Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Removable Orthodontic Appliance with Interproximal Reduction to Correct Mandibular Anterior Crowding

Rifda Muthia Sabrina[1], Bramita Beta Arnanda[2]
Department of Orthodontic, Faculty of Dentistry, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Article Info
Keywords:
removable orthodontic,
interproximal reduction,
anterior crowding

ABSTRACT
Anterior crowding occurs due to a lack of coordination and disparity between tooth size and dental arch, resulting in available space limitation causing anterior tooth rotation and overlap. Removable orthodontic appliances combined with the Interproximal Reduction (IPR) technique have been used to correct anterior crowding. Case: A 26-year-old female came to Soelastri Dental and Oral Hospital of The Muhammadiyah Surakarta University with Angle Class I Dewey Type 1 malocclusion and individual dental malposition of maxillary and mandibular anterior (SNA 81°; SNB 78°; ANB 3°; overjet 3.3 mm; overbite 3.75 mm; convex profile). The treatment was carried out using removable orthodontic appliances combined with the IPR technique. Case Management: The Hawley appliances, consisting of labial arches and Adam clasps with active components were used for this case. A design modification of a U-shaped maxillary acrylic baseplate was made to free the torus on the palatal area. The IPR technique was done on the anterior teeth by slicing 0.25 mm for each side. The patient was instructed to use the appliances for 20 - 22 hours daily. Dental evaluation was scheduled every week to reactivate the springs. After 6 months, both mandibular canines were corrected and 41 showed significant movement mesiolabially. Conclusion: Patient compliance in wearing and maintaining the appliance could affect the correction of anterior crowding.

Corresponding Author:
Rifda Muthia Sabrina
Department of Orthodontic, Faculty of Dentistry,
Universitas Muhammadiyah Surakarta, Surakarta, Indonesia
rmuthiasabrina@gmail.com

INTRODUCTION

Anterior crowding is defined as one of the common characteristics of malocclusion where anterior teeth are misaligned [1]. It is considered to be one of the major oral health problems, after caries and periodontal disease. It was found to be around 39% and 93% in both children and adolescents [2]. A retrospective study by Yuvashree found that nearly 46% of patients were experiencing mandibular arch crowding[3]. The study also found that this condition affected females (50%) more than male subjects (33.86%). Another study also found that 46% of children between 6 and 12 years old and 85% of children between 12 and 17 years old had experienced this condition [3,4].

There are two types of malocclusions: skeletal and dental. Skeletal malocclusion can be identified using a cephalometric radiograph by determining the ANB angle. Skeletal class I

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

occurs when the ANB angle is between 0° and 4°, indicating a normal relationship between the upper and lower jaws. On the other hand, skeletal class II and class III occur when the ANB angle is increased to more than 3° and decreased to less than 0° [2].

Dental malocclusion is a disturbance found in the alignment between the dental arches. According to the Angle classification of occlusion and malocclusions, there are three classes based on the anteroposterior position of the first molars in the upper and lower jaws [5]. This condition occurs due to a lack of coordination and disparity between tooth size and dental arch, resulting in available space limitation, causing tooth rotation and overlap [4,6]. It is a multifactorial disease with a strong hereditary tendency. Factors affecting the development and severity of crowding include the growth direction of the mandible, premature loss of deciduous teeth, mesiodistal width of the teeth, incisor and molar inclinations, oral and perioral musculature, and arch dimensions. Dental crowding is most frequently found involving the lower incisors [4].

Malocclusion has been reported to affect Oral Health-Related Quality of Life (OHRQoL), which is the subjective experience of oral diseases symptoms impacting well-being. OHRQoL involves many aspects of life, such as stomatognathic systems, sleeping, social interactions, self-esteem, and satisfaction. It was reported that some patients with mild malocclusion appeared to have greater concerns than those with severe malocclusion. Another disadvantage of having malocclusion is that improper contacts between every tooth can cause difficulty in proper oral hygiene care, which easily result in plaque accumulation, causing various periodontal diseases [7].

