Submitted: 31 August, 2023 Accepted: 10 October, 2023 Published: 03 January, 2024 DOI:10.22514/jocpd.2024.022

ORIGINAL RESEARCH

Journal of Clinical Pediatric Dentistry

Comparison between effects of mini-implant anchorage and face-bow anchorage in orthodontics for children

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Abstract

To study the values of mini-implant anchorage in orthodontics for children in the mixed dentition stage, 78 children in the mixed dentition stage who had accepted orthodontic treatment in our hospital from January 2020 to January 2021 were enrolled into this study. All children were treated with straight-wire appliance. According to their anchorages, children were divided into observation group and control group based on the random number table. Children in the control group used face-bow to control the anchorages and children in the observation group used mini-implants to control the anchorages. After treatment, the upper central incisor convex distance difference, inclination angle of the upper central incisor, displacement of the molar, gingival health, masticatory function, treatment effect and adverse reaction rate of children in two groups were compared. One year after treatment, compared with children in the control group, children in the observation group had smaller the upper central incisor convex distance difference, inclination angle of the upper central incisor, displacement of the molar, small scores of plaque index (PLI), bleeding index (BI) and gingival index (GI), stronger biting force and higher masticatory efficiency, lower adverse reaction rate during treatment, better treatment effect, higher satisfaction of orthodontic treatment. And differences of all the above indexes were statistically significant ($p < 0.05$). Mini-implant anchorages have good stability and directive force, and have certain values in orthodontics for children in the mixed dentition stage.

Keywords

Orthodontics treatment; Children in the mixed dentition stage; Mini-implant anchorage; Face-bow anchorage

1. Introduction

Malocclusion is a common oral disease and has negative impact not only on patients' appearances and chewing functions, but also on their mental health [1–3]. Traditionally, malocclusion is often intervened by orthodontic treatment at the stage of permanent teeth. However, at that time, children's oral statuses have been mature and it is difficult to perform orthodontic treatment [4, 5]. With the changes in medical philosophy, more children accept orthodontic treatment at the stage of mixed dentition [6, 7]. Children at mixed dentition stage need selective serial extraction and anchorage control to correct the dentition [6–8]. Face-bow anchorage is commonly used in clinical cases, but it lacks stability and has large wounds [9, 10]. Mini-implant anchorage is a temporary anchorage with small size and wide applications. It is easy to be implanted and is stable. Now it is commonly used in orthodontic treatment of adducting anterior teeth, pressing posterior teeth and moving the molars [11, 12]. At present, there have been studies on the application of mini-implant anchorage in the orthodontic treatment of children at the mixed dentition stage, but there are few relevant reports and its effect is still in the studying. In order to study the effect of mini-implant anchorage in orthodontics for children in the mixed dentition stage, we have conducted the following study.

2. Objects and methods

2.1 Objects

78 children in the mixed dentition stage who had received orthodontic treatment in our hospital from January 2020 to January 2021 were randomly selected and enrolled into this study.

1. Inclusion criteria: patients were 6 to 12 years old and in the mixed dentition stage; patients had irregular teeth arrangement; patients had orthodontic indications; patients had good oral hygiene; patients didn't receive orthodontic treatment before; less than half of alveolar bone of patients was absorbed; patients cooperated on the study and follow-up visit.

2. Exclusion criteria: patients who had combined congenital tooth loss, oral mucosal lesions or systemic diseases were excluded; patients who didn't cooperate on the treatment were

excluded.

3. According to the methods of anchorage control, children were divided into observation group and control group based on the random number table, 39 children each. Children in the observation group used mini-plant anchorage, while children in the control group used traditional face-bow anchorage control. In the observation group, there were 18 boys and 21 girls with a mean age of 10.57 ± 2.26. 22 children had crowded teeth. 17 children had bi-dental arch protrusion. In the control group, there were 16 boys and 23 girls with a mean age of 10.57 ± 2.26. 20 children had crowded teeth. 18 children had bi-dental arch protrusion. There was no significant difference between the general information of the two groups ($p > 0.05$).

