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Efficacy of Arthroscopic Diskopexy on Condylar Growth in Temporomandibular Joint Anterior Disk Displacement: A Randomized Clinical Trial

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Quality of Care



Background: Adolescents with temporomandibular joint (TMJ) anterior disk displacement (ADD) frequently develop dentofacial deformities. It is unknown whether adjunctive arthroscopic diskopexy compared with orthodontic treatment alone increases condylar growth and then improves dentofacial deformity. This study aimed to determine whether arthroscopic diskopexy before functional appliance (joint-occlusal treatment) or single functional appliance (occlusal treatment) increases condylar growth and improves dentofacial deformity among adolescents with TMJ ADD.

Methods: A multicenter, randomized, parallel, controlled trial was conducted in 3 centers in China. Adolescents diagnosed with TMJ ADD and dentofacial deformity were enrolled. Eligible participants were randomly assigned to a joint-occlusal group or occlusal group at a ratio of 2:1. Magnetic resonance imaging scans and cephalometric radiographs were evaluated at baseline, at 8 months, and at 14 months. The primary outcome was changes in condylar height from 14 months to baseline. Secondary outcomes were changes in skeletal position.

Results: A total of 240 patients (14.65 ± 1.88 years of age) were randomized (joint-occlusal group, 160; occlusal group, 80). The overall difference in condylar height between groups was 3.65 mm (95% CI, 3.10 to 4.19 mm; $P < 0.001$). The between-group differences in condylar height on the left and right sides were 3.60 mm (95% CI, 2.92 to 4.28 mm; $P < 0.001$) and 3.69 mm (95% CI, 3.06 to 4.32 mm; $P < 0.001$), respectively. Significant between-group differences were noted in skeletal position (all $P < 0.001$).

Conclusion: Joint-occlusal treatment can promote condylar growth and improve dentofacial deformity in adolescents after 14 months when compared with single occlusal treatment. (*Plast. Reconstr. Surg.* 154: 544e, 2024.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, I.

Temporomandibular joint (TMJ) anterior disk displacement (ADD) is one of the most common TMJ disorders, with rates ranging from 7.3% to 30.4% in the adolescent population.¹ With the aid of magnetic resonance imaging (MRI),

Nebbe and Major reported that the prevalence of ADD was approximately 50% in preorthodontic adolescents.² Apart from the easily recognized symptoms, such as clicking, pain, and restricted jaw movement, ADD can initiate a cascade of events

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leading to osteoarthritis and condylar resorption in patients, especially adolescents.³ Pubertal patients are more susceptible when bone growth spurts run parallel with prolonged ADD, as this has severe compound outcomes later in life such as mandibular retrusion and asymmetry.

Orthodontics and plastic surgery operations, including mandibular augmentation, are popular therapeutic options for this population. However, relapse after these treatments is often a critical problem.⁴ Studies have reported that the recurrence rate of orthodontic treatment or orthognathic surgery reached 83% to 100% in patients with TMJ ADD.^{5,6} Condylar resorption or mandibular growth inhibition caused by ADD is the most crucial yet overlooked factor accounting for intractable mandibular retrusion or asymmetry.⁶ Generally, the more severe the mandibular retrusion or asymmetry, the more advanced the ADD stage.⁷ Therefore, only orthodontic or plastic therapy for adolescents with ADD and mandibular retrusion or asymmetry might seem like a “treatment trap.”

Up to now, the management of ADD mainly focused on relieving patients’ symptoms rather than correcting the displaced articular disk. Given the hazards of ADD, reestablishing a normal articular disk-condyle relationship may contribute to condylar adaptive remodeling, especially at puberty. Arthroscopic technique of disk repositioning and suturing is an effective method to reposition the displaced disk, and the operation time is short.⁸ Our previous studies based on 2167 consecutive patients have confirmed that the success rate of arthroscopic diskopexy reached 95% over 24 months of follow-up.⁹ Nevertheless, there is a lack of high-quality evidence on the efficacy of surgical intervention for condylar growth in adolescents with ADD. Therefore, we established a joint-occlusal treatment model, which involves repositioning the displaced disk first by arthroscopic diskopexy and then by applying a functional appliance to correct jaw deformity. The present study aimed to determine whether joint-occlusal treatment versus single functional appliance treatment promote the temporomandibular condylar growth and improve the dentofacial

deformity among adolescents with ADD and mandibular retrusion or asymmetry at 14 months.

PATIENTS AND METHODS

Trial Design

This study was an investigator-initiated, open-label, assessor-blinded, multicenter, parallel-group, randomized, controlled clinical trial conducted in 3 centers in China. Ethics approval was obtained from the human research ethics committee of our institution (2017-347-T256). Participants and their legal guardians received written and verbal information about the study. Signed consent was obtained from all the participants and their legal guardians. The trial followed the Consolidated Standards of Reporting Trials reporting guideline and complied with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Study Participants

The trial population consisted of adolescent patients with TMJ ADD diagnosed based on MRI findings. Key inclusion criteria were patient aged between 10 and 20 years; presence of symptoms such as clicking, pain, or restricted jaw movement; and detection of mandibular retrusion or asymmetry. Key exclusion criteria included severe condylar resorption and histories of orthodontic or TMJ treatments.

