basis of the presence or absence of a II Class malocclusion [Farronato et al., 2016]. Considering their prevalence in the population and the fact that Class II malocclusion, especially if accompanied by an increased overjet, is often a cause of concern for patients and parents, the aim of this study is to analyse what the scientific literature suggests regarding the timing of treatment. In particular, we wanted to compare the results of treatment performed in two steps and treatment performed in one step.

Generally, a two-step treatment requires a first treatment when only the permanent incisors and first molars have erupted, followed by a second treatment in permanent dentition. Class II malocclusions have a strong transverse component, since the constricted maxillary bone impedes physiological sagittal mandibular growth. The expansion of the maxilla disrupts the occlusion determining a slight forward position of the mandible, and a statistically significant increase in the SNB angle is obtained during treatment [Maspero et al., 2015a; Farronato et al., 2011]. Teeth themselves act as an endogenous functional appliance, encouraging a change in the mandibular posture and subsequently a change in the maxillary-mandibular occlusal relationship. When this does not occur, the mandibular growth can be influenced by a variety of orthodontic appliances because of the skeletal and neuromuscular adaptations that occur as a response to therapy. Fixed (headgear) or functional appliances could be applied to correct the skeletal discrepancy and to achieve a Class I molar relationship. An additional aim might be to achieve a normal overjet and overbite at this time, as well as aligning the incisors and securing space in the arches for the developing canine and premolar teeth, via the use of palatal and lingual arches [Dugoni et al., 1992]. The early treatment should be as short as possible, followed by a period of contention.

One-step treatment is instead carried out in a single stage, when the patient is in late mixed or permanent dentition. Once sagittal correction has been achieved, the patient is usually required to wear upper and lower fixed appliances to level and align the teeth and to finish the orthodontic treatment [Brierley et al., 2017]. These two different therapeutic approaches set off a heated debate and whether early treatment for Class II malocclusion is

truly effective or not remains controversial.

The proponents of the 2-phase treatment suggest that there are significant benefits to early intervention including the following.

- Normalisation of the skeletal pattern and growth.
- A reduction of the length of any subsequent phase II treatment.
- Future courses of orthodontic treatment are simpler and quicker.
- Reduced need for future extraction of permanent teeth.
- Reduced risk of traumatic dental injuries is also significantly reduced [Brierley et al., 2017].
- Elimination of the adaptive changes in the upper airway and predisposing factors to OSAS (in particular, there is a positive impact of Andresen appliance therapy on the PAP dimension) [Maspero et al., 2015b].

Clinicians advocating a single-phase treatment argue that this approach:

- Decreases total treatment time.
- Is carried out at the optimum time which coincides with the adolescent growth spurt.
- Reduces the patients' total time off of school.
- Reduces the parents/carers' time off work.
- Avoids the difficulties of the contention period between phase I and phase II.
- Reduces the financial burden of treatment.
- Reduces the consequences of a prolonged course of treatment including enamel demineralisation and root resorption [Brierley et al., 2017].

The greatest benefit of proceeding with a first phase of treatment seems to be the opportunity to achieve an aesthetic, functional and stable result. The major disadvantage of waiting for permanent teeth to be in occlusion and of considering the one-step treatment for Class II is the risk of results which might not be stable over time. We therefore conducted a literature review to investigate and analyse the questions above mentioned.

Materials and methods

This paper is a critical systematic review of the Literature in order to compare the two-step treatment started early with that performed in a single step with the patient in early adolescence. An electronic database search was carried out using the US National Library of Medicine database (PubMed service <http://www.ncbi.nlm.nih.gov/sites/entrez/query.fcgi>). Keywords set: early treatment and Class II have been joined to their synonyms through the use of Mesh search. The terms then inserted in PubMed were: "Early treatment Class II OR 1 phase orthodontics OR orthodontic timing Class II". To restrict the research, the following limits were inserted:

- year of publication between 1990 and 2016;
- study Type: RCT, review and meta-analysis;
- english language of publication;
- publication on dental journals.

The search yielded 126 articles (RCT, review). The titles and abstracts of each article were read and evaluated in order to select randomised controlled clinical trials about the one or two-step treatment of Class II malocclusions. Articles in which purpose and results were not relevant and articles of which the abstract was not available have been excluded. From this screening we selected 20 articles of which the full text has been researched and evaluated.

Results

The selected articles were reviewed and evaluated by two independent operators, who both excluded seven of them. Ultimately were selected 13 articles that refer to four major working groups, respectively from Manchester, North Carolina, Florida and Queen Mary University of London.

