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Age dependent treatment response to the Carriere ® Motion 3D ™ appliance for the correction of Class II malocclusion

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Abstract
Introduction and Purpose
Class II malocclusion is a common anomaly. Both adults and adolescents with Class II malocclusion can be treated. One of the methods for correction is Carriere ® Motion 3D ™ appliance (CMA).
The aim was to evaluate and compare the rate of tooth movement depending on age during treatment with Carriere ® Motion 3D ™ appliance (CMA).
Material and method
The retrospective study investigated medical records of 28 adult and 27 adolescent subjects who were treated with the Carriere ® Motion 3D ™ distalizer to correct Class II malocclusion. Time (in days) needed to achieve 1 mm correction was calculated for each patient, based on the quotient of days needed for Class II correction and the distance required to achieve Class I canine relationship. The difference between groups was analyzed using the Mann-Whitney-U test.

Results
Phase I treatment with CMA lasted on average 5,67 ± 2,01 months for adults and 4,67 ± 1,48 months for teenagers. The mean time to achieve 1 mm correction was 36,77 ± 11,01 days in the adult group and 36,59 ± 26,17 days in the adolescent group. The results showed no statistically significant difference between the two groups.
Conclusions
CMA can be applied to efficiently treat Class II malocclusion in adolescent as well as adult patients. No difference in age related tooth movement using the CMA was found.

Key words: Malocclusion; Angle Class II; Orthodontic Appliance Design; Patient Compliance; Orthodontic appliances

Introduction

The Carriere ® Motion 3D ™ appliance (CMA) is a device introduced by Luis Carriere in 2004 to correct sagittal dimension and obtain a Class I relationship at the beginning of treatment, before placing brackets. The CMA is a rigid bar with two pads:

- canine (anterior) pad which provides a hook for the attachment of Class II elastics,
- molar (posterior) pad consists out of a ball-and-socket joint.[1]

The device is made from mold-injected, nickel-free stainless steel.[1]

The appliance is bonded using a light-cured adhesive to the surface of the canine and first molar.[1] In a special "shorty" version, it can be bonded to the first maxillary premolar and first maxillary molar when canines cannot be used for attachment (e.g. canines are not yet erupted or are located in a high vestibular position).[2]

To provide attachment for Class II elastics a buccal tube is bonded to the second or first (in cases when the second molars have not yet erupted) mandibular molar.

There are several anchorage options to prevent mesialization of the lower posterior segment and protrusion of lower incisors. They include a passive or hamula lingual arch, full mandibular fixed appliance and lower Essix appliance.[1]

According to the designer, the distalizer may be used for both adults and growing patients. The CMA facilitates following movements to correct Class II malocclusion:

- distal rotation of the maxillary first molars around their palatal roots (if necessary),
- the production of a force for distal molar movement,
- independent movement of the posterior (from canine to molar) segment as a unit.[1]

The rate of tooth movement depends on many factors such as careful treatment planning, patient compliance or intake of anti-inflammatory medication during orthodontic therapy. However, individual biologic response to orthodontic force is believed to be the main factor in the rate of tooth movement.[3–6] Studies conducted on animals and humans have proven that age can influence the biologic response and thus rate of tooth movement.[7–10]

Purpose

The purpose of this retrospective study was to compare age related treatment response to the Carriere ® Motion 3D ™ appliance.

Up to date, no other studies reporting age related treatment response to CMA were found.

Material and methods

Approval for this study was obtained from the Bioethical Committee of the Lower Silesian Medical Chamber (2/BNR/2021).

Subjects with Class II malocclusion and treated with the Carriere ® Motion 3D ™ appliance in either of the two branches of the private practice during the years 2016 to 2021 were identified.

Inclusion criteria were: age up to 14 years old for adolescents and 21 years and older for adults, uni-/ or bilateral Class II molar and canine relationship before therapy, treated with the Carriere ® Motion 3D ™ appliance for the correction of Class II malocclusion, non-extraction treatment, Essix retainer in the lower arch for mandibular anchorage, availability of complete treatment records, finished phase I of orthodontic therapy.

Exclusion criteria were: skeletal deformities, ongoing phase I of orthodontic therapy, duration of phase I treatment with CMA longer than 12 months. Additionally, subjects between the age of 15 and 20 years were

excluded, to avoid errors resulting from individual maturation. Close upper age limits for adolescents and lower limits for adults could possibly blur the age dependent differences.