Randomization

Based on our previous results showing that new bone formation on the condyle was found after disk reposition surgery,^{9,10} the ratio of the experimental group to control group was set at 2:1, with deference to ethical considerations. Patients who met the inclusion criteria were randomized to receive arthroscopic diskopexy plus a functional appliance (joint-occlusal group) or single functional appliance (occlusal group) treatments. Permuted block randomization with a block size of 6 was used. Random results were generated by third-party statisticians based on an interactive Web response system. Sealed, opaque, consecutively numbered envelopes concealed allocations by an independent researcher and were opened in numerical order in 3 centers.

Interventions

For adolescents who were diagnosed with TMJ ADD and mandibular retrusion or asymmetry, the conventional treatment protocol was to protrude the mandible using a functional

Disclosure statements are at the end of this article, following the correspondence information.

Related digital media are available in the full-text version of the article on www.PRSJournal.com.



Fig. 1. Photographs of the functional appliance. Herbst appliance was used for patients with open bite (*left*). ARS were suitable for patients without open bite (*right*). ARS, anterior repositioning splints.

appliance,^{11,12} which was deemed the occlusal group. The principle of bite-jumping is as follows: the bite-jumping standard is advancing the mandible to an incisal edge-to-edge position to solve mandibular retrusion.^{13,14} Patients with open bite were suitable to receive a Herbst appliance. For patients without open bite, anterior repositioning splints were used (**Fig. 1**). When mandibular asymmetry was present, the mandibular midline was corrected simultaneously when repositioning the mandible.¹⁵

In the joint-occlusal group, patients first received the arthroscopic diskopexy before the functional appliance. During the arthroscopic diskopexy, a 2.7-mm 0-degree arthroscope set (Stryker, San Jose, CA) involving a 3.2-mm outer protective cannula, a video surveillance system, and an image printer were used. In addition, customized suture equipment (Shanghai ShenDing Industrial Co. Ltd, Shanghai, People's Republic of China), including a 12-gauge suture needle, a pair of self-designed grippers (a lasso type and a hook type), and a surgical suture (medical-grade woven polyester with an inner core) was also used.¹⁶ (**See Figure, Supplemental Digital Content 1**, which shows photographs of customized suture equipment used in the arthroscopic technique. The pair of self-designed trocars [*left*]. The pair of self-designed grippers [a lasso type and a hook type] [*right*], <http://links.lww.com/PRS/G946>.)

The arthroscopic procedure performed under local anesthesia comprised a combination of anterior release, disk reduction, and disk suture. First, an arthroscope was introduced into the concavity for diagnostic review. Then, a coblation probe was used for anterior release. Third, a suturing needle was inserted between the bilaminar zone and the posterior band. In addition, a pair of

self-designed grippers (a lasso type and a hook type) was used to catch the surgical suture. Finally, the disk was pulled backward and the sutures were tied underneath the cartilage of the external auditory canal.^{9,17} (**See Video 1 [online]**, which demonstrates the procedure of arthroscopic diskopexy). The occlusal treatments in both groups were carried out by orthodontists, and the arthroscopic surgery in the joint-occlusal group was performed by surgeons who underwent unified and standardized training in arthroscopic surgery.

Data Collection and Blinding

In the occlusal group, patients were instructed to wear the functional appliance within 1 month following baseline; they were instructed to wear the appliance continuously (for 24 hours per day) for 6 months. The functional appliance was removed at 7 months. In the joint-occlusal group, arthroscopic diskopexy was performed on patients before wearing the functional appliance.

MRI, lateral, and posteroanterior cephalometric radiographs were evaluated at baseline, at 8 months (1 month after removing functional appliances), and at 14 months. Visual analogue scale (VAS) score was monitored as a safety outcome to evaluate TMJ pain intensity.¹⁸ The degree of malocclusion, including left and right molar relationships, overbite, and overjet, was documented at each time point. Jaw movements, such as maximum interincisal opening (MIO), protrusion, and left and right excursions were assessed, and mouth open tracing was recorded. The endpoint was set at 14 months.

Because the intervention included surgery, patients, and researchers who conducted the intervention could not be blinded. However, orthodontists, outcome assessors, and statisticians

were blinded to the group assignment. All outcome assessors were trained and calibrated by experienced senior professors before implementation of the study. Intraclass correlation coefficient values for the interexaminer reliabilities ranged from 0.72 to 0.86.

