The timing of treatment for Class II malocclusions in children: a literature review

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There are two general strategies prevailing today for the timing of treatment for Class II malocclusion.[1-6] The first calls for intervention during the pre-adolescent years (ages 8-11) with limited goals that include correction of the molar distocclusion, improvement of the overjet/overbite relationships and incisor alignment.[2] This so-called "early treatment" is usually followed by a more definitive intervention during adolescence (ages 12-15) designed to finish and detail the occlusion. The second major approach to the timing of Class II treatment is to accomplish the entire correction during the adolescent years.

Early treatment as described here should not be confused with either "interceptive" or "preventive" treatment. These latter approaches usually involve fairly limited appliance interventions which successfully produce a satisfactory result without further treatment at adolescence. In contrast, early treatment of a Class II malocclusion is defined as a first phase of a comprehensive treatment, begun prior to adolescence and designed to achieve Class II correction with a second phase required for the completion of treatment.[7]

Efficacy of early treatment of Class II malocclusion

Two lines of thought suggest that commencing orthodontic and/or orthopedic Class II correction in the pre-adolescent period is more effective than delaying it until later. First, the tissues of the craniofacial complex may be more adaptive at a younger age. Second, pre-adolescent patients may be more compliant than teenagers.

Animal studies using both functional jaw orthopedics[8-10] and extra oral forces[11,12] have clearly shown that significant craniofacial modification can be effected in both adult and young animals. However, the magnitude and rate with

Abstract

Two basic strategies for the timing of treatment for Class II malocclusions in children are common: (1) correction achieved in two phases, one during pre-adolescence (early treatment) and the other during the teen years; and (2) correction accomplished in one phase of active treatment during the adolescent years. The issues of efficacy and cost(risk)-benefit of these strategies have not been well delineated. Most clinical studies examining these issues have suffered serious methodological deficiencies, such as being retrospective, lacking adequate controls, and evaluating only successfully treated cases. However, despite a lack of objective data, clinicians have shown considerable interest in recent years in two-phase treatment. This paper reviews major issues of two-phase Class II treatment and concludes by delineating several important clinical questions which could be resolved by a carefully controlled prospective study.

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Key Words

Class II malocclusion • Early treatment • Cost-benefit • Functional appliance • Headgear

which these changes were achieved were greater in the younger animals. Several possible mechanisms for this have been suggested: the bones are less mineralized and therefore more easily deformed,[13,14] sutures and ligaments are more cellular[15] resulting in more rapid biological responses, and growing tissues are generally more responsive to external forces. Clinicians have made the empirical observation that the best orthopedic results are obtained when growth is most active[16] and that the juvenile period has greater growth on the average at its beginning.[17-19] Although there is much to be learned about the adaptive process, the mechanisms at play during various developmental stages and the role played by growth in these responses, pragmatic considerations have led advocates of both functional jaw orthopedics[20] and headgear therapy[21] to conclude that Class II correction can most readily be achieved in the early mixed dentition.

The most frequently used early treatment appliances require a significant degree of patient cooperation to be successful. In one study of problems and failures in 264 consecutively treated cases, Berg reported inadequate patient cooperation in nine percent of the headgear cases and 32 percent of the activator cases.[22] Several studies have assigned the best cooperation ratings to pre-adolescent patients,[23-25] especially those who performed well in school.[24,26,27] However, other investigators have reported no relationship between age and compliance.[28-30] The conclusion that early treatment is more effective because of a higher degree of cooperation obtained from this age group bears further scrutiny. Moveover, the high level of patient refusal for retreatment in Berg's study of treatment failures prompted him to conclude that the orthodontist generally has a limited period of good cooperation at his disposal.[22] This opinion is shared by many clinicians and may argue against embarking on an early treatment strategy which would require two phases of compliance as well as a long period of retention.

The most common appliances used to achieve early treatment goals in the correction of Class II malocclusions are fixed edgewise with a headgear, or some form of functional appliance (e.g. the functional regulator of Frankel or the activator). In the treatment of Class II cases, two basic philosophies are often debated. The first attempts to move teeth, keeping the existing relationship of the mandible to the maxilla. Correction is achieved by posterior movement of the maxillary dentition and anterior movement of the mandibular dentition (i.e. primarily dentoalveolar changes). As growth ceases, this approach becomes more necessary in the nonsurgical patient. Since many orthodontists view such dental compensation as a compromise for many Class II patients, the opportunity to avoid dentoalveloar change is often cited as a major advantage of early treatment.