Patients or their parents signed an orthodontic informed consent form prior to therapy. All patients were treated with CMA using the same protocol. The treatment was supervised by one physician (J.M.). The correct length of CMA was selected in accordance with manufacturer instructions. The appliance was bonded to the canine and first molar. Additionally, a buccal tube with hook was placed on the ipsilateral second molar in the opposite arch, for elastics anchorage. A clear Essix retainer (thickness 1mm) was used in the mandibular arch. Only standardized Force 1™ (1/4-inch, 6 oz) and Force 2™ (3/16-inch, 8 oz, Henry Schein Orthodontics) elastics recommended for CMA treatment were used during therapy. Every patient was instructed to use Force 1™ elastics during the first month of CMA therapy and Force 2™ starting with the second month. Instructions also included all time elastics wear, except for meals and teeth brushing.

Figure.1(A-F)

Figure 1A Right side pre-treatment

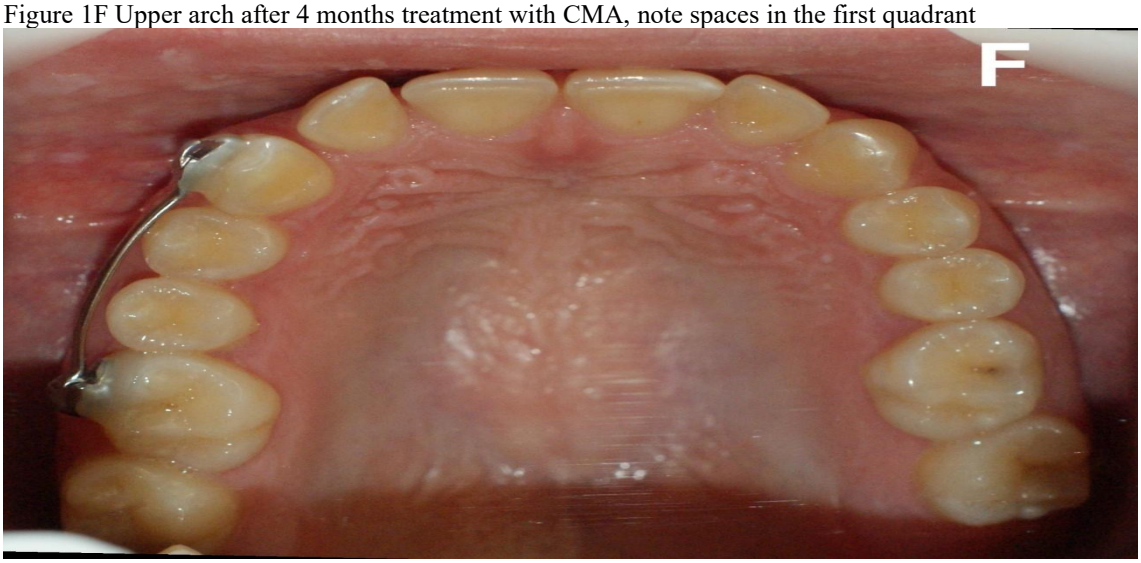
Figure 1B Left side pre-treatment

Figure 1C Upper arch pre-treatment

Figure 1D Right side after 4 months treatment with CMA

Figure 1E Left side after 4 months treatment with CMA

Figure 1F Upper arch after 4 months treatment with CMA, note spaces in the first quadrant



The retrospective data analysis was conducted by two investigators (K.M., M.C.). The primary search identified 78 patients. Out of them, 23 were excluded from the study due to ongoing CMA therapy or not matching the age/treatment duration criteria. Data concerning date of birth, age during therapy, gender, date of CMA bonding (beginning of phase I), date of reaching Class I canine relationship (study endpoint) and distance (in mm) needed to achieve Class I canine relationship was collected from medical records.

The correction distance needed to achieve Class I canine relationship was measured (in mm) by one examiner (K.M.) on 3D casts using the Ortodoncja 9 (Ortobajt, Wroclaw, Poland) software. Reference surfaces for canine relationship were based on the study of Yin et al.[11] On digital models in centric occlusion, one surface was placed according to the long axis of the maxillary canine. The second reference surface was placed parallel to the first, through the interproximal contact point between mandibular canine and first premolar. Correction distance was measured perpendicular to both surfaces.

If a patient was treated using CMA on both sides, each side was assessed separately, as an independent study case.

The duration (in days) from beginning of phase I to study endpoint (Class I canine relationship) was calculated for each patient. The results concerning days necessary to correct 1 mm were determined based on the quotient of days needed for Class II correction and the distance required to achieve Class I canine relationship in each case.