Outcomes

The primary outcome was changes in the condylar height from 14 months to baseline. Condylar height was evaluated based on MRI findings and was measured as the vertical distance between 2 perpendicular lines to the ramal plane that ran through the apex of the condylar head and the lowest point of the mandibular notch, respectively.¹⁹ Secondary outcomes were changes in the condylar height from 8 months to baseline, changes in the skeletal position from 8 and 14 months to baseline. Changes of ANB angle (the angle formed by point A, nasion, and point B), SNB angle (the angle formed by sella, nasion, and point B), and Pog-N-per (horizontal distance from pogonion to the vertical line of the Frankfort horizontal plane through nasion) based on lateral cephalometric radiographs were determined in terms of mandibular retrusion.²⁰ Changes in Me_x (the distance from menton to midline) measured in posteroanterior cephalometric radiographs were calculated to evaluate mandibular asymmetry.²¹

Statistical Analysis

Sample size calculation was conducted based on the primary outcome of this study (change in condylar height). According to the results reported by Yu et al.,²² the mean change in condylar height in the ADD group and healthy group was approximately 0.37 mm and 0.94 mm, respectively, and the SD was 1.13 mm. Patients were randomly assigned (2:1 ratio) to the joint-occlusal and occlusal groups. With an α value of 0.05, 90% power, and assuming a 20% dropout, sample sizes of 160 and 80 patients were required for the joint-occlusal and occlusal groups, respectively.

The primary and secondary analyses were both performed in the per-protocol set. For the primary analysis, considering the correlation between left and right condylar height, mixed effect was used to compare the difference between the 2 groups. For the secondary outcomes, an analysis of covariance was performed, with changes in the ANB, SNB, Pog-N-per, and Me_x from baseline to 8 months and 14 months as the dependent variable; treatment as the independent variable of interest; and baseline of ANB, SNB, Pog-N-per, and Me_x as a covariate. The

generalized estimation equation model was used to compare the difference of VAS score, molar relationship, and mouth open tracing between groups. The mixed effect model was performed to evaluate the difference in overbite, overjet, MIO, protrusion, and left and right excursion. Subgroup analyses are planned for the change from baseline in ANB, SNB, Pog-N-per, Me_x , and condylar height, respectively. The general linear model was used to perform the subgroup analysis for treatment by subgroup interactions. The least squares means and its 95% confidence intervals were presented. The Bonferroni correction was applied to address multiplicity concerns in relation to multiple secondary outcomes and different visiting time points. In total, there were 4 secondary outcomes and 2 time points included for analysis, resulting in a total of 8 comparisons being made. To account for multiple comparisons, the adjusted significance level was set at 0.00625.

All the statistical analysis were performed by SAS9.4. The forest plots were generated by the R package forest. All statistical tests were two-sided, and statistical significance was set at $P < 0.05$.

RESULTS

Study Participants

A total of 240 patients were identified as eligible for the study from 3 institutions in China between January 1, 2019, and April 30, 2021; the follow-up period ended in June 30, 2022. Of the 240 patients, 160 were randomized to the joint-occlusal group and 80 patients were randomized to the occlusal group. Eight patients withdrew after randomization because either they or their families withdrew consent to treatments. Fourteen patients in the occlusal group switched to the joint-occlusal group before 14 months because of obvious condylar resorption. Fifteen patients in the joint-occlusal group and 16 in the occlusal group were lost to follow-up at 14 months; therefore, 201 patients (83.8%) completed the 14 months trial (Fig. 2). Baseline characteristics were similar between the 2 groups (Table 1), except that the patients in the joint-occlusal group had more severe Me_x (3.15 mm versus 2.52 mm).

Primary Outcomes

Changes in the condylar height between the joint-occlusal and occlusal groups are presented in Table 2. The overall effects between groups at 8 months and at 14 months were significant (2.32 mm, 95% CI, 1.84 to 2.80 mm; 3.65 mm, 95% CI, 3.10 to 4.19 mm; respectively, both $P < 0.001$).