The correction of mandibular crowding can be carried out by slicing, extraction, distalization, and surgical and non-surgical expansion of the mandible [4.] Numerous cases of anterior crowding with skeletal class I malocclusion had been successfully treated using removable orthodontic appliances with Interproximal Reduction (IPR). It is indicated for mild to moderate crowding with a maximum space discrepancy of 8 mm. The IPR is done by slicing the enamel using a grinding strip to gain and provide space for tooth correction. This technique is a great alternative for expansion and extraction in some orthodontic cases [8,9]. This article aims to report a case of removable orthodontic treatment with IPR in correcting mandibular anterior crowding.

METHOD

This study employed a case study approach to analyze the use of a removable orthodontic appliance combined with interproximal reduction (IPR) in correcting mandibular anterior crowding. A single patient exhibiting moderate anterior crowding in the lower jaw was selected for observation and treatment. Clinical procedures included initial assessment through intraoral examination, photographic documentation, and dental impressions to evaluate crowding severity. The treatment plan involved the fabrication and use of a customized removable orthodontic appliance in conjunction with gradual interproximal enamel reduction between selected teeth to gain sufficient space for alignment. Progress was monitored over a period of several months through regular clinical check-ups, photographic

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

comparisons, and measurements of tooth movement. The outcome was assessed based on improvements in alignment, patient comfort, and oral health status post-treatment.

RESULT AND DISCUSSION

Case

A 26-year-old female came to Soelastri Dental and Oral Hospital of the Muhammadiyah Surakarta University with a chief complaint of crowded teeth in the lower arch. The patient admitted to having her mandibular deciduous teeth extracted several times due to retained deciduous teeth and had never done any orthodontic treatment before. The patient had no allergies or systemic diseases and no history of drug consumption.

The extra-oral examination showed a convex facial profile with competent lips (Figure 1). Normal muscle tone in the masticatory muscles and no abnormality or pain were found in the temporomandibular joint areas. Freeway space was found to be 2.4 mm and considered to be normal. On intra-oral examination, it was found that the patient had a class I molar and canine relation (neutrocclusion) on both sides with parabola-shaped dental arches. Malpositions of 13, 11, 21, 22, 23, 34, 33, 41, 43, and 45 with a diastema found between 23 and 24. No involvement of the upper frenulum was found. A lobular-shaped torus was evident on the roof of the mouth. Oral hygiene index showed a value of 1.1, which was considered to be good (Figure 2).

Table 1. Malpositions of the maxillary teeth

Tooth	Dental Malpositions
13	Distopalatotorsi
11	Mesiopalatotorsiversion
21	Mesiopalatotorsiversion
22	Distopalatotorsiversion
23	Mesiobuccotorsi

Table 2. Malpositions of the mandibular teeth

Tooth	Dental Malpositions
34	Distobuccotorsiversion
33	Mesiolinguotorsiversion
41	Mesiolinguotorsiversion
43	Linguoversion
45	Buccoversion

Table 3. Mesiodistal widths of the teeth

Tooth	Mesiodistal Width (mm)	
16	8.3	Normal
15	6.3	Normal
14	7.7	Normal
13	6.8	Normal

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Tooth	Mesiodistal Width (mm)	
12	6.5	Normal
11	10	Normal
21	8.3	Normal
22	6.7	Normal
23	7.6	Normal
24	7.1	Normal
25	6.4	Normal
26	10.1	Normal
36	5.2	Normal
35	5.6	Normal
34	6.4	Normal
33	7	Normal
32	7	Normal
31	11	Normal
41	5	Normal
42	5.8	Normal
43	6.5	Normal
44	7	Normal
45	6.8	Normal
46	10.9	Normal

The study model analysis showed a normal overjet of 3.3 mm and overbite of 3.75 mm with no shifting of the maxillary and mandibular midline. The analysis was carried out and the results were as follows: 1) Pont analysis showed mild contractions of 0.7 mm for the inter-premolar width and 0.4 mm for the inter-molar width; 2) Korkhaus analysis showed a mild retrusion of 2.4 mm; 3) Howes analysis showed a premolar index of 42.7%, whereas the fossa canina index was 49.6%; 4) Arch determination analysis showed a total of 1 mm and 1.5 mm space deficiency in the upper and lower jaw; 5) Arch Length Discrepancy (ALD) analysis showed a space deficiency of 1.8 mm and 2.6 mm in the upper and lower jaw; 6) Carey analysis had found that the discrepancy in every region was less than the mesiodistal width of the first premolar, hence IPR or slicing was indicated for the treatment (Table 6).