The other basic philosophy applies the facial orthopedic concept in an attempt to effect changes in the relationships of the jaws themselves, maintaining tooth movement as a minor component of the correction. The maxilla is prevented from making its normal downward and forward displacement and the mandible is stimulated to move anteriorly. In the ideal application of this approach, teeth are moved only to relieve crowding, level the curve of Spee and position the teeth ideally over their apical bases.

The Functional Regulator and Activator

Orthopedic changes McNamara has claimed that the most frequent skeletal problem in Class II malocclusions in pre-adolescents is mandibular retrognathia.[31] This would suggest that an appliance with the demonstrated ability to stimulate significant mandibular growth would be an important part of the clinician's armamentarium. Animal studies have demonstrated that appliances which position the mandible anteriorly can stimulate significant mandibular growth, primarily by an enhanced remodeling response at the condyle.[8-10,32-35] This observation is supported by studies on humans using both the activator[36-38] and the functional regulator of Frankel[39,40] although the increases are more subtle. However, there are several other reports which have indicated that neither appliance stimulates any more mandibular growth than would ordinarily occur in children of this age[41,42] and that the Class II correction is achieved primarily by dentoalveolar changes.[43-46] Therefore, current data leave unresolved the issue of whether functional appliances have significant orthopedic effects in anteriorly positioning the mandible in humans.

There is substantial agreement on the action of functional appliances in the maxilla. Both appliances appear to restrict forward horizontal growth.[36,38,43,44,47-51] However, there is some debate about the magnitude of this restriction with regard to the Frankel; several investigators have concluded it has no appreciable effect on the position of the maxilla.[39,40,52,53] In a comparative study, Owen concluded the Frankel seems to effect less maxillary retraction than does the extraoral force of a headgear.[54]

Dentoalveolar change Both of these functional appliances correct Class II malocclusions by encouraging substantial dentoalveolar

change.[38,40,45,55] Both reduce overjet by proclination of lower incisors[40,41,47,48,52,56-58] and the Frankel also retroclines maxillary incisors.[40,41,47,52] The latter appliance has been shown to move the mandibular molars anteriorly and superiorly[39-41,47] with little effect on the maxillary molars.[39,40,47] Likewise, the activator is thought to correct molar relationships by maintaining the maxillary molars and encouraging forward and superior movement of the mandibular teeth.[43,59]

It has been argued that with more care, a better diagnosis, a more appropriate treatment plan, or greater technical expertise, better results could have been obtained with these appliances.[60] In the final analysis, however, these studies do not allow one to conclude that functional appliances impart substantial orthopedic change. There is most agreement on their maxillary orthopedic effect of restricting the normal forward growth of the maxilla which occurs during the pre-adolescent years. There is agreement that functional appliances bring about corrections by substantial dentoalveolar change. These findings tend to cast doubt on the argument that early treatment with functionals is advantageous because relatively more orthopedic versus dentoalveolar corrections can be obtained.

The Headgear

Orthopedic change Animal studies have shown that posterior extraoral traction to the maxillary complex can produce a substantial orthopedic effect which should be beneficial in the correction of some Class II malocclusions.[11,12] Clinical studies have also demonstrated that extraoral force is effective at restricting maxillary horizontal growth.[61-65] In fact, several studies are also available which indicate that headgear therapy can reposition the maxillary complex posteriorly and inferiorly in growing patients.[5,66-70] Armstrong has demonstrated remarkably rapid (three to four months) correction of Class II malocclusions in growing patients with the use of continuous heavy forces parallel to the occlusal plane.[71]

Although not attached to the mandible or primarily aimed at mandibular alteration, headgear treatment has been shown to effect mandibular remodeling;[72] the mandible and chin point have been shown to relocate anteriorly in standard edgewise treatment.[66,73-76] Whether this represents a change which would not have occurred in untreated individuals remains unclear.