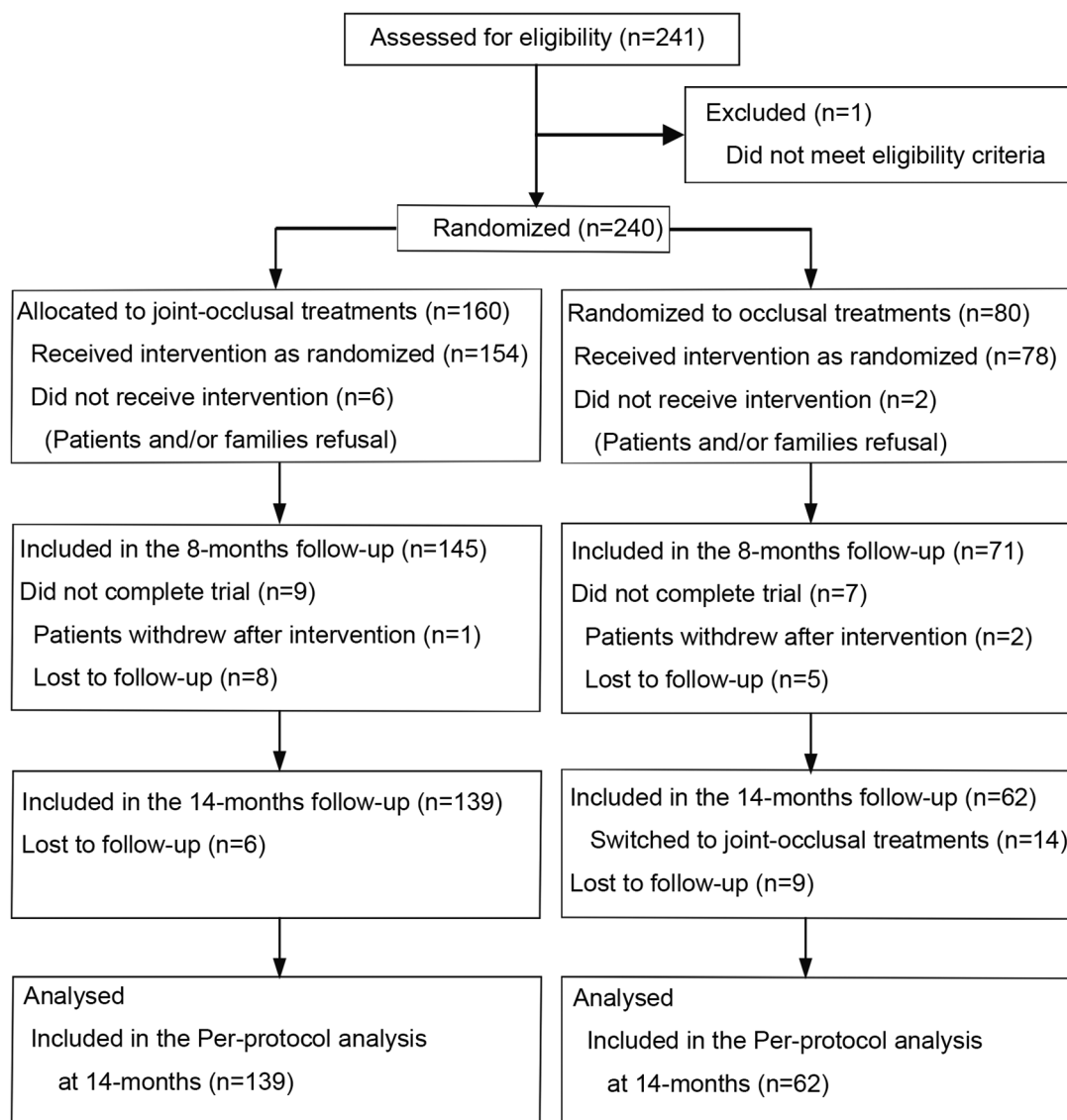


Fig. 2. Consolidated Standards of Reporting Trials flow diagram.

Interaction between the centers, left and right sides, and groups of the condylar height are shown. (See Table, Supplemental Digital Content 2, which shows the interaction between the centers, left and right sides, and groups of the primary outcome, <http://links.lww.com/PRS/G947>.)

Secondary Outcomes

The skeletal changes between the joint-occlusal and occlusal groups are presented in Table 3. Significant between-group differences were noted in the skeletal position including ANB, SNB, Pog-N-per, and Me_x (all $P < 0.001$). Interaction between the centers and groups of the secondary outcomes are shown. (See Table, Supplemental Digital Content 3, which shows the interaction

between the centers and groups of the secondary outcomes, <http://links.lww.com/PRS/G948>.)

Subgroup Analysis

Subgroup analysis revealed that adolescents of both sexes, at any age, and with the diagnoses of bilateral disk displacement without reduction and unilateral disk displacement without reduction had a marked increase in condylar height after joint-occlusal treatment (all $P < 0.05$). (See Figure, Supplemental Digital Content 4, which shows subgroup analysis of the condylar height. The left side of condylar height [*above*] and the right side of condylar height [*below*], <http://links.lww.com/PRS/G949>.) Post hoc subgroup analysis also demonstrated that adolescents of both sexes,

Table 1. Baseline Characteristics in the Joint-Occlusal Group versus the Occlusal Group^a