2.2 Methods

2.2.1 Selective serial extraction

All children extracted their deciduous cuspids to ensure the permanent lateral incisor to grow. According to the condition of children's teeth arrangement, the doctor decided whether to extract the first deciduous molar when the first two cuspids grew, so as to ensure that the cuspids can grow in the proper position and to relieve the congestion of the maxillary anterior teeth. Parents were advised to take children back to the dentist on time so that the doctor could adjust the sequence of tooth extraction according to children's biting condition.

2.2.2 Anchorage control

2.2.2.1 Face-bow anchorage

All children were treated with straight-wire appliance and children in the control group used face-bow anchorage control. Transpalatal arch was used to enhance the anchorage control of face-bow. Children wore face-bow 8 to 12 hours a day for 9 months. Each month, children should go back to hospital and the doctors would adjust the face-bow according to the teeth movement. Children should pay attention to oral hygiene when wearing the face-bow.

2.2.2.2 Mini-implant anchorage

Children in the observation group used mini-implant anchorages made by Ningbo Cibei Medical Treatment Appliance Co., Ltd. Before treatment, the doctor rinsed the child's mouth with 0.02% chlorhexidine and performed local anesthesia with lidocaine. Then the doctor checked the position and shape of the teeth roots, and marked the implant site. Then the doctor checked the adjacent tissues and placed the mini-implant. To avoid soft tissues being involved into the mini-implant, the mucosa in the area of the alveolar bone flap needed to be incised. After treatment, radiographs of dental cusps were taken to confirm the relationship with the teeth roots. After treatment, antibiotics were taken to prevent infection. Children were informed to pay attention to their oral hygiene and clean the area around the implant with oral irrigator or sterile irrigation needles, and avoid hitting the implant with the toothbrush when brushing. After the cartilage was healed, the doctor added force on the micro-titanium nail with chain rubber bands. Children were required to return to the dentist every other month to adjust the force according to the tooth movement.

2.3 Indicators

(1) One year after treatment, the upper central incisor convex distance difference, inclination angle of the upper central incisor, displacement of the molar of children in two groups were compared and tested with CT (Computed Tomography). Each child received CBCT (Cone Beam Computed Tomography) examination by the same physician. All indicators were measured continuously three times, and the average value was taken as the final result.

(2) Compare the gingival health. All indicators were examined by the same physician, who was unaware of the groups.

1. Plaque index (PLI) [13]: a probe was wiped along the gingival margin to detect the quantity and thickness of plaque. The scores ranged from 0 to 3. More points indicated more plaque.

2. Bleeding index (BI) [14]: a periodontal probe with blunt end was used to detect bleeding state. The scores ranged from 0 to 5. More points indicated more bleeding.

3. Gingival index (GI) [15]: the scores ranged from 0 to 3. More points indicated worse gingival status.

(3) Masticatory function [16]: biting force and masticatory efficiency were included. 1. A biting test piece was put at the first molar of the lower jaw and children were asked to bite the piece 10 times continuously. 3 times of the maximum biting force were selected to calculate the average value. 2. The masticatory efficiency was calculated with peanuts. The children were given 2 g of peanuts to chew for 20 times on each side. And then they rinsed their mouth. The doctor collected the spits and residue in the teeth fossa. Then the doctor dried and weighed them to calculate the masticatory efficiency. Masticatory efficiency = the weight difference of peanuts before and after chewing/the weight of peanuts before chewing.

(4) Adverse reactions: oral infection, oral discomfort, edema of soft tissues.

(5) Effect evaluation had three levels: effective, improved and ineffective. Effective meant the physiological and anatomical relationship between the teeth was normal, and the dentition was orderly; improved meant the relationship between the teeth was obviously improved, and the dentition was generally orderly; ineffective meant that the above standards were not met.

(6) Treatment satisfaction evaluation: to evaluate the children's satisfaction with the treatment, a questionnaire was distributed. The questionnaire asked children about their satisfaction with the treatment, which was divided into three levels: very satisfied, satisfied and dissatisfied.