One of the studies undertaken in North Carolina has selected as a sample a group of 166 children in mixed dentition, with an overjet > 7 mm, then divided into three groups. A third of the children began treatment with headgear, a third with a functional appliance (modified Bionator), while a third underwent observation alone and was considered as a control group. After 15 months a second phase of treatment for all the three re-randomised groups was performed. The type of treatment was that considered the most appropriate by the clinician who followed the patient, out of the four involved with the trial. Among the 166 children who completed the first stage only 4, which in the first phase were treated with functional unit, had no need to continue with the second phase of treatment. The authors evaluated the dental and skeletal measures, the PAR index, the duration of treatment and the percentage of children who required extractions or orthognathic surgery at the end of the second phase of treatment. Considering dental values in both the sagittal and vertical planes, the study reports that at the end of the second phase of treatment there are no statistically significant differences between the groups treated in one or two steps. Likewise, there are no differences about the PAR index. The authors did not find any advantage in terms of number of extraction and of orthognathic surgery need: the percentage of children who underwent extractions, in fact, showed no statistically significant differences between those subjected to treatment with one or two stages and also the percentage of children who have been subjected to orthognathic surgery is similar in both groups. The children who underwent a single phase treatment had a lower overall duration than children subjected to the treatment in two stages [Tulloch et al., 2004].

In another study undertaken in North Carolina the authors evaluated the incidence of incisal trauma after accident comparing the early treatment group to that in which treatment was not undertaken until adolescence. The results show no statistically significant difference between the two groups. It would seem, in fact, that most of the incisal trauma often occurs at a very early age, often before

the first phase of orthodontic treatment [Koroluk, 2003].

In Florida, Wheeler et al. [2002] designed a study to evaluate the efficacy of early treatment in the correction of Class II malocclusions. The authors evaluated children in mixed dentition with Class II malocclusion. Of the 325 children who underwent randomisation, 277 began the trial and were divided into three groups. The first group was treated with headgear associated to bite-plane, the second group was treated with a functional appliance (Bionator), and the third group did not undergo any treatment. At the end of the early treatment period, cephalometric tracings showed the effectiveness of the treatment itself through a reduction in the value of the ANB angle with statistically significant differences from the untreated children. The same authors, in the continuation of the study, compared the skeletal improvements gained in the treatment of Class II carried out in one or two stages. Skeletal improvements achieved after the first phase of treatment in children treated with headgear/bite-plane or bionator lost statistical significance when reassessed at the end of the second phase of treatment and compared with those patients who underwent a single treatment phase.

Other authors from Florida University who compared the PAR index on cast models, despite the statistically significant difference at the end of the first phase, do not confirm this difference at the end of the second phase of treatment [King et al., 2003]. The centric analysis performed on patients who underwent one or two phases treatment showed the same result: the end of the early treatment leads to an improvement of the mandibular values; these differences are not statistically significant at the end of the second stage of treatment [Dolce et al., 2005]. Pavlow et al. [2008] then evaluated the long-term effects on the occlusion stability looking for differences between subjects treated in one or two phases. The evaluation of the models 5 years after the second treatment phase showed a slight increase in the stability of the results achieved in patients subjected to the 2-step treatment, however, this difference was not statistically significant.

The University of Florida working group also compared the variations in the size of the arch of Class II malocclusions treated in one or two phases of treatment by analysing scans of cast models. Findings showed differences in the size of the arch between subject who underwent an early treatment and those under observation. The patients subjected to the first stage of treatment showed an increase in the length and width of the arch. These differences did not appear, however, at the completion of the second stage of treatment [Wortham et al., 2009]. In another study from Florida University the authors examined the prevalence and incidence of incisor trauma: incisor injury was scored at every data collection point with the Ellis index by a blinded examiner using dental casts, intraoral photos, and panoramic and periapical x-rays. Twenty-five percent of the subjects had incisor trauma at the baseline examination, and 28% experienced new or worsening maxillary incisor injury during the study. No significant differences were

found with regard to sex and prevalence of injury at baseline. No differences in incidence of trauma were found between the 3 treatment groups throughout the study ($P = 0.19$); however, boys were more likely to experience maxillary incisor injury (odds ratio estimate, 2.37; 95% CI, 1.33, 4.21), and those with an injury at baseline were more likely to experience an additional injury (odds ratio estimate, 1.81; 95% CI, 1.03, 3.17) [Chen et al., 2011].

O'Brien et al. [2009a] at Manchester University undertook a study to investigate whether early treatment of Classes II with Twin-block determined a facial aesthetic improvement. The profiles of 20 subjects in the Twin-block treatment group and 20 subjects in the control group were drawn. These drawings were then shown to 30 children aged between 10 and 11 years and to 24 teachers. Children and teachers had to assign, based on their first impression, to each drawing a rating of one to five according to the Likert scale. The results showed that the drawn profile of subjects who received early treatment were considered more pleasant than those of the subjects in the control group. The same authors have also investigated and compared through a multicentric study the effects obtained by orthodontic treatment carried out in two phases and those obtained via a single treatment step in patients with Class II malocclusion [O'Brien et al., 2009b]. One hundred and seventy patients aged between 8 and 10 years with a Class II malocclusion and overjet ≥ 7 mm were divided into two groups, one group was subjected to early treatment with Twin-block and the control group remained under observation for a period of 15 months. At the end of early treatment patients were asked to wear the Twin-block as a retainer while the control group was simply kept under observation. For subjects in both groups a treatment was then undertaken when they reached adolescence. Of the 74 subjects in the study group, 66 continued with the second part of the treatment. Six of them were treated with functional appliances, 11 continued with a mixed treatment with functional orthodontic appliances and fixed appliances, and only 49 underwent fixed orthodontic treatment. Of the 78 subjects who were kept under observation alone, 72 decided to start treatment. Of these, 12 were treated with functional appliances, 46 continued with a mixed treatment with functional and fixed orthodontic appliances and 14 with fixed orthodontics. By analysing these data, it is possible to observe that early treatment, even if it does not eliminate the need for a second treatment stage, influences the type of the latter. Patients treated early with Twin-block tend not to have to use functional appliances during the second step of treatment when compared with those patients who underwent the one-step treatment. Considering instead the duration of the treatments we see that the treatment in two phases, while reducing the duration of the second step, requires a total time longer than that in a single step. As regards the overjet, the authors report a significant reduction in the group treated with Twin-block compared to the observation group at the end of the first step of treatment. If the overjet, however, is evaluated at the end of the adolescent stage of treatment, the differences between

the two groups are not statistically significant.

Similar results are reported in respect of the ANB angle value. The ANB value decreased during the first phase of treatment in patients treated with Twin-block, while it remained unchanged in subjects undergoing observation. At the end of the second step of treatment, however, the ANB values between the two groups did not differ significantly. The psychological effects of the treatment were evaluated through a Piers-Harris questionnaire that allows to evaluate the values of self-esteem. The results showed that self-esteem increased at the end of the first phase of treatment in patients receiving early treatment compared to those who underwent observation alone. At the end of the adolescent treatment, however, this difference in the values of self-esteem disappeared. Evaluating the need for extractions between the two groups we observed that 28 subjects who underwent early treatment had to undergo extractions, while 38 subjects treated in one step underwent extractions. This trend is not statistically significant.

O'Brien and other authors from Manchester University performed a Cochrane systematic review of the treatment of Class II Division I malocclusion [Thiruvengkatachari et al., 2013], then they summarised the most clinically relevant findings of their work [Thiruvengkatachari et al., 2015]. Three early treatment studies with data from 353 participants were included in this review. The results showed no significant difference for any outcomes, except new incidence of incisor trauma, which was significantly less for the early treatment group. The risk ratio analysis for new incisor trauma showed that providing early treatment reduced the risk of trauma by 33% and 41% in the functional and headgear groups, respectively. However, when the numbers needed to treat were calculated, early treatment with functional appliances prevents 1 incidence of incisal trauma for every 10 patients (95% CI, 5-174), and headgear treatment prevents 1 incidence of incisal trauma every 6 patients (95% CI, 3-23).

The London University meta-analyses demonstrated a statistically significant reduction in ANB (-1.4 degrees, 95 CI: -2.17, -0.64) and overjet (-5.81mm, 95 CI: -6.37, -5.25) with both functional appliances and headgear versus control. In the long-term, however, statistical significance was not found for the same outcomes. Treatment duration was prolonged with both functional appliances (6.85 months, 95 CI: 3.24, 10.45) and headgear (12.47 months, 95 CI: 8.67, 16.26) compared to adolescent treatments [Sunnak et al., 2015].