Table 4. ALD analysis of the maxillary

Segment	Discrepancy (mm)
16 – 15	-0.7
14 – 13	-0.3
12 – 11	-0.1
21 – 22	-0.8
23 – 24	-0.7
25 – 26	-0.6
Total	-1.8 mm

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Table 5. ALD analysis of the mandibular

Segment	Discrepancy (mm)
36 – 35	+0.4
34 – 33	+0.3
32 – 31	-1.1
41 – 42	-1
43 – 44	-0.9
45 – 46	-0.3
Total	-2.6 mm

Table 6. Carey analysis

Region	Discrepancy (mm)	Analysis
I	-0.8	< ¼ first premolar
II	-0.2	< ¼ first premolar
III	-1.1	< ¼ first premolar
IV	-0.4	< ¼ first premolar

Figure 1. Pre-treatment extra-oral pictures

Figure 2. Pre-treatment intra-oral pictures

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

A lateral cephalometric radiograph was taken and traced to determine the patient's skeletal pattern (Figure 3). Orthopantomography was also taken (Figure 4) to assess the mandibular condyles, periodontal condition, bone density, and dental characteristics, i.e., root lengths [10,11].

Figure 3. Pre-treatment cephalometric radiograph

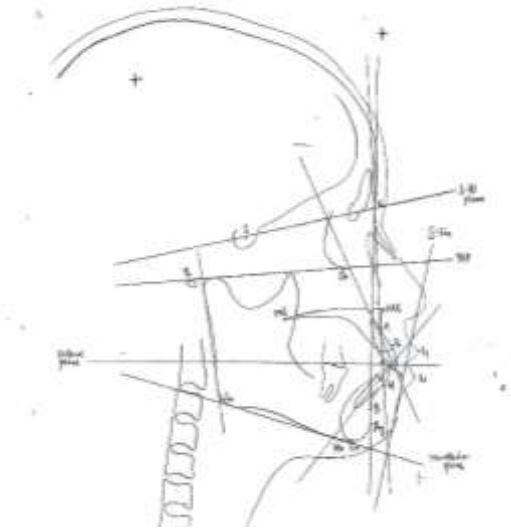

Figure 4. Cephalometric tracing

Figure 5. Pre-treatment orthopantomogram

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Table 7. Steiner's cephalometric analysis

	Patient's Measurement	Interpretation
	Skeletal	
SNA	81°	Normal
SNB	78°	Normal
ANB	3°	Normal
	Dental	
INA	19.5°	Normal
INA Linear	5 mm	Normal
INB	37.5°	Proclination
INB Linear	7 mm	Proposition
Interincisal Angle	115.5°	Proclination
	Soft Tissue	
S-line	Lips ahead of the S-line	Protrusive

Case Management

A diagnosis of Angle Class I Dewey Type 1 malocclusion with dental malposition of maxillary and mandibular anterior was determined. The treatment was carried out using removable orthodontic appliances with interproximal reduction based on ALD analysis. The maxillary appliance consisted of a reversed labial arch and Adam clasps for retention with a U-shaped acrylic baseplate to free the torus on the palatal area. The auxiliary springs consisted of a continuous spring to correct and stabilize the position of four incisors, a z-spring to correct 13, and a finger spring for distalization of 23. Meanwhile, the mandibular appliance consisted of a labial arch and Adam clasps with z-springs to correct 33, 41, and 43 (Figure 6). The patient had a normal overjet, hence neither protraction nor retraction was needed.