The statistical analysis was conducted using IBM SPSS Statistics for Windows version 23.0 (IBM Corp., Armonk, NY, USA). The difference between groups for continuous variables was analyzed with Mann-Whitney-U test. The Kolmogorov-Smirnov test was applied to determine the distribution of variables. The findings were

presented as variables with corresponding 95% confidence intervals and associated P-values. A P-value of less than 0.05 was considered statistically significant.

Results

The adult group comprised out of 28 subjects and the adolescent group out of 27 subjects. The minimal age among teenagers was 11 years old and the maximal was 15 years old (mean 13,29 ± 1,26). In the adult group age ranged between 20 and 40 years (mean 31,78 ± 5,2). Table 1 shows the gender frequency for both groups.

Table 1 - Gender frequency

Gender frequency

Gender	Adult	Adolescent	All
	Frequency		
Male	4	11	15
Female	24	16	40

The duration of phase I (from beginning of therapy to study endpoint) varied slightly between groups. In the adult group the Class II correction was achieved in a mean time of 5,67 ± 2,01 months, whereas in the adolescent group in a mean time of 4,67 ± 1,48 months.

The correction distance needed to achieve Class I was on average 4,77 ± 1,44 mm and 4,52 ± 1,76 mm for adults and teenagers respectively.

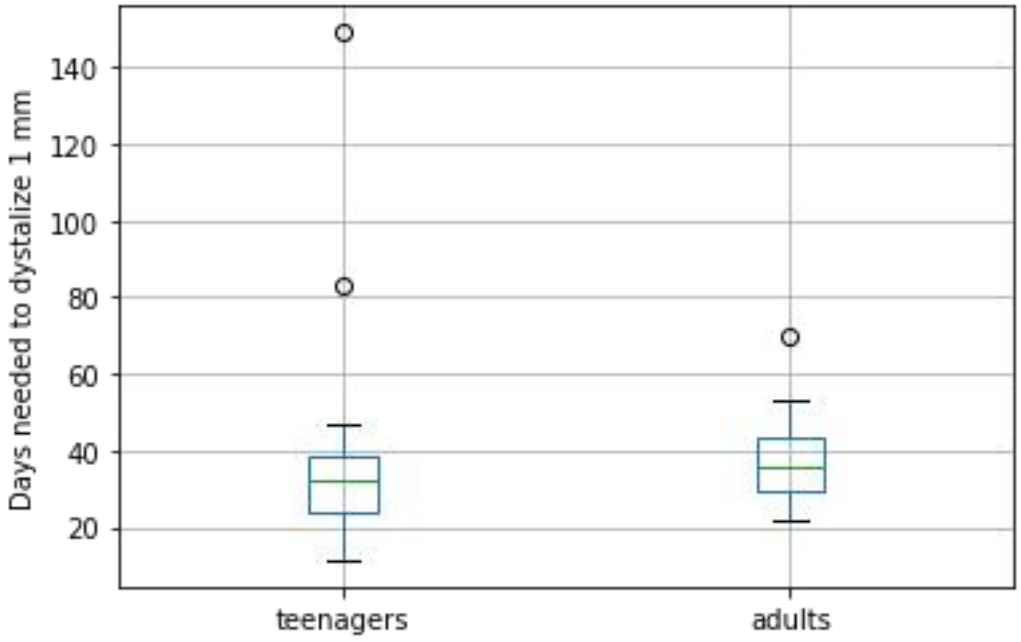
Intergroup comparison showed no statistically significant difference between the groups considering time needed to correct 1 mm. The results are presented in Table 2 and Figure 2.

Table 2 – Mean time necessary to dystalize 1mm (in days)

Group	Adult		Adolescent		
	Mean	SD	Mean	SD	**P value**
Days/mm	36,77	11,01	36,59	26,17	0.111

**P* value < 0.05

Figure 2 Days needed to distalize 1 mm in groups



Discussion

Time needed to complete the first phase of treatment (i.e., correction of Class II, achieving a Class I canine and molar relationship) using CMA lasted, in this study, on average 5,67 ± 2,01 months for adults and 4,67 ± 1,48 months for adolescents. Said results are comparable to those of other authors. According to Hamilton et al. phase I lasted from 5 to 8 months, for patients aged between 11 and 18 years old.[12] Sandifer et al. reported mean CMA treatment duration of 4.4 months, mean patients age was 11,3 years.[13] Areepong et al. showed mean results of 4.9 months for skeletal Class I patients and 4.2 months for skeletal Class II patients, all patients were adolescents.[14] Kim-Berman et al. also examined treatment duration using CMA on a group of adolescent patients (age 12.8 ± 1.3 years), phase I lasted an average of 5.2 ± 2.8 months.[2] There were no studies reporting CMA treatment time results concerning adult patients.

In comparison to treatment time using only elastics in non-extraction Class II cases, the published results differ. Popowich et al. reported average time for Class II elastic wear of 10 ± 6 months[15], whereas Aras and Pasaoglu presented results of 6.85 ± 1.08 months[16]. Another study reported active treatment time with Class II elastics of 8.5 months.[17]

Two main factors that should be considered, when interpreting the results of this study, are age dependent biologic response to orthodontic force and patient compliance. An animal study conducted on rats by Bridges et al. showed a greater amount and rate of tooth movement in younger animals compared to older rats.[8] However, another study conducted by Ren et al. concluded that tooth movement in juvenile and adult rats can be equally efficient except for delayed reaction to orthodontic forces in adult animals.[7] Nickel et al., who examined tooth movement in humans, reported significantly faster canine retraction in actively growing patients compared to adults.[9] Similar results showed Alikhani et al., with a significantly greater amount of canine retraction in the adolescent group compared to the adult group during the same period.[3] A literature review published in 2018 presented results of faster orthodontic tooth movement with higher cytokine levels in younger patients and delayed movement onset in older patients.[10]

The results of the present study could not prove a difference between the rate of tooth movement in adolescent and adult patients during therapy with CMA. However, the Carriere ® Motion 3D ™ dystalizer is a compliance dependent appliance. To achieve results, the patients ought to actively participate in the treatment by wearing elastics. Patient compliance was identified to be one of the most limiting factors during Class II correction, when using elastics. It can influence not only orthodontic treatment duration, but also the quality of results.[18] Limited cooperation leading to longer therapy can result in increased risk of periodontal disease, patient frustration or added stress for clinicians and patients family.[19] The time of elastics wear cannot be determined objectively and is always dependent on the patients testimony. Studies that have investigated compliance in orthodontics focused on removable appliances. Timing mechanisms used to evaluate removable appliance wear included temperature [20] or tension sensors [21]. A systematic review conducted by Al-Moghrabi et al. revealed that patients routinely underestimate the duration of wear, mean discrepancy between self-reported and objectively assessed wear was 5.02 hours per day.[22] However, positive effects were reported by Leone et al.[23], who examined the influence of reminder text messages on the cooperation of Class II patients with regard to intermaxillary elastics. Their results showed a 3.7 times greater Class II correction, during the same period, in the experimental group than in the control group. Said results prove that reminder text messages can positively influence compliance with elastics.[23] Another study investigated whether a brief psychological survey (locus of control scale, LOC) could anticipate compliance problems during orthodontic treatment. Yet the results showed that compliance cannot be predicted by LOC evaluation before treatment.[24] Egolf et al. conducted a survey study that identified factors significantly correlated with compliance, namely pain/discomfort, health awareness and some personality traits, such as stoic/sensitive along with self-confidence.[25]

Regarding results of the present study, one could hypothesize that the statistically insignificant difference in tooth movement rate between the adolescent and adult group could have been affected by lower compliance in the adolescent group. Adult patients can, naturally, present a greater level of health awareness and therefore be more compliant than adolescents. Said difference in cooperation could have influenced the treatment time. In consequence, a decrease in the biologically determined difference in tooth movement rate between adolescents and adults might have occurred.

Although it was not investigated in the present study, the overall experience with Carriere ® Motion 3D ™ appliance, reported by other authors, was good or really good.[12] The initial reaction to the appearance of the appliance was also reported as positive.[12] This may be connected to the fact that the upper incisors remain appliance free for the first phase of treatment. Esthetics can also be improved if clear Essix retainers are used in the lower arch. Additionally, Hamilton et al. reported that 100% of subjects treated with CMA experienced no effect on school nor getting along with friends.[12] Another advantage of CMA, according to its designer Luis Carriere, is that the correction of Class II occurs at the beginning of treatment, when compliance is best.[1]

Conclusions

The Carriere ® Motion 3D ™ appliance can successfully be used in Class II treatment of adolescent and adult patients. No difference in age related tooth movement rate during the treatment with CMA was found. Further studies on CMA therapy on adult patients would be of benefit.

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