| Characteristics | Joint-Occlusal Group (%) | Occlusal Group (%) | <i>P</i> |
|-------------------------------------|--------------------------|--------------------|----------|
| No. | 160 | 80 | |
| Sex | | | 0.045 |
| Male | 35 (21.88) | 9 (11.25) | |
| Female | 125 (78.13) | 71 (88.75) | |
| Age, yr | 14.63 (1.96) | 14.66 (1.73) | 0.885 |
| Body height, cm | 165.89 (7.42) | 165.69 (6.39) | 0.841 |
| Body weight, kg | 54.18 (9.50) | 52.16 (8.06) | 0.104 |
| Body mass index, kg/m ^{2b} | 19.65 (2.85) | 18.97 (2.52) | 0.074 |
| TMJ diagnosis | | | 0.004 |
| bDDwoR | 76 (47.50) | 37 (46.25) | |
| bDDwR | 3 (1.88) | 4 (5.00) | |
| uDDwoR | 54 (33.75) | 28 (35.00) | |
| uDDwR | 0 (0.00) | 5 (6.25) | |
| uDDwR&uDDwoR | 27 (16.88) | 6 (7.50) | |
| Condylar height, mm ^c | | | |
| Left joint | 21.19 (3.40) | 20.76 (3.10) | 0.335 |
| Right joint | 21.10 (3.51) | 20.83 (3.92) | 0.599 |
| ANB angle, deg | 5.53 (2.41) | 5.15 (2.25) | 0.239 |
| SNB angle, deg | 76.07 (3.84) | 76.43 (3.21) | 0.472 |
| Pog-N-per, mm | 10.54 (6.91) | 9.55 (7.01) | 0.302 |
| Me _x , mm | 3.15 (1.91) | 2.52 (2.43) | 0.001 |

bDDwoR, bilateral disk displacement without reduction; bDDwR, bilateral disk displacement with reduction; uDDwoR, unilateral disk displacement without reduction; uDDwR, unilateral disk displacement with reduction; uDDwR&uDDwoR, unilateral disk displacement with reduction and unilateral disk displacement without reduction.

^aValues are presented as means (SDs) or No. (%).

^bCalculated as weight in kilograms divided by height in meters squared;

^cCalculated as the vertical distance between two perpendicular lines to the ramal plane that run through the apex of condylar head and the lowest point of mandibular notch, respectively.

at any age, and with the diagnoses of bilateral and unilateral disk displacement without reduction had marked improvement in their skeletal position after joint-occlusal treatment (all $P < 0.05$). (See **Figure, Supplemental Digital Content 5**, which shows subgroup analysis of the skeletal position. The ANB angle [*above, left*], the SNB angle [*above, right*], Pog-N-per [*below, left*], and Mex [*below, right*], <http://links.lww.com/PRS/G950>.)

Clinical Examination Outcomes

There was no statistically significant molar relationship between the 2 groups or 2 sides (both $P > 0.05$). No statistical significance was found in overbite between groups ($P > 0.05$). However, the overjet decreased significantly in the joint-occlusal group ($P < 0.0001$). (See **Figure, Supplemental Digital Content 6**, which shows occlusion changes in joint-occlusal and occlusal groups at every time point. The left molar relationship [*above, left*], the right molar relationship [*above, right*], overbite [*below, left*], and overjet [*below, right*], <http://links.lww.com/PRS/G951>.)

Significant increase of MIO in the joint-occlusal group was found ($P < 0.05$). The overall effect of protrusion, left and right excursion, and mouth open tracing between groups was not

statistically significant (all $P > 0.05$). (See **Figure, Supplemental Digital Content 7**, which shows jaw movements in joint-occlusal and occlusal groups. MIO was significantly increased in joint-occlusal group [*above, left*]. The overall effect of protrusion [*above, right*], left excursion [*below, left*], and right excursion [*below, right*] between groups was not statistically significant, <http://links.lww.com/PRS/G952>. See **Figure, Supplemental Digital Content 8**, which shows mouth open tracing changes in the joint-occlusal and occlusal groups, <http://links.lww.com/PRS/G953>.) Typical cases in the joint-occlusal group and the occlusal group are presented in **Figure 3**.

Treatment Safety

The generalized estimating equation model was used to compare the difference in the pain intensity by VAS score between the 2 groups. The difference in the trend between the 2 groups was significant ($P < 0.001$). Changes of the VAS scores are presented in **Figure 4**.

DISCUSSION

To our best knowledge, the present study is the first randomized clinical trial to compare

Table 2. Condylar Height Changes in Joint-Occlusal versus Occlusal Groups by Per-Protocol Set Analysis

| | 8 Mo (95% CI) | | 14 Mo (95% CI) | | <i>P</i> ^a | Joint-Occlusal vs. Occlusal | | <i>P</i> ^a |
|------------|------------------|------------------------|------------------|------------------------|-----------------------|-----------------------------|------------------|-----------------------|
| | Joint-Occlusal | Occlusal | Joint-Occlusal | Occlusal | | Joint-Occlusal vs. Occlusal | | |
| Overall | 1.57 (1.30–1.84) | -0.75 (-1.15 to -0.35) | 2.32 (1.84–2.80) | -0.87 (-1.32 to -0.41) | <0.001 | 2.78 (2.47 to 3.08) | 3.65 (3.10–4.19) | <0.001 |
| Left side | 1.63 (1.29–1.98) | -0.57 (-1.09 to -0.05) | 2.20 (1.58–2.82) | -0.73 (-1.30 to -0.17) | <0.001 | 2.87 (2.49–3.24) | 3.60 (2.92–4.28) | <0.001 |
| Right side | 1.51 (1.19–1.82) | -0.93 (-1.40 to -0.46) | 2.44 (1.86–3.01) | -1.00 (-1.53 to -0.48) | <0.001 | 2.69 (2.34–3.04) | 3.69 (3.06–4.32) | <0.001 |

^aMean change differences in the joint-occlusal group vs. the occlusal group.

Table 3. Skeletal Position Changes in the Joint-Occlusal Group vs. the Occlusal Group by Per-Protocol Set Analysis

| | 8 Mo (95% CI) | | 14 Mo (95% CI) | | <i>P</i> ^a | Joint-Occlusal vs. Occlusal | | <i>P</i> ^a |
|-----------------|------------------------|-----------------------|------------------------|------------------------|-----------------------|-----------------------------|------------------------|-----------------------|
| | Joint-Occlusal | Occlusal | Joint-Occlusal | Occlusal | | Joint-Occlusal vs. Occlusal | | |
| ANB | -0.96 (-1.13 to -0.80) | 0.51 (0.26–0.76) | -1.48 (-1.78 to -1.17) | 0.69 (0.32–1.05) | <0.001 | -1.92 (-2.17 to -1.68) | -2.61 (-3.05 to -2.17) | <0.001 |
| SNB | 1.17 (0.95–1.38) | -0.39 (0.70 to -0.07) | 1.55 (1.17–1.93) | -0.86 (-1.29 to -0.43) | <0.001 | 2.02 (1.73–2.31) | 2.88 (2.37–3.40) | <0.001 |
| Pog-N-per | -1.77 (-2.32 to -1.22) | 1.07 (0.24–1.89) | -2.83 (-3.83 to -1.84) | 1.64 (0.68–2.59) | <0.001 | -3.57 (-4.21 to -2.93) | -5.21 (-6.36 to -4.06) | <0.001 |
| Me _x | -1.13 (-1.35 to -0.91) | 0.52 (0.19–0.85) | -1.65 (-2.05 to -1.25) | 1.50 (1.18–1.81) | <0.001 | -1.56 (-1.78 to -1.35) | -3.06 (-3.45 to -2.68) | <0.001 |

^aMean change differences in the joint-occlusal group vs. the occlusal group.

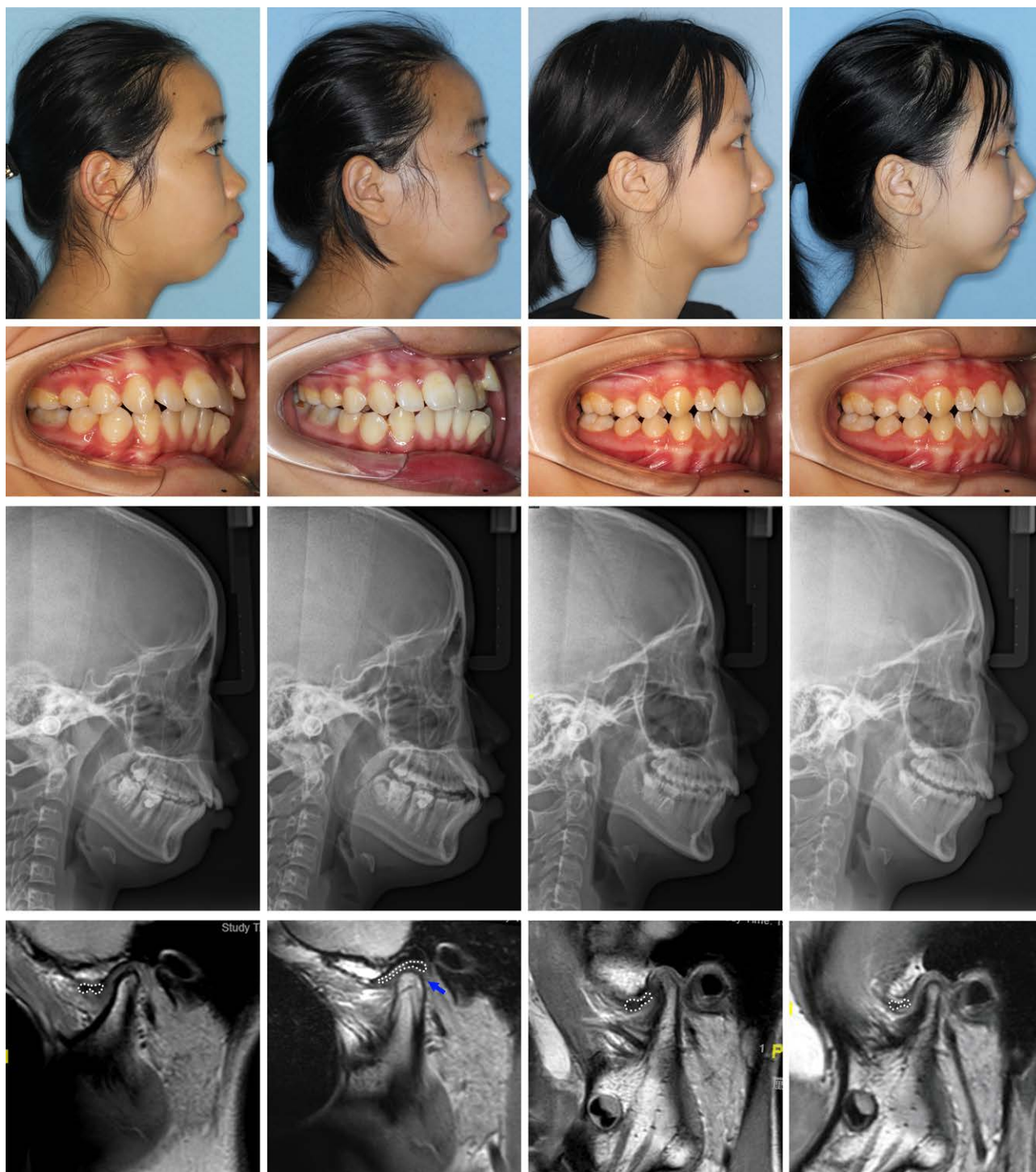


Fig. 3. Typical cases in the joint-occlusal and occlusal groups. Clinical examination, lateral cephalometric radiograph, and MRI image before and after treatments. The left 2 columns were a case at baseline (*left*), and at 14 months (*second from left*) in the joint-occlusal group. The right two columns were a case at baseline (*second from right*), and at 14 months (*right*) in the occlusal group (*dotted line, disk; blue arrow, new bone*).

the effect of joint-occlusal treatment and single occlusal treatment on the increment of condylar height and improvement of the dentofacial deformity. In the present study, a between-group

difference in the condylar height was observed, with a significant increment in the condylar height in the joint-occlusal group at 14 months (2.78 mm), whereas it inversely decreased in the

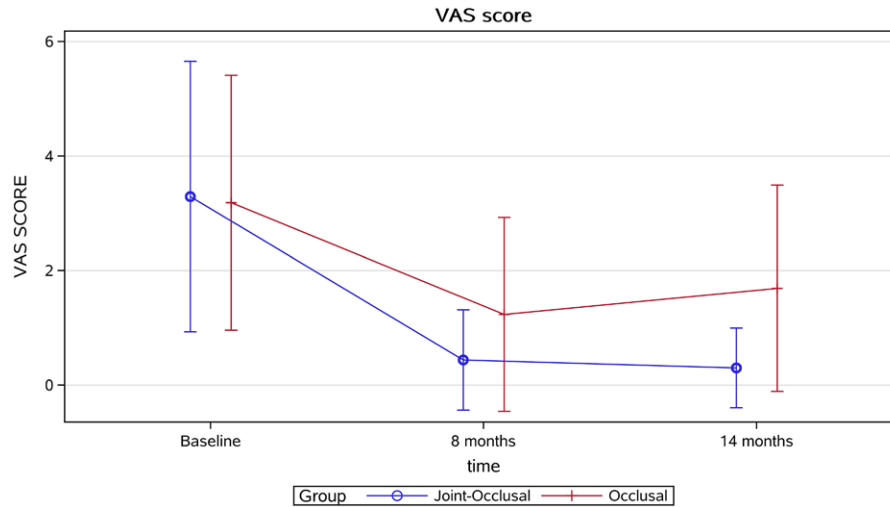


Fig. 4. VAS score changes in the joint-occlusal group versus the occlusal group ($P < 0.001$).

occlusal group (-0.87 mm). Notably, the increment of condylar height resulted in a significant improvement of jaw deformity. Remarkably, according to study from Buschang et al., mean yearly velocities of condylar growth were 2.0 to 3.1 mm/year at the pubertal growth peak.²³ Our results revealed that a normal condylar-disk relationship could restore the normal growth of condyle and improve dentofacial deformity, whereas disk displacement led to inhibition of condylar growth, which aggravated dentofacial deformity. It was noteworthy that findings from this study present the first important evidence and a new prospect on the efficacy of arthroscopic diskopexy among adolescents with TMJ ADD and jaw deformity.

With additional attention paid to the influence of ADD, several studies have investigated the relationship among ADD, condylar height, and dentofacial deformity.^{2,7,24} Generally, the more severe the disk displacement, the shorter the condylar height and the more deformed the mandible.^{3,21,25} Furthermore, studies confirmed that condylar growth was beneficial to correct the dentofacial deformity.¹⁵ To this extent, how to prevent condylar height decrease and even promote condylar height increase has important clinical significance, especially for patients with mandibular retrusion and asymmetry. Therefore, we used the condylar height as the primary outcome.

Although there are a number of controlled clinical trials on the management of TMJ ADD, rare studies referred to the surgical interventions, especially the arthroscopic diskopexy.²⁶⁻²⁹

Moreover, in most of these studies, the primary outcomes were pain intensity and MIO rather than the condylar growth. Our study also confirmed significant pain relief and MIO increase after joint-occlusal treatment. Therefore, this study is the first randomized clinical trial to investigate the condylar growth and dentofacial deformity by arthroscopic diskopexy in ADD patients.

The temporomandibular disk is the primary stress-distributing tissue, which acts by providing lubrication and minimizing shear-related tractional forces between the moving surfaces.^{30,31} Once the disk displaces anteriorly, the mechanical loading on the condylar surface increases, which can lead to cartilage degeneration and result in condylar resorption and dentofacial deformity in turn.³²⁻³⁴ Conversely, our findings indicated that arthroscopic diskopexy can produce adaptive amelioration through new bone formation.^{9,10} The reason might be that once the disk displacement is corrected, the pressure on the condylar surface releases. Condylar growth could be further promoted by using a functional appliance.³⁵ If condylar growth occurs in bilateral TMJ, the mandible will rotate in a counterclockwise direction and mandibular retrusion would be corrected. Accordingly, if condylar growth takes place in unilateral TMJ, then the mandible will deflect to the normal side and mandibular asymmetry would improve. (See **Video 2 [online]**, which demonstrates the relationship between condylar height and jaw deformity.)

The findings from the present study preliminarily reveal that TMJ ADD, as a high

incidence of oral diseases, could lead to condylar absorption and dentofacial deformities in turn. However, a significant proportion of patients who present with dentofacial deformities have their initial visit to orthodontic or plastic clinics, especially in those younger than 20 years.³⁶ Therefore, attention should be paid to the presence of TMJ ADD in adolescents with jaw deformity and under orthodontic or plastic surgical treatment, which would fully improve the effect of diagnosis and treatment of dentofacial deformities and reduce the recurrence rate. A multidisciplinary collaborative treatment model, including plastic surgeons, TMJ surgeons, and orthodontists, is suggested to diagnose and treat these patients. Findings in the present study also provide clinical evidence of promoting the development of oral and plastic practice strategies for the diagnosis and treatment of adolescent dentofacial deformities in the future.

Limitations

There are some limitations that need to be addressed. First, the observation period was 14 months, which was not very long. However, according to the study of Lei et al., condylar height changes can be detected at 6 months.³⁷ Furthermore, our findings confirmed the necessity of disk reposition for adolescents with ADD, and an obvious increment in condylar height and improvement in jaw position were found. Second, this trial mainly focused on adolescents and young adults because TMJ bone changes have a more severe influence on craniofacial growth in this population. Whether the joint-occlusal treatment model is suitable for adult patients remains unclear. Third, there is evidence that early mandibular distraction osteogenesis at mixed-dentition stage in craniofacial microsomia did not alter the need for orthognathic surgery at skeletal maturity.³⁸ Although our study revealed obvious condyle regeneration and jaw deformity decrease in adolescent patients, it is not clear whether this treatment can decrease the complexity of orthognathic surgery at maturity or even avoid the surgery.

CONCLUSIONS

Arthroscopic diskopexy before functional appliance treatment may promote temporomandibular condylar growth by restoring the normal disk-condylar position and further

improve dentofacial deformity in adolescent patients with TMJ ADD after 14 months. In contrast, single functional appliance treatment could lead to a reduction in condylar height and deterioration of dentofacial deformity in these patients.

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DISCLOSURE

The authors have no financial interest in any of the products, devices, or drugs mentioned in this article.

PATIENT CONSENT

Parents or guardians provided written informed consent for use of patients' images.

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CODING PERSPECTIVE

Coding perspective provided by Jeff Kozlow MD MS is intended to provide coding guidance.

| | |
|-------|--|
| 21010 | Arthrotomy, temporomandibular joint |
| 29800 | Arthroscopy, temporomandibular joint, diagnostic, with or without synovial biopsy (separate procedure) |
| 29804 | Arthroscopy, temporomandibular joint, surgical |

- The procedure described in the article, a TMJ arthroscopy, is best reported with codes in the CPT 2980X family.
- Given the manipulation and repositioning of the cartilage, code 29804 (Arthroscopy, temporomandibular joint, surgical) would be reported for this procedure.
- Code 29800 (Arthroscopy, temporomandibular joint, diagnostic, with or without synovial biopsy [separate procedure]) would not be reported separately, as the diagnostic arthroscopy is included in the “surgical” code. This is standard in CPT for similarly related procedures.
- The TMJ arthrotomy code 21010 would be reported only if the procedure is performed separately from the arthroscopy procedure for a different indication or diagnosis.

CODING PRINCIPLE: TMJ arthroplasty coding is relatively straightforward, with work beyond a biopsy being considered “surgical” and reported with code 29804.

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