2.4 Statistics

SPSS 19.0 (IBM, Armonk, NY, USA) was used for data processing. The measurement data were expressed as ($\bar{x} \pm s$). The means between the two groups was compared by t test, and the count data was expressed by use cases. The χ^2 test was used for the comparison between the two groups. $p < 0.05$ was considered to be statistically significant.

3. Results

3.1 Comparison of the upper central incisor convex distance difference, inclination angle of the upper central incisor and displacement of the molar

One year after treatment, the upper central incisor convex distance difference, inclination angle of the upper central incisor, displacement of the molar of children in the observation group were all smaller than those in the control group, and the differences were statistically significant ($p < 0.05$). More details can be found in Table 1.

3.2 Comparison of gingival health

Scores of PLI, BI and GI that children in the observation group got were all lower than those in the control group, and the differences were statistically significant ($p < 0.05$). More details can be found in Table 2.

3.3 Comparison of masticatory function

The biting force and masticatory efficiency of children in the observation group were higher than the control group, and the differences were statistically significant ($p < 0.05$). More details can be found in Table 3.

3.4 Comparison of adverse reactions

The adverse reaction rate of children in the observation group was lower than the control group, and the difference was statistically significant ($p < 0.05$). More details can be found in Table 4.

3.5 Comparison of effect evaluation

The treatment effect of the observation group was better than that of the control group, and the difference was statistically significant ($p < 0.05$). More details can be found in Table 5.

3.6 Comparison of satisfaction evaluation

The satisfaction of orthodontic treatment of children in the observation group was higher than those in the control group, and the difference was statistically significant ($p < 0.05$). More details can be found in Table 6.

4. Discussions

Malocclusion is a common oral disease with deformity of teeth, occlusion and jaw caused by congenital or acquired factors in children's growth. It includes dentition crowding, tooth torsion, maxillary protrusion and mandibular retraction [17, 18]. Studies have shown that, the morbidity of malocclusion in modern people is 40% to 80%, while the morbidity of Chinese children is 67%. Malocclusion has negative effect not only on children's oral development and biting function, but also on children's maxillo-facial growth, thus influencing their mental health. The American Association of Orthodontists (AAO) advised that children should accept oral examination from mixed dentition stage at the age of 7 to timely solve problems such as tooth decay and dental replacement disorders. With the changes of modern oral health concepts, more children accept orthodontic treatment at mixed dentition stage [19, 20].

A stable and effective anchorage is vital to a successful orthodontic treatment [21, 22]. Previous clinical cases used internal anchorages, external anchorages and intermaxillary anchorages. Internal anchorages include fixed hyoid arch, lip bumper, transpalatal arch or multiple teeth. External anchorages include external hyoid arch. Intermaxillary anchorages include intermaxillary traction. But all these anchorages are uncomfortable and unstable, having limited values in children in the mixed dentition stage [23–25]. Mini-implant anchorage is made of titanium and its inner threaded pattern can be fixed with the patients' bone tissues in a mechanical way [26]. In addition, mini-implant anchorage is small and can be placed in various positions with small wounds. It's comfortable and stable as well [27].

This study has found that, after treatment, the molar displacement, upper and central incisor deviation, upper and central incisor dip of children in the observation group who used mini-implant anchorages were all smaller than those in the control group who used face-bow anchorages. It indicates that mini-implant anchorage is more stable and has stronger directive force [28, 29]. One reason is that, mini-implant anchorage directly relies on the bones and can meet the requirements of orthodontic treatment. And the direction of orthodontic force can be easily controlled as well [30]. Besides, mini-implant anchorage is made of titanium, which has good biocompatibility and is more comfortable for children. Moreover, this material has strong corrosion resistance, which can effectively reduce the corrosion of food residues, and is conducive to maintaining good oral biting and chewing functions. The small size of the mini-implant anchorage is also convenient for oral cleaning, reducing adverse reactions caused by poor oral hygiene. This study has found that, the biting force and masticatory efficiency of children in the observation group were higher than those in the control group, and their scores of PLI, BI and GI were all lower than those in the control group. Their adverse reaction rate during treatment was lower than those in the control group as well. These findings indicate that mini-implant anchorage is more comfortable for children in the mixed dentition stage and can help them maintain normal oral functions and gingival health. Finally, the treatment effect and satisfaction of orthodontic treatment of children in the observation group were higher than those in the control group, indicating that mini-implant anchorage has good values in orthodontics for children in the mixed dentition stage.

