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Expert Opinion Article

Development Of Dental Arches: Efficacy Of Aligners In Mixed Dentition (Retrospective Study)

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Abstract:

Introduction : The development of dental arches and the interception of transverse discrepancies in mixed dentition are essential for balanced facial growth. While conventional interceptive devices are highly effective, they have limitations in acting teeth and arches simultaneously. Today, the use of clear aligners has emerged as an alternative that may overcome these limitations. Our study aims to evaluate the clinical effectiveness and predictability of aligners in the development of dental arches in patients with mixed dentition.

Method : A retrospective clinical study was conducted on 19 young patients in the mixed dentition phase who underwent early treatment with clear aligners. The quantity of maxillary expansion was analyzed in both the anterior and posterior regions to assess the effectiveness and predictability of the aligners. Additionally, we examined the various sagittal and vertical malocclusions, as well as dental misalignment, that were corrected in parallel with arch development

Result: The analyses show significant arch development, with the highest score in the anterior region. Harmonization of dental arches was observed and significative changes in dental misalignments and malocclusions

Discussion : Clear aligners appear to be a promising option for arch development in mixed dentition. Although their effectiveness depends on several factors, including digital planning of tooth movements and patient compliance, this approach offers improved comfort and reasonable treatment durations. Further studies are needed to optimize protocols and enhance the predictability of outcomes.

Conclusion : This retrospective study provides an opportunity to explore the clinical outcomes achieved with clear aligners, which could contribute to their use in the field of early interceptive orthodontics

Introduction

The development of the dental arches and interception of transverse discrepancies during mixed dentition is crucial for correcting transverse anomalies, such as maxillary endognathia and posterior crossbites. These treatments aim to widen the maxilla, increase the arch perimeter, and provide favorable conditions for balanced facial growth of both the maxilla and the mandible. This facilitates the spontaneous alignment of erupting teeth and helps prevent sagittal and vertical malocclusions. Conventional interceptive devices are effective, but they have limitations in acting on the teeth and arches simultaneously. They also present discomfort for young patients and challenges in maintaining oral hygiene (1).

Today, Adult patients have shown keen interest in clear aligners because they combine aesthetics, comfort, and effective orthodontic results. Their use in young patients presents an alternative that may offer solutions to the limitations of conventional interceptive appliances.

Several systems of aligners adapted for pediatric use are available on the market, including Invisalign First/Teen (leader of the field), ClearCorrect Teen, Orthocaps Kids/Teens, and eCligner Junior and others.

These systems have developed soft and comfortable materials for young patients, incorporating predefined spaces to accommodate the eruption of permanent teeth, wear-time indicators to evaluate patient's compliance, in addition to therapeutic

protocols for transverse arch expansion. [Ali and Miethke, 2012].

However, to date, very few studies have evaluated the efficacy and predictability of maxillary expansion using aligners in young patients with mixed dentition.
Our study aims to evaluate the clinical efficacy and predictability of aligners in the development of dental arches in patients with mixed dentition.

Materials et Methods
Study design:
This is a Retrospective cohort study evaluating the efficacy and predictability of maxillary expansion by clear aligners in young patients with mixed dentition

Data selection
Patient selection was carried out using digital records from an orthodontic clinic specialized in mixed dentition clear aligner treatment in Casablanca, Morocco, over a five-month period, from January 16 to May 30, 2024. All patients were treated using the Invisalign First/Teen system. Nineteen patients were selected based on inclusion and exclusion criteria.

Eligibility criteria
- Inclusion criteria

Healthy children aged 6-12 years with stable mixed dentition
Adequate coronal height of first permanent molars
Presence of transverse maxillary deficiency
Patients who had completed their early treatment with aligners and subsequently underwent a second intraoral digital scan for retention and containment.
- Exclusion criteria

Children with syndromic conditions or pathologies affecting maxillary growth
Delayed eruption of first permanent molars Wide arches not requiring expansion Incomplete clinical documentation

Clinical intervention
The orthodontic treatment consisted notably of maxillary expansion by aligners, together with other alignment dental movements and harmonization of the two arches. Patients were informed to change aligners after every 7 days and worn for 22 hours daily as recommended by Houle et al., 2017. Digital impressions were taken using an iTero® intraoral scanner. Models were analyzed as well as treatment plan established using ClinCheck® software (Align technology).

Clinical and virtual measurements
- This study was based on the analysis of 3D digital models imported into ClinCheck and the Invisalign® platform. Reference points for transverse measurements were taken from digital impressions at the following anatomical points: mesio-palatal cusps of temporary and permanent molars, palatal cusps of premolars, and cusps of temporary and permanent canines.
- Inter-canine distance (DIC), Inter-premolar 1 / molar temporaire 1 distance (DIPM1)

Inter-premolar 2 / molar temporaire 2 distance (DIPM2), Inter-molar distance (DIM)
- The comparative analysis was carried out in three key phases: Initial tooth position (P0), Planned expansion by the ClinCheck® software (P1), and Achieved expansion after treatment with aligners (P2).

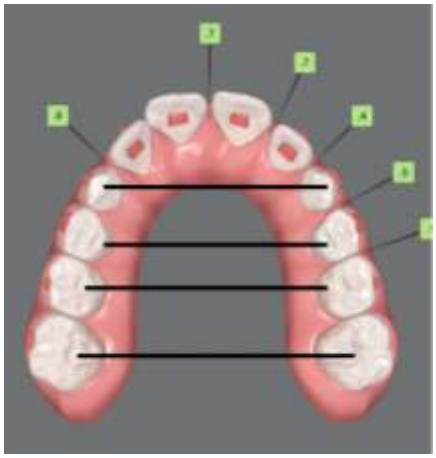

Fig 1: Reference points for the various dimensions to be measured

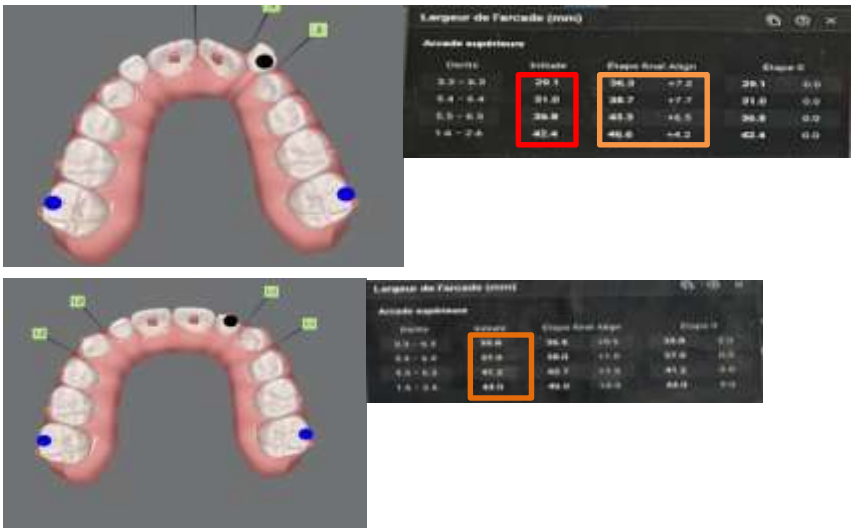

Fig2 : A (First) : clinchek avant et **B (second)** : clinchek après ; P0(rouge), P1 et P2 (Orange)

Statistical analysis

Statistical analysis was conducted using JAMOVI software (version 2.3.24a). A descriptive analysis was performed to characterize the population before and after treatment. Comparative analysis was then carried out between two paired groups (pre- and post-treatment) and between two independent groups (planned expansion and achieved expansion). Results were considered statistically significant for a p-value < 0.05.

Result

1- Descriptive results:

The study included 19 patients with a mean age of 8.79 ± 0.7 years and a predominance of females (52.6%). The average treatment duration was 7.47 ± 1.84 months. The initial transverse dimensions were relatively homogeneous among patients, with an inter-canine distance (DIC) of 33 ± 2.67 mm, an inter-first premolar distance (DIPM1) of 35.7 ± 2.48 mm, and an intermolar distance (DIM) of 46 ± 1.78 mm. The planned expansions' value varied depending on the clinical conditions and are intended to develop the maxillary arch and result into a harmonious parabolic form.

2- Analytical results :

Table 1/ Comparison between planned transverse corrections and achieved transverse corrections.

Variable	Planned	Achieved	P value
DIC	37.4+/-1.76	35.9+/-2.00	**<.001***
DIPM1	40.7+/-1.39	38.7+/-1.69	**<.001***
DIPM2	45.7+/-1.62	43.5+/-2.28	**<.001***
DIM	50.4+/-2.04	48.2+/-2.13	**<.001***

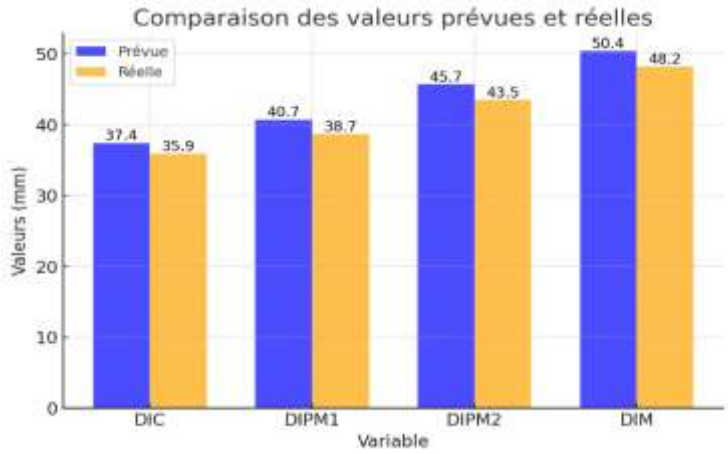

Fig3: Diagram illustrating the comparison between Planned (Clincheck) and achieved values

There is a statistically significant difference between the post-treatment transverse dimensions predicted by the software and those achieved after expansion with aligners. The achieved transverse dimensions are significantly lower than those predicted by clincheck (Table 1).

Table 2/ comparison between the quantity of expansion planned and achieved

	EXPANSION PLANNED	*EXPANSION ACHIEVED*	*P-VALUE*
CANINE	4.44+/-2.30	2.89+/-2.26	<.001
1ST PREMOLAR	5.03+/-2.16	2.98+/-1.87	<.001
2ND PREMOLAR	4.98+/-2.17	2.83+/-2.33	<.001
MOLAR	4.48+/-2.12	2.22+/-1.49	<.001

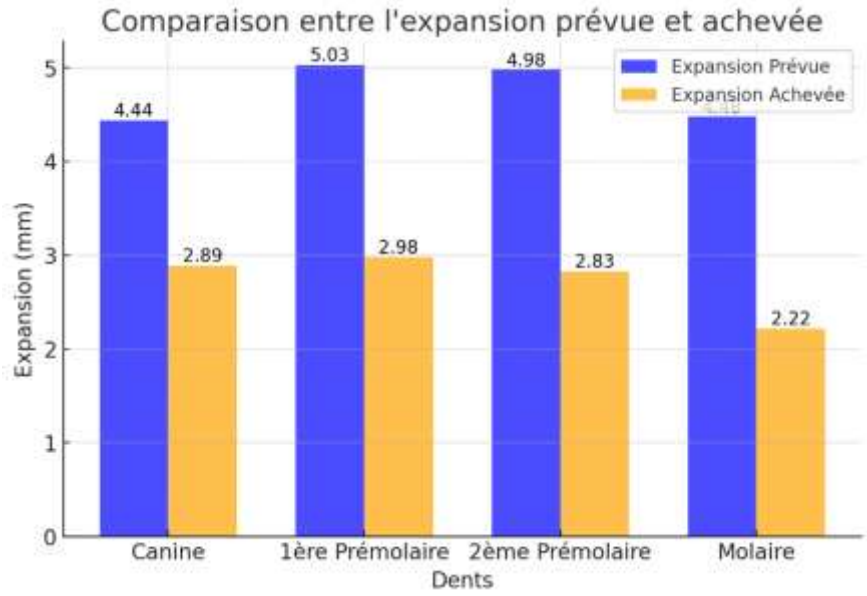

Fig 4: Diagram comparing P1 et P2

Table 2 shows a significant difference between the quantity of planned expansion and the quantity achieved. This difference being particularly at the molar level suggests reduced effectiveness of aligners for posterior expansion.

Table 2 also demonstrates greater efficiency at the canine level (65%). This efficiency progressively decreases in the posterior region. Thus, aligners appear to favor anterior and mid-arch expansion, while posterior expansion remains limited

Table 3/ Correlation between the transverse corrections planned and achieved

	Rho pearson	P value
DIC planned/achieved	0.6	**0.006***
DIPM1 planned/achieved	0.4	0.12
DIPM2 planned/achieved	0.3	0.2
DIM planned/achieved	0.5	**0.02***

-There is a strong, positive correlation (r = 0.6; r = 0.5), statistically significant (p = 0.006; p = 0.02) between the planned and achieved inter-canine and inter-molar values. In other words, the greater the quantity of expansion planned by the software at the canine and molar regions, the greater the quantity of expansion achieved after treatment.

Table 4/ Efficacy of Aligners

Maxillaire expansion (Region)	***Efficiency in percentage***
Canine	65%
First premolar	59%
2nd premolar	57%
Molar	50%

Table 4 shows higher efficiency at the canine level (65%). This efficiency progressively decreases in the posterior segments. Thus, the design of aligners appears exhibit more predictable anterior expansion, while posterior expansion remains limited.

Discussion

The advent of pediatric aligner systems such as Invisalign First® system has revolutionized interceptive orthodontics and allowed children to benefit from early orthodontic treatment while meeting their aesthetics and comfort expectations. The transparent aligners of the Invisalign® First system, specifically designed for patients requiring early correction, can improve the form of the dental arch and reserve space for erupting teeth (5). Expansion can be achieved at the canines, premolars, and molars regions (6). A posterior expansion of up to 2 mm per quadrant is predictable with aligners, although predictability decreases as the planned expansion increases (6,7).

However, few studies have evaluated the efficiency of this system and the precision of maxillary expansion achieved compared to the software's predictions. Therefore, the objective of this study was to compare the movement of the expansion planned using the ClinCheck® software with the movement of the clinically achieved expansion obtained after treatment with aligners in children with mixed dentition.

The results of this study confirm that Invisalign® First aligners offer a certain degree of predictability for maxillary expansion in mixed dentition, although the achieved expansion values were significantly lower than the predicted values. This is similar with the observations of Houle et al. (2017), who noted a frequent overestimation of expansion movements by digital aligners (8). In our study, statistically significant differences were observed between the predicted and achieved values for all transverse variables (DIC, DIPM1, DIPM2 and DIM, $p < 0.001$). This indicates an underachievement of the planned expansion movements, with an average efficiency of 50% to 65%, particularly for the molars (50%) and canines (65%). These results confirm the conclusion of Galluccio et al. (2023), who also observed limited effectiveness of expansion of aligners in the posterior region (6).

The significant positive correlation observed between the predicted and achieved values for the inter-canine ($r = 0.6$, $p = 0.006$) and inter-molar ($r = 0.5$, $p = 0.02$) regions suggests that digital treatment planning is more reliable for these areas. However, the lower predictability in the inter-premolar regions highlights the limitations of aligners in controlling complex movements, particularly in children with mixed dentition. This is similar to findings of Keilig et al. (2024), who demonstrated that vestibular translational movements often need to be adjusted to improve their effectiveness (7).

The variability between the planned and achieved expansion with Invisalign First® can be explained by the progressive loss of force exerted by the aligners due to the thermoplastic properties of their material, their limited action on the palatal suture, and less effective posterior anchorage, hence reducing molar expansion. Also, biological variability and patient compliance may also influence treatment outcomes. On the other hand, the statistically significant positive correlations between the planned and achieved expansion at the canine and molar levels suggest the need to implement overcorrection of transverse dimensions during digital simulation and to overestimate the planned expansion to improve treatment predictability.

Although Invisalign® First can achieve maxillary expansion, its effectiveness remains lower than that of traditional expansion appliances such as the Hyrax and Haas expanders, which produce more predictable skeletal expansion (Weissheimer et al., 2011).

In addition, Invisalign First® produce a progressive expansion that is primarily dentoalveolar in nature (8). The major limitations of this study lie in the small sample size (19 patients) and the absence of a control group, which restricts the clinical interpretation of the results. Further studies with larger sample sizes and comparisons with conventional approaches are needed to confirm these observations.

Conclusion

The predictability of aligners for maxillary expansion in young patients with mixed dentition is promising but presents notable limitations, as demonstrated by the significant discrepancies between planned and achieved outcomes. Special attention should be given to the use of aligners in this context in order to maximize their effectiveness and optimize clinical outcomes.

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