Dentoalveolar change In addition to the orthopedic effects of headgear in Class II correction, dentoalveolar changes have been reported. In his retrospective study designed to compare edgewise treatment with and without headgear, Poulton reported that the orthopedic component to the Class II correction in his sample was only 20 percent to 30 percent, attributing a majority of the correction to dentoalveolar change.[77] This finding was confirmed by Gianelly and his co-workers.[78] The major dentoalveolar effects of cervical traction in the correction of Class II malocclusions are extrusion and distalization of maxillary molars.[63,67,79-82]

The reviewer might conclude that with headgear treatment, as with functional appliances, most of the orthopedic effect is on the maxilla and a substantial percentage of the Class II correction is dentoalveolar. Comparative functional and headgear studies have been unable to detect technique-dependent differences.[76,78,83,84] There are apparently several potentially successful modes, albeit probably similar, for achieving an early correction of the Class II malocclusion. However, the impacts of relapse and continued growth which will undoubtedly occur during the remainder of pre-adolescence remain problematic.

Stability of the Class II correction

Definitions of orthodontic relapse vary. Some believe that a degree of regression is inevitable immediately after removal of active appliances and this should not be considered as treatment failure or relapse.[85,86] Others think that any reversal of a correction is relapse and steps should be taken to prevent it.[87]

Several aspects of Class II correction are particularly prone to relapse. Treated Class II malocclusions tend to maintain a net decrease in overjet in spite of a fairly consistent tendency toward relapse.[88-90] Similar findings have been reported for both the activator and headgear.[91] With the activator, Madone and Ingervall[92] found little relapse in overjet after retention but their sample had a high prevalence of post-retention dual bite.

There is disagreement about the relative stability of molar correction. Some studies report good stability,[89,93] while others indicate a tendency for molar correction achieved with the activator to relapse after retention and long-term follow-up.[92] There is agreement in the literature that expanded mandibular canine width is unstable,[94-96] and mandibular incisors which have been proclined have a fairly consistent tendency to relapse.[85,97,98]

Much remains to be learned about the stability of Class II correction. There are no data specifically addressing relapse of pre-adolescent treatment; the most appropriate length of retention, if any, remains in dispute.[99-101] Several

decades ago, orthodontists seemed to believe that retention should not be necessary if proper occlusion and equilibrium had been established. However, this view does not appear to be widely held today.[102-104]

Wood's [105] provocative study of the effect of retention on the relapse of Class II, division 1 cases serves to highlight the central problems. He found that one of the more important factors related to relapse of overjet was initial severity, but did not detect statistical differences between retained and unretained cases.

Costs (risks)

The major costs of early treatment may be associated with tissue damage, abnormal function, abnormal growth, treatment time and its related financial burden, and loss of patient compliance. Any orthodontic treatment can be associated with damage to the dentition or to the periodontium.

The risks of damage to the dentition are primarily dental caries, enamel decalcifation, pulpitis or pulpal necrosis and root resorption. The increased prevalence of caries and decalcification seen in orthodontic patients has long been recognized as being related to increased plaque retention and difficulty in maintaining proper oral hygiene.[106]

These risks are common to all fixed orthodontic appliances. There are no studies which specifically address the risks of caries and decalcification associated with either headgear or functional appliances. However, because these appliances are removable, thereby allowing more normal oral hygiene practices, one may reasonably predict the risks to be less than with full fixed appliances. Moreover, if the early treatment strategy actually does reduce the amount of time in fixed appliances, a reduction in enamel decalcification and decayed-missing-filled teeth (DMF) might be predicted as a benefit of such an approach.

Orthodontic treatment has been clearly associated with root resorption;[107] headgear treatment has the potential to cause substantial amounts of molar root resorption.[108] However, there are no studies available related to this type of problem when using functional appliances.

Reversible pulpal injury is a common response to orthodontic treatment.[109-112] Markus[113] reported that teeth became more responsive to electric pulp testing immediately following orthodontic activation while Burnside and coworkers.[114] reported that patients in orthodontic appliances were less sensitive than controls. Possibly there is an acute sensitization followed by a prolonged desensitization which may or may not be reversible. Experimental data, using respiratory rate as an indicator of pulpal injury, have indicated that a 72-hour orthodontic treatment can cause a 27 percent reduction in pulp function in human premolars.[111] These respiratory rates remained depressed for at least one week after the force was discontinued; there was significantly less effect in younger subjects than in older people with more patent root apices.[112] Animal studies have also indicated that such pulpal injury can be irreversible depending on the intensity and duration of the irritation and the resistance of the pulp.[115] There are no reports of pulpal problems unique to the early treatment appliances.

The risks of damage to the periodontium associated with fixed orthodontic appliances have been studied extensively. Although associations between malocclusion and periodontal disease or the presence of periodontal disease after orthodontic treatment have been claimed by some,[116-121] the overwhelming weight of evidence does not support such a link.[122-128] However, orthodontic appliances have been demonstrated to have the potential to damage the periodontal support of treated teeth. There are reports of significant gingival recession in the incisor region as a consequence of excessive dental compensation.[129-131] It also seems that, in spite of good oral hygiene, a reversible generalized moderate hyperplastic gingivitis accompanies the placement of fixed appliances.[106,132-139] In a small percentage of individuals there is a loss of periodontal attachment and alveolar bone, which is considered to be clinically insignificant.[132-135] The potential for periodontal problems associated with the early treatment strategy seems to exist, but there are no studies addressing the question.

Functional disorders of the masticatory system are common[140-142] and the etiology is generally considered to be heterogeneous and multifactorial.[143] However, the prevalence of mandibular dysfunction in patients treated with functional appliances conforms to the prevalence in untreated subjects.[58,92] Similar findings have been reported in patients who have had fixed appliance therapy.[144-146]

Evidence that early treatment of Class II malocclusion with either headgear or functional appliances may create abnormal growth patterns in some instances is lacking. However, animal data demonstrate clearly that it is, at least, feasible to change a Class I growth pattern into a malocclusion,[9,33] and therefore the potential exists for improper diagnosis and treatment of early Class II malocclusion to establish an abnormal growth pattern. Ethical considerations would obviously make a thorough investigation

n human subjects very difficult.

Evidence of extended treatment times or related financial burdens of the early treatment strategy is only anecdotal. Some clinicians claim that the early correction is time well spent because it resolves problems which would otherwise have to be addressed at adolescence and that total time in active treatment is probably similar in both approaches. Others feel that the efforts of early treatment and retention until adolescence are not counterbalanced by the savings in time during the second phase of therapy. Clear data on this question are lacking.

Cooperation has been cited as both a benefit and a cost of early treatment. Advocates of early intervention claim patients are more cooperative during the pre-adolescent years, while the advocates of delayed treatment feel precious "cooperative potential" is consumed by early treatment approaches, leaving less for the final stage. However, the literature previously reviewed on age and cooperation[23-25,28-30] and the existence of a finite amount of cooperation available from each patient[22] are inconclusive.

To review, the literature fails to clearly indicate any costs (risk) unique to early treatment. Although the potential for tissue damage is obvious, there is no clear association between early treatment and excessive risk in this regard. The claims that the early correction of malocclusion may offer some protection against functional disturbances also remains to be confirmed. The absence of reports of the creation of abnormal growth patterns from early treatment suggests the unlikelihood of this being a significant risk, however, direct data are lacking. There are only clinical anecdotes for increased or decreased total treatment time and the financial burden associated with the early treatment of Class II malocclusion. The evidence for or against early treatment-associated compliance is also inconclusive. Therefore, there is considerable need for clarification of each of these cost (risk) issues before the clinician or parent can intelligently choose to treat early or delay correction until adolescence.

Benefits

Several important benefits have been attributed to the early treatment of Class II malocclusion: prevention of injury to incisors associated with large overjets;[21] interception of the development of dysfunction; psychosocial advantages for the child during an important formative period of life, as well as for the parent; improved prognosis for the adolescent phase of treatment (i.e. less treatment time, better facial esthetics, enhanced stability, less need for the extraction of permanent teeth). Because the patient is being followed closely by the clinician prior to the adolescent phase of treatment, choosing the most appropriate time to start fixed appliance therapy is facilitated.

An association between overjet and maxillary incisor injury has been established.[147-149] The issue of whether or not early overjet correction is an effective preventive measure is more complicated than the simple association between overjet and incisor injury would suggest. This is because treatment timing as it relates to age of injury plays a role. For instance, if the preponderance of incisor trauma occurs in the early mixed dentition, most would have occurred prior to or during the correction of the overjet. In this event, although overjet relates to incisor trauma, overjet correction as routinely performed could be an ineffective prophylactic measure.

Some epidemiological studies of children and adolescents have found associations between features of malocclusion and dysfunction.[150-153] Riolo et al. found such associations to be greater in adolescents than in children.[153] Some investigators[145,152] have concluded that treatment of malocclusion in childhood may be prophylactic with respect to functional disorders.

The relationship between malocclusion and an individual's perceptions of facial attractiveness has been established in several societies around the world.[154-159] Moreover, malocclusion is known to carry a psychosocial stigma.[160-163] The significance of this stigma in the pre-adolescent years is emphasized by the data of Shaw et al.[160] They interviewed 531 school children between nine and 13 years of age and found that teasing about the teeth was the fourth most common target following height, weight and hair. Seven percent of this sample reported such teasing. MacGregor's work on the effects of facial deformity further suggests that in addition to the well known stigma, malocclusions may carry the potential for considerable anxiety.[164] In this study, individuals with milder forms of facial disfigurement, such as malocclusion, suffered more psychological distress than individuals with greater deformity, supposedly because they had not developed protective mechanisms and were in a constant state of anxiety in social interactions because ridicule was inconsistent and unpredictable. It would seem reasonable, then, that early partial correction of malocclusion may have significant psychosocial benefits. Surprisingly, one study was unable to demonstrate any improvement in body image or self-concept when orthodontic treatment was carried out at adolescence.[165]

Does early partial correction of Class II malocclusion offer any clear improvement in prognosis for the more definitive phase of treatment at adolescence? Suggestions have been made that early headgear[1,70,165,167] and activator[43] phases of treatment have favorable effects on the subsequent eruption patterns of the teeth. They might possibly establish a more normal growth pattern, and thereby reduce the need for dental compensation.[2,68] Such influences should have a beneficial impact on future treatment. If major orthopedic changes are possible and appropriate diagnoses can be made reliably at an early age, a better prognosis should indeed be possible for the adolescent phase following early treatment because appropriate jaw relationships will have been achieved. However, it is not clear that either headgear or functional appliances offer that degree of orthopedic control or stability. Moreover, the degree to which early Class II correction mitigates the need for dentoalveolar compensation at adolescence remains to be clarified.

On the other hand, if significant dentoalveolar compensational movements result from early treatment or remain necessary for the adolescent phase of treatment, the prognosis should be more guarded. The data indicate that several dentoalveolar compensational movements may have significant negative esthetic effects. For instance, maxillary incisor retraction is reflected in upper lip retraction.[91,168-170] This presents few esthetic problems for the patient with maxillary dentoalveolar protrusion, but may have a significant negative impact for patients with mandibular retrognathia.[171,172]

There are no data available related to support other claims of beneficial effects of early partial correction. These claims include the following: the final result after treatment in the teens is more stable; there is less need for the extraction of permanent teeth; and the clinician picks the time for adolescent treatment. The last claim is obviously true, but whether or not it represents a clear advantage in the outcome of treatment remains to be demonstrated.

Conclusion

The means are available to achieve partial correction of the Class II malocclusion during the pre-adolescent years. There appears to be considerable pressure coming from both the professional and lay communities to do so, even though the correction usually has to be finalized at adolescence. Data comparing the efficacy of such an approach to the more traditional one-phase treatment at adolescence are lacking, as are adequate cost (risk) — benefit data. Clinical studies of methods of early treatment have been rife with serious methodological deficiencies, e.g., being retrospective, lacking adequate controls, and evaluating only successfully treated cases.

Several important clinical questions regarding the timing of treatment for Class II malocclusion remain unresolved:

1. Does early Class II correction offer significant improvement over observation only during pre-adolescence?
2. Are there significant orthopedic and dental components to early correction, and to what extent does each contribute?
3. What role, if any, does retention play in early Class II correction?
4. Is the Class II craniofacial growth pattern altered by early intervention, or does the pre-treatment Class II growth pattern re-establish itself? Does retention impact this response?
5. Do the benefits of early intervention balance favorably with the costs (risks) when compared to observation only?
6. How does the initial severity of the malocclusion impact all these questions?

The orthodontic specialty and the patients it serves would benefit from well-designed prospective clinical studies addressing these issues.

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