Discussion

This review of the literature shows that orthodontic treatment carried out early in children aged between 7 and 9 years yields an effective overjet reduction. This improved incisive prominence occurs both in subjects treated with functional appliances and in patients treated with headgear. Comparing the effects of early treatment with functional

appliance and headgear there were no statistically significant differences in final overjet and ANB angle value at the end of the first and second phase of treatment. Early treatment results in statistically significant skeletal changes in the relationship between the bone bases of the maxilla and mandible in subjects treated compared to those who underwent observation alone.

Considering however the results obtained at the end of the second phase of treatment, we do not find significant differences between the subjects treated in two phases and those treated later in a single phase. More precisely, by comparing the major studies in the universities of Manchester, North Carolina and Florida we can summarise that all studies report that at the end of the first phase of treatment there is a significant difference in terms of both overjet and ANB angle value between treatment group and control group. Early treatment also has a significant effect on PAR scoring, specifically the group treated early has a lower PAR score when compared with the control group. The results of these studies also suggest that early treatment leads to an increase of self-esteem in subjects treated when compared with the control group. After the second treatment phase subjects treated in two stages and those treated in one step had no statistically significant differences in overjet, final ANB value or PAR score. The improvement in the bone basis relation at the end of early treatment would seem to be a danger of accelerating growth, rather than a permanent change. Considering instead the time and costs of care, treatment in two stages is longer and entails greater total costs than the single stage one. Nevertheless, the early treatment tends to reduce the duration and complexity of the two-step treatment. This can be considered an advantage as the adolescent patient is usually less inclined to undertake orthodontic treatment with respect to the child. Although there are no significant differences in change in the skeletal pattern between patients subjected to early treatment and those treated in one step, it is important to remember that treatment for skeletal Class II is effective if carried out in growing subjects. It can be argued that beginning the orthodontic treatment later with a single-step approach, for some subjects there the residual growth might be insufficient for correction. It would therefore be desirable to decide the timing of treatment, assessing the skeletal age of the patient rather than their chronological age. A critical analysis of the studies considered for this research it is important to emphasise that none of them considered a different treatment timing for each individual.

Cozza et al. [2006] and Baccetti et al. [2009] studies on functional devices efficiency and their ability to promote the mandibular growth in Class II subjects, have shown that the additional amount of mandibular growth is significantly greater if the functional treatment is carried out during the pubertal peak of skeletal maturation. Considering the different growth curve between males and females it would seem reasonable to set the beginning of early treatment at different chronological ages. Early treatment seeking to modify the growth of the jaws and contrast the dysfunctional

component should be made by considering the differences in the growth curve between males and females, and more specifically the trend of the growth curve of the individual. By not taking into account the different growth curve of males and females, there is the risk of performing an early treatment in a male at a time of growth deceleration without obtaining the expected results [Goracci et al., 2017]. As for females, there is the risk that most of the growth has already taken place when starting treatment late.

It should also be noted that Class II malocclusion actually includes a wide variety of clinical situations that require specific and different treatments. In particular, it is necessary to investigate the presence of extrinsic factors that can aggravate or support the malocclusion. The presence of bad habits such as interposition of lips or tongue should not only be identified and recognised but should be interrupted by an early treatment in order to restore a state of harmony between the various skeletal and muscular components. The analysed studies focus on the sagittal plane of Class II division I malocclusion, without specifying the vertical and transverse component of the malocclusion itself. The presence of a deep bite tends to mask the sagittal severity of Class II malocclusions. Even the presence of problems affecting the transverse plane is of great clinical importance. The resolution through early treatment of a narrowed maxilla tends to favour mandibular advancement improving the Class II malocclusion [Showkatbakhsh et al., 2013].

Among the reasons for starting treatment early, so we can recognize the presence of skeletal problems in the three planes of the space, there is the need to exploit the potential for growth of the young patient and stop bad habits [Lione et al., 2015]. We can add to these the risk of dental trauma and the onset of potential social and aesthetic problems caused by the presence of increased overjet [Fabiani et al., 2017].

Limits

We analysed several studies in which different kind of appliances have been used to achieve the sagittal correction, different indexes were taken into account, there were different mean ages of the sample.

Conclusions

From this review of the literature and in particular from the major studies on the issue it is possible to assume that both the one- and two-step treatment are effective in correcting Class II malocclusion, with no significant difference for any outcome, except new incidence of incisor trauma, which was significantly less for the early treatment group. Conditions such as the presence of skeletal impairments, the risk of incisors trauma and the aesthetic discomfort may be suitable motivations for undertaking early treatment.

Conflict of interest

The Authors state not to have any conflict of interest.

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