The ALD analysis found a total of 1.8 mm and 2.6 mm space deficiency in the upper and lower jaw, respectively. The IPR technique was planned out to gain space for tooth correction and was done on 12, 11, 21, and 22 by slicing 0.25 mm for each side or 1.75 mm in total. A 2.5 mm reduction was also done on 33, 32, 31, 41, 42, and 43. The patient was instructed to use the appliance for 20 - 22 hours and clean it using a toothbrush daily. Dental evaluation was scheduled every week to check the progress and reactivate the springs.

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Figure 6. The design of removable orthodontic appliances

The treatment lasted for 6 months and several changes were found during the last evaluation. Both mandibular canines, 33 and 43, were corrected and 41 showed significant movement mesiolabially. Maxillary anterior incisors showed significant movements (Figure 8) but were yet to be corrected. The overjet and overbite measurements were found to be 3.3 mm and 3.75 mm, respectively.

Figure 7. Intra-oral pictures with removable orthodontic appliances

Figure 8. Intra-oral pictures on the last evaluation

Mandibular anterior crowding can be effectively corrected with a removable orthodontic appliance, which can be managed by general dentists. It is less complex and costs much less than fixed orthodontic treatment, but it can only be used in cases that require simple dental

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

movements. The active component of the removable appliance will apply controlled forces of 25 – 50 grams, resulting in uncontrolled tipping movement of the teeth and moving by about 1 mm per month. Uncontrolled tipping in orthodontics is a movement where the crown tilts to the direction of the applied force, while the root moves in the opposite direction [12]. The tooth movement in the periodontal space was caused by creating pressure and tension at the apical and cervical areas of the tooth. This theory is called the pressure-tension theory [13].

The pressure-tension theory was hypothesized by Sandstedt in 1904. The biomechanism starts with a compression in the periodontal ligament area, which results in alteration of blood flow and a decrease in oxygen levels. Low oxygen levels can cause a decrease in the Adenosine Triphosphate (ATP) activity, causing direct and indirect effects on cellular activity [13].

Table 6. Factors affecting tooth movement

Factors	Pressure Side	Tension Side
Blood Flow	Decreases	Increases
O_2 Level	Decreases	Increases
CO_2 Level	Increases	Decreases
Replication of Cell	Decreases	Increases
Production of Fiber	Decreases	Increases

In this case, orthodontic forces were exerted to trigger tipping of 33, 41, and 43 in labio-lingual directions. Compression occurred on the cervicofacial and apicopalatal surfaces, leading to bone resorptions and dental movements in the direction of force. Conversely, tension emerged on the cervicopalatal and apicofacial surfaces, triggering bone formations and appositions by osteoblasts [14,15].

Several chemical agents act as mediators in tooth movement, i.e., chemokines, cytokines, prostaglandins, and osteoclasts. Some of the cells on the pressure side undergo apoptosis. Apoptosis is the process of programmed cell death. The necrosis of the cells causes an acute inflammatory response, releasing chemokines. Chemokines are small proteins that release the monocytes during orthodontic movement. These monocytes will turn into macrophages or osteoclasts after exiting the bloodstream and entering the periodontal tissue [13].

The inflammatory response in the pressure side causes inflammatory cells to accumulate and releases cytokines. There are over 50 cytokines and some of which mediate the bone remodeling, such as IL-1, alpha1 beta, Tumour Necrosis Factor (TNF), and IL-6. On the other hand, prostaglandins helps inflammatory mediation by vasodilation and adhesion of inflammatory cells and vascular permeability. A study in 1980 had proved that an increase in osteoclasts was found after prostaglandin injection. Another study in 1996 also found that the rate of tooth movement increased after local prostaglandin injection. Lastly, osteoclast is a multinucleated giant cell derived from hematopoietic stem cells. Local cells will produce RANKL decoy (osteoprotegerin) to deregulate osteoclast formation; therefore, the OPG levels in the pressure side will be lower than at the tension side [13].

Jurnal Eduhealth
Volume 16, Number 03 2025 DOI 10.54209/eduhealth.v16i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

However, the outcome does not rