***Title of the Article:***

**The Role of Upper Jaw Expansion in Adjusting TMJ and Occlusal Balance for Posterior Crossbite**

**ABSTRACT:**

**Objective:**

This study aims to evaluate the clinical effectiveness of slow maxillary expansion with distal expansion plates for managing unilateral posterior crossbite with mandibular deviation, focusing on occlusal balance, mandibular alignment, and overall treatment outcomes.

**Materials & Methods**:

Twenty children (aged 7-10 years) with unilateral posterior crossbite and functional mandibular deviation were treated using a distal expansion device comprising an acrylic base, Adams clasp, a central expander, a labial arch, and a posterior bite plane.

The expander was activated every 5 days to widen the upper jaw, followed by a 3-month fixation period and a 6-month monitoring phase to ensure stability. Measurements of intermolar and intercanine widths were taken at four stages: pre-expansion, post-expansion, post-fixation, and post-monitoring. CBCT scans were obtained before treatment and after the monitoring phase end changes in the temporomandibular joint.

**Result:**

Maxillary and mandibular widths increased significantly (P < 0.05), showing effective arch expansion. Lower dental midline deviation reduced notably after treatment, indicating improved mandibular alignment. Additionally, anterior joint distance on the affected and medial joint distances on both sides showed significant improvement, reflecting better TMJ alignment and functional stability.

**Conclusion:**

Within the limitations of the present study, it can be concluded that slow maxillary expansion using removable expansion plates is an effective method for treating unilateral posterior crossbite in the mixed occlusion stage.

**Introduction:**

Posterior crossbite occurs when the upper teeth’s buccal cusps occlude palatally to the lower teeth’s buccal cusps. 1 Moyers classified posterior crossbites into dental, functional, and skeletal types 2 Functional unilateral posterior crossbite is common in mixed dentition, with a prevalence of 22% 3 If left untreated, it can lead to temporomandibular joint (TMJ) issues, mandibular asymmetry, and restricted maxillary growth, necessitating early intervention.4

Rapid maxillary expansion (RME) is commonly used to treat these crossbites but can cause vestibular tilting, posterior tooth elongation, vestibular cortex perforation, pain, and gingival recession 2, 4, 5 An alternative is slow maxillary expansion, which involves weekly activation and can expand the intermolar width by 8 mm. 6, 7 Studies suggest slow expansion offers long-term stability, with an 84% success rate6, 8.

Removable expansion devices, like the W-arch or four-ring devices, offer advantages including better hygiene and lower costs9. These devices are activated biweekly by 0.2 mm and worn continuously, except during meals10. They increase maxillary and mandibular arch distances and influence mandibular condyle positioning, reducing joint cavity dimensions 11.

Despite their benefits, there is limited evidence on patient-centered outcomes such as pain, discomfort, and acceptance 12. This study aims to evaluate removable expansion plates for effectiveness, impact on TMJ, and patient acceptance. Hypotheses include their ineffectiveness, minimal TMJ impact, and low patient acceptance.

**Research hypotheses:**

* Hypothesis 1: removable expansion plates are ineffective in treating unilateral functional posterior crossbite.
* Hypothesis 2: Removable expansion plates do not affect mandibular condyle position in the temporomandibular joint (TMJ).
* Hypothesis 3: there is no acceptance among patients of treatment using removable expansion plates.

**Materials and Methods**

This randomized clinical trial investigated the correction of unilateral functional posterior crossbite in mixed dentition. The study involved 20 children aged 7–10 from Damascus University’s Orthodontics and Maxillofacial Surgery Department, meeting specific inclusion criteria. Eligible patients had mixed dentition with functional unilateral posterior crossbite, symmetrical maxillary narrowing, good oral health, and no prior orthodontic treatments.

**Sample Size Estimation**

The sample size was calculated using Minitab® Version 18, considering a 2 mm Minimal Clinically Important Difference (MCID) for intermolar width13 and a 1.62 mm standard deviation. With a significant level of 0.05 and a 10% dropout rate, the sample size was set at 20.

**Randomization**  
Patients were randomly assigned using a computer-generated list via Minitab® Version 17.

**Patient Recruitment and Records**

Upon meeting the selection criteria, patients and their families were informed of the study objectives. After consent, comprehensive medical and dental histories, intra- and extra-oral photographs, plaster models, and CBCT images were taken.

**Treatment Protocol**

**Device Fabrication**: Impressions were sent to the lab for custom expansion plates, comprising an acrylic base, Adams retractors, a central expander, a labial arch, and a posterior bite lift.  
**Active Treatment**: Devices were worn full-time except for eating and brushing. Expansion occurred every five days with follow-ups every three weeks until crossbite correction.  
**Fixation Stage**: Devices were worn for three months post-expansion.  
**Post-Fixation**: Patients discontinued use but were monitored every eight weeks for six months. In cases of relapse, additional treatment was considered.

Close-up of a person's mouth

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***Figure (1): expansion plate equipped with a central expander and a smooth bilateral posterior bite lift.***

Evaluation of the changes in the intra-dental widths studied on plaster models:

Taking impressions: the appropriate impression was selected; the alginate impressions were taken; and the hard plaster was poured within 10-12 minutes of taking the impression using the aforementioned materials. Evaluation times for plaster models: impressions were taken at the following evaluation times:

T0: before the start of expansion

T1: after the end of the active treatment phase.

T2: after the end of the fixation phase, which lasts 3 months.

T3: after the end of the monitoring phase, which lasts 6 months starting from the end of the fixation phase.

Markers used on plaster models: the following reference points were determined: central pits of the permanent first molars, lateral buccal cusp tips of the permanent mandibular first molars, palatal surface of the maxillary primary canines, lateral buccal cusp tips of the mandibular primary canines7 (Figure 2).

Measurements performed: the following measurements were performed using an electronic biaculus: maxillary intermolar distance: the distance between the central pits of the permanent right and left maxillary first molars. Mandibular intermolar distance: the distance between the lateral buccal cusp tips of the permanent right and left mandibular first molars. Dimension Maxillary intercanine distance: the distance between the most medial point on the palatal surface of the upper right and left primary canines. Mandibular intercanine distance: the distance between the apex of the lower right and left primary canines. If the canines are retracted, the point will be located in the centre of the retracted area. In cases where normal occlusal relationships are available and an increase in the maxillary intercanine and molar dimensions is achieved, the treatment is considered effective and successful. However, if normal occlusal relationships are not achieved, this is considered a criterion for the presence of narrowing of the maxillary dental arch compared to the mandibular dental arch and thus the treatment fails.7

A drawing of teeth with black lines

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***Figure (2): Transverse measurements on plaster models***

Evaluation of the changes in the mandibular path during closure through clinical examination:

The mandibular path during closure was studied starting from the rest position of the mandible until reaching the maximum tuberous interlocking position while the patient was sitting upright with his head facing forward (the normal head position). If this position was difficult to determine, the head was positioned so that the Frankfort horizontal plane was parallel to the floor of the room. In addition, a Tapping Test was performed to relax the patient's orofacial muscles. Thus, when examining the resting position, the mandible was isolated from any deviation resulting from the unilateral posterior crossbite and the lower dental midline is aligned with the upper facial midline (Figure 3). When occluding and reaching the maximum tuberous interlocking, the lower dental midline and the lower skeletal midline were examined (Figure 4), and the amount of deviation and quantity were determined in millimetres (mm). These changes were evaluated at the previously mentioned times.



|  |  |
| --- | --- |
| ***Figure (3): Resting position. The harmony of the upper and lower dental midlines can be noticed.*** | ***Figure (4): Deviation of the median line at the maximum tuberous interlocking*** |

Evaluation of changes in the temporomandibular joint condyle:

Full Field of View (CBCT) images were taken with high resolution using the PaX-i3D green device from Vatech according to the following parameters: 50-90 kVp (1 kVp step) – 4-16 mA (0.1 mA step), imaging time 5.9 seconds and voxel size 0.2 mm within an imaging field of 15\*17 cm, paying attention to the patient’s position during imaging, as he stands upright with the Frankfort horizontal plane parallel to the ground and the patient’s occlusion in the position of maximum kyphoscoliosis. The reference levels used in this study are shown in (Table 1). The measurements that were made are summarized in (Table 2) and (Figure 5).

|  |  |  |
| --- | --- | --- |
| **Level** | **Abbreviation** | **Definition** |
| Frankfort horizontal plane | FH plane | The horizontal plane passing through the right and left OR points and the highest point on the external auditory canal. |
| Midsagittal reference plane | MSR plane | The plane perpendicular to FH passing through (Sella) and (Nasion) |
| Anteroposterior reference plane | PO plane | The plane perpendicular to FH passing through the right and left PO |

***Table (1) - Reference levels***

|  |  |
| --- | --- |
| Mandibular condyle |  |
| Mesiodistal position of the condyle (mm) | Cdmed to MSR plane |
| Condyle angle with FH (°) | ​​(Cdmed - Cdlat) – FH |
| Condyle angle with PO (°) | (Cdmed - Cdlat) – PO |
| Condyle angle with MSR (°) | (Cdmed - Cdlat) – MSR |
| Mesial joint distance | the shortest distance between the most medial points of the mandibular condyle and the most distal points of the joint fossa |
| Lateral joint distance | the shortest distance between the most distal points of the mandibular condyle and the most medial points of the joint fossa |
| Anterior joint distance | the shortest distance between the most anterior points of the mandibular condyle and the most posterior points of the joint fossa |
| Superior joint distance | the shortest distance between the most superior points of the mandibular condyle and the most anterior points of the joint fossa |
| Frankfort horizontal plane (FH), Anteroposterior plane (PO), Midsagittal reference plane (MSR), Roof of the sphenoid fossa (RG), Sphenoid fossa (GF), Most medial point on the head of the condyle (Cdmed), Most lateral point on the head of the condyle (Cdlat), Most anterior point on the head of the condyle (Cdant), Most posterior point on the head of the condyle (Cdpost), Most superior point on the head of the condyle (Cdsup) | |

***Table (2) - The measurements adopted in this study***

A screenshot of a computer

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***Figure (5): Measurements on the mandibular condyle***

Three reference lines were drawn after orienting the image according to them in three planes: the line passing through the anterior and posterior nasal spines (ANS-PNS) in the Axial plane (Figure 6), the line perpendicular to the SN and passing through S in the Sagittal plane (Figure 7), and the line passing through the two lowest points on the lower orbital rims (drawn using the 3D/Virtual image) (Figure 8).

A screenshot of a computer

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***Figure (6): the line passing through the anterior and posterior nasal spines (ANS-PNS) in the Axial plane***

A computer screen shot of a skull

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***Figure (7): Line perpendicular to SN and passing through S in the Sagittal plane***

***Figure (8): Drawing using 3D image***

A computer screen shot of a skull

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**CBCT image evaluation times:**

T0: before the start of expansion and application of devices and T1: after the end of fixation which corresponds to T3 in the plaster models after six months from the end of the three-month fixation phase. The measurements adopted were compared to the time(s) T0, T1

**Patient acceptance assessment:**

A questionnaire was devised to study the levels of pain and discomfort and the extent of patients' acceptance of the dilation device. The questionnaires were distributed to the patients, and the questions as well as the options under each question were explained to them in a plain language. The questions were answered by the patients themselves either in the treatment chair or at home based on their preferences. The researcher answered all the queries the patient had without affecting their answers to the questions in the questionnaire. In the event of severe pain, patients were allowed to take (Paracetamol 500 mg), provided that the painkiller was taken after filling out the questionnaire and not before that in order not to affect the accuracy of the assessment. The questionnaires were distributed at multiple times from the first day of expansion until the end of treatment.

**Questionnaire on pain, discomfort and functional disabilities:**

The questionnaire on pain, discomfort and functional disabilities (Questionnaire No. 4) was filled out by the patient at the following times:

1. The first time (T1): on the first day of applying the device.
2. The second time (T2): one week after applying the device.
3. The third time (T3): two weeks after applying the device.
4. The fourth time (T4): one month after applying the device.

The patient was asked to choose a degree from 0 to 100 that expresses the amount of pain they feel.

The answer to the pain felt questionnaire was through the use of Visual Analog Scale (VAS), which is a horizontal line 100 (mm) long with two anchor points at its beginning and end (for describing the matter to be tested). For instance, when asking about the amount of pain, point 0 means no pain, and point 100 means the worst pain possible felt, and the patient marks the point on the line that they feel to be reflecting their current condition. The scale scores are determined by measuring the distance in (mm) from the beginning of the scale to the point specified by the patient.

**Statistical study:**

The results obtained were organised and analysed using Minitab®Version 19 software (Minitab Inc., State College, Pennsylvania, USA). The Wilcoxon test was performed to study the differences between the studied time periods for all variables (intermolar width, intercanine width, correction of mandibular deviation, changes at the level of the temporomandibular joint, and variables of patient acceptance of treatment). The data on the position of the mandibular condyles on the right and left sides were analysed using the Mann-Whitney U test. The confidence level in this study is 0.95%.

**Method error:**

All studied variables were randomly re-measured for eight patients (20% of the sample) by the same researcher at a time interval of 2 weeks. The reliability of measuring the quantitative variables was determined using the Paired T-test. As such, the reliability of measuring the ordinal variable ARI was determined using the Wilcoxon matched-pairs signed-ranks test, in order to assure the absence of any systematic error. The intra-examiner reliability of the researcher's measurement of the quantitative variables was determined using the Intra-class Correlation Coefficient (ICC) test. As for the ordinal variable (ARI), the Kappa agreement score between the two measurements was calculated in order to determine the random error.

**Results**

The study included 20 children aged 7–10 years with unilateral posterior crossbite and mandibular slippage. Following treatment with a removable sliding expansion device, two patients were excluded due to extended treatment duration, leaving 18 participants for analysis.

**Plaster Model Analysis** The results of the Wilcoxon test to study the significance of the two-way differences in the amount of intermolar and intercanine widths are summarized in (Table 3). The results showed statistically significant differences when comparing the stage before the start of expansion and each of the remaining three stages (after the end of the active treatment stage, after the end of the fixation stage, and after the end of the control stage) separately (P < 0.05) when comparing the values ​​of the amount of intermolar and intercanine widths in the maxilla. For the mandibular arch, intermolar width significantly increased across all stages, while intercanine width was higher after treatment compared to the fixation phase but did not show significance in other comparisons.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Studied jaw** | **The two compared stages** | **Intermolar width** | | | **Intercanine width** | | |
| **Difference between the two medians** | **Z value** | **P value** | **Difference between the two medians** | **Z value** | **P value** |
| The Maxilla | After the end of the active treatment stage - Before the start of expansion | 6.28 | -3.724 | **0.000** | -0.01 | -2.059 | **0.039** |
| After the end of the fixation stage - before the start of expansion | 6.29 | -3.724 | **0.000** | 0.17 | -2.059 | **0.039** |
| After the end of the monitoring stage - before the start of expansion | 6.58 | -3.724 | **0.000** | 0.19 | -2.059 | **0.039** |
| After the end of the fixation stage - after the end of the active treatment stage | 0.01 | -1.530 | 0.126 | 0.18 | -2.668 | **0.008** |
| After the end of the monitoring phase - After the end of the active treatment phase | 0.30 | -0.245 | 0.807 | 0.20 | -2.040 | **0.041** |
| After the end of the monitoring phase - After the end of the fixation phase | 0.29 | -0.296 | 0.767 | 0.02 | -0.943 | 0.345 |
| The Mandible | After the end of the active treatment phase - Before the start of expansion | 0.14 | -2.371 | **0.018** | -0.01 | -0.178 | 0.859 |
| After the end of the fixation phase - Before the start of expansion | 0.20 | -3.185 | **0.001** | -0.01 | -0.711 | 0.477 |
| After the end of the monitoring phase - Before the start of expansion | 0.30 | -3.300 | **0.001** | 0.08 | -1.177 | 0.239 |
| After the end of the fixation phase - After the end of the active treatment phase | 0.06 | -2.829 | **0.005** | 0.00 | -0.674 | 0.500 |
| After the end of the monitoring phase - After the end of the active treatment phase | 0.16 | -2.950 | **0.003** | 0.10 | -1.355 | 0.176 |
| After the end of the monitoring phase - After the end of the fixation phase | 0.10 | -2.201 | **0.028** | 0.09 | -2.070 | **0.038** |

***Table (3): Results of Wilcoxon test to study the significance of the two-way differences in the amount of intermolar width and intercanine width***

**Midline deviation correction:**

The results of the Wilcoxon test (Figure 9) showed that the values ​​of the amount of correction of the midline deviation (in mm) after the end of the active treatment phase, after the end of the fixation phase, and after the end of the monitoring phase were statistically, significantly smaller than before the start of expansion (P < 0.05). Meanwhile, no statistically significant differences were recorded in the average amount of correction of the deviation of the lower dental midline (in mm) between the three stages (after the end of the active treatment stage, after the end of the fixation stage, and after the end of the control stage).

***Figure (9): Arithmetic mean of the values of the midline correction value***

Study of the position of the mandibular condyle:

Table (4) shows the results of the Wilcoxon test to study the significance of the differences before and after treatment for the joint values ​​on each side separately in addition to the results of the Mann-Whitney U test to study the significance of the differences between the values ​​of the affected and not affected sides before and after treatment. A statistically significant increase of 0.39 was observed in the anterior joint distance on the affected side. As such, a statistically significant increase was also recorded in the medial joint distance on both sides. The application of the tilt expansion device also led to a significant change in the value of the condyle angle in the sagittal plane with the SN column on the affected side, accompanied by a change in the value of the condyle angle in the axial plane with the line passing from ANS -PNS on the not affected side. In contrast, the results of the Mann-Whitney U test showed a significant change in the values ​​of the condyle angle in the axial plane with the line passing from ANS -PNS between the not affected and affected sides before and after treatment (P < 0.05). Meanwhile, no differences were observed between the two sides when comparing the other values.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **The studied joint value** | **Side** | **Average difference between pre and post treatment** | **Z value** | **P value** | **Before /after treatment** | **Average difference between right and left sides** | **U value** | **P value** |
| Anterior joint distance AJS | affected | 0.39 | -2.860 | 0.004 | Before | -0.34 | 221.0 | 0.064 |
| Not affected | 0.19 | -1.379 | 0.168 | After | -0.14 | 187.0 | 0.443 |
| Superior joint distance SJS | affected | -0.29 | -0.501 | 0.616 | Before | 0.24 | 161.0 | 0.988 |
| Not affected | -0.12 | -0.109 | 0.913 | After | 0.06 | 159.5 | 0.938 |
| Posterior joint distance PJS | affected | -0.70 | -1.070 | 0.284 | Before | 0.34 | 144.5 | 0.584 |
| Not affected | -0.74 | -0.783 | 0.434 | After | 0.39 | 126.0 | 0.265 |
| Mesial Joint Distance MJS | affected | 0.39 | -2.993 | 0.003 | Before | -0.17 | 169.5 | 0.815 |
| Not affected | 0.24 | -2.424 | 0.015 | After | -0.02 | 153.5 | 0.791 |
| Lateral Joint Distance DJS | affected | 0.14 | 0.931 | 0.365 | Before | -0.23 | -0.761 | 0.452 |
| Not affected | -0.19 | -1.364 | 0.190 | After | 0.09 | 0.305 | 0.762 |
| Condylar Angle In Sagittal Plane With SN Column | affected | 1.11 | -2.027 | 0.043 | Before | -0.55 | 186.0 | 0.462 |
| Not affected | 1.29 | -1.155 | 0.248 | After | -0.73 | 189.5 | 0.389 |
| Axial plane condyle angle with line passing through ANS -PNS | affected | 1.37 | -1.352 | 0.176 | Before | 8.59 | 78.50 | 0.007 |
| Not affected | 3.81 | -2.681 | 0.007 | After | 6.15 | 97.0 | 0.040 |
| Axial plane condyle angle with Midsagittal line | affected | -1.11 | -1.833 | 0.084 | Before | 2.18 | 1.023 | 0.313 |
| Not affected | 0.15 | 0.118 | 0.907 | After | 0.92 | 0.542 | 0.592 |
| Condyle distance to Midsagittal line | affected | 0.37 | -0.676 | 0.499 | Before | 2.32 | 104.0 | 0.068 |
| Not affected | 1.19 | -1.309 | 0.191 | After | 1.51 | 120.5 | 0.192 |

***Table (4): Wilcoxon test results to study the significance of differences among the joint values on each side separately before and after treatment, in addition to the Mann-Whitney U test results to study the significance of differences between the values of the right and left sides before and after treatment.***

Study of patient acceptance of treatment: The Wilcoxon test was conducted to study the significance of the binary differences in the average amount of pain, the average amount of patient discomfort, and the difficulty in speaking between the four studied time periods. It was found that the values ​​of the amount of pain decreased significantly with the increase of the studied time period (P < 0.05). As for the average amount of difficulty in chewing and swallowing, it was found that there were no statistically significant differences between the studied time periods. The results of the study of patient acceptance of treatment are presented in Table (5).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **The studied variable** | **Comparison of pain intensity values ​​between two periods:** | **Difference between the two medians** | **Z value** | **Significance level value** |
| Amount of pain | After one week - on the first day | -15.00 | -4.087 | 0.000 |
| After two weeks - on the first day | -32.00 | -3.956 | 0.000 |
| After one month - on the first day | -39.00 | -3.986 | 0.000 |
| After two weeks - after one week | -17.00 | -3.886 | 0.000 |
| After one month - after one week | -24.00 | -3.718 | 0.000 |
| After one month - after two weeks | -7.00 | -2.326 | 0.020 |
| Amount of discomfort | After one week - on the first day | -16.00 | -3.926 | 0.000 |
| After two weeks - on the first day | -24.50 | -3.965 | 0.000 |
| After one month - on the first day | -32.50 | -3.963 | 0.000 |
| After two weeks - after one week | -8.50 | -3.494 | 0.000 |
| After one month - after one week | -16.50 | -3.779 | 0.000 |
| After one month - after two weeks | -8.00 | -3.176 | 0.001 |
| Difficulty in chewing | After one week - on the first day | 0 | 0 | 1.000 |
| After two weeks - on the first day | 0 | 0 | 1.000 |
| After one month - on the first day | 0 | 0 | 1.000 |
| After two weeks - after one week | 0 | 0 | 1.000 |
| After one month - after one week | 0 | 0 | 1.000 |
| After one month - after two weeks | 0 | 0 | 1.000 |
| Difficulty in swallowing | After one week - on the first day | -0.50 | -1.000 | 0.317 |
| After two weeks - on the first day | -1.00 | -1.000 | 0.317 |
| After one month - on the first day | -1.00 | -1.000 | 0.317 |
| After two weeks - after one week | -0.50 | -1.000 | 0.317 |
| After one month - after one week | -0.50 | -1.000 | 0.317 |
| After one month - after two weeks | 0 | 0 | 1.000 |
| Difficulty in speaking | After one week - on the first day | -12.50 | -3.624 | 0.000 |
| After two weeks - on the first day | -23.50 | -3.763 | 0.000 |
| After one month - on the first day | -32.50 | -3.765 | 0.000 |
| After two weeks - after one week | -11.00 | -3.824 | 0.000 |
| After one month - after one week | -20.00 | -3.761 | 0.000 |
| After one month - after two weeks | -9.00 | -3.307 | 0.001 |

***Table (5): The results of the Wilcoxon test to study the significance of the binary differences in the average amount of pain, the amount of discomfort, difficulty in chewing and swallowing, and difficulty in speaking between the four studied time periods (on the first day, after one week, after two weeks, after one month) in the studied sample***

**Discussion**  
Maxillary narrowing, a common orthodontic issue, is treated with slow maxillary expansion (SME). This study examined SME using removable plates for unilateral posterior crossbite correction in 7–10-year-olds, focusing on early malocclusion correction and TMJ impact.

The removable device with a smooth posterior bite lift showed several benefits over fixed appliances, including better oral hygiene, lower cost, and greater comfort. Patients activated the device twice weekly until overcorrect, followed by a three-month stabilization phase. The results confirmed significant maxillary intermolar and intercanine width increases (P < 0.05), indicating effective expansion and spontaneous mandibular growth. These findings align with prior research by Sollenius et al. (2019) and Godoy et al. (2011) 9, 14, supporting the device’s long-term stability.

TMJ changes showed improved anterior joint distance on the affected side post-treatment, with stable other measurements. This suggests effective occlusion correction without adverse effects, highlighting individual responses based on age, health, and compliance.

Pain and discomfort were initially moderate but significantly reduced within two weeks, aligning with Rabah (2020) 15 Chewing and speaking difficulties also lessened, indicating patient adaptation.

Overall, removable expansion plates effectively corrected malocclusion, improved symmetry, and were well-tolerated. However, the six-month observation period limits the study's scope. Future research with longer follow-ups and larger samples is recommended to validate these findings and assess long-term outcomes.

In conclusion, removable devices offer a reliable, patient-friendly solution for managing unilateral posterior crossbite, enhancing occlusal alignment and TMJ function while ensuring comfort and satisfaction.

**Conclusions:**

Within the scope of the present study, the following conclusions can be drawn:

* Slow maxillary expansion using removable expansion plates is an effective method for treating unilateral posterior crossbite in the mixed occlusion stage.
* The application of removable expansion plates leads to a significant improvement in the mandibular deviation caused by the crossbite.
* The removable expansion plates achieve equal or close correction on both sides of the mouth and improve the mandibular condyles' forward movement.

### **Declarations:**

#### **Ethics approval and consent to participate**

Not applicable.

#### **Funding**

Not applicable.

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