However, the sample size is relatively small and this study is single-centered, so the conclusions may have some errors. To enhance the reliability of the conclusions, it is necessary to add more samples and conduct further research.

5. Conclusions

In conclusion, mini-implant anchorage has better stability and stronger directive force, and has high values in orthodontics for children in the mixed dentition stage.

TABLE 1. Comparison of the upper central incisor convex distance difference, inclination angle of the upper central incisor and displacement of the molar.

Group	n	Molar displacement (mm)	Upper central incisor convex distance difference (°)	Inclination angle of the upper central incisor (°)
Observation group	39	4.06 ± 0.44	2.46 ± 0.51	14.25 ± 2.69
Control group	39	6.77 ± 0.74	4.71 ± 0.69	30.13 ± 3.54
t		19.658	16.376	22.305
p		<0.001	<0.001	<0.001

TABLE 2. Comparison of gingival health.

Group	n	PLI	BI	GI
Observation group	39	0.36 ± 0.06	0.45 ± 0.13	0.44 ± 0.11
Control group	39	0.84 ± 0.25	0.87 ± 0.25	0.91 ± 0.27
t		11.659	9.308	10.067
p		<0.001	<0.001	<0.001

PLI: plaque index; BI: bleeding index; GI: gingival index.

TABLE 3. Comparison of masticatory function.

Group	n	Biting force (N)	Masticatory efficiency (%)
Observation group	39	143.15 ± 31.17	89.58 ± 26.58
Control group	39	122.58 ± 26.85	72.47 ± 31.27
t		3.123	2.604
p		0.003	0.011

TABLE 4. Comparison of adverse reactions.

Group	n	Edema of soft tissues	Oral discomfort	Oral infection	Oral inflammation	Total
Observation group	39	0 (0.00)	1 (2.56)	1 (2.56)	1 (2.56)	3 (7.69)
Control group	39	3 (7.69)	4 (10.27)	2 (5.13)	2 (5.13)	11 (28.21)
χ^2/t		-	-	-	-	5.571
p		-	-	-	-	0.018

TABLE 5. Comparison of effect evaluation (n (%)).

Group	n	Effective	Improved	Ineffective	Effective rate
Observation group	39	20 (51.28)	16 (41.03)	3 (7.69)	36 (92.31)
Control group	39	14 (35.90)	15 (38.46)	10 (25.64)	29 (74.36)
χ^2		-	-	-	4.523
p		-	-	-	0.033

TABLE 6. Comparison of satisfaction evaluation (n (%)).

Group	n	Very satisfied	Satisfied	Not satisfied	Satisfaction
Observation group	39	29 (74.36)	7 (17.95)	3 (5.13)	36 (92.31)
Control group	39	17 (43.59)	12 (30.77)	10 (25.64)	29 (74.36)
χ^2		-	-	-	4.523
p		-	-	-	0.033

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this study are included in this published article. The datasets used and/or analyzed during the present study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

ZWH—designed the research study. XWQ—performed the research. LH—analyzed the data. FYR—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Sinopharm (Hubei) Stomatological Hospital Co., LTD (the ethical approval number: LW-2019-034). Patients and their families were informed of the study and signed the informed consent form.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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How to cite this article: Zhouwen Hou, Xiaowei Qu, Lei Hou, Fuying Ren. Comparison between effects of mini-implant anchorage and face-bow anchorage in orthodontics for children. Journal of Clinical Pediatric Dentistry. 2024; 48(1): 198-203. doi: 10.22514/jocpd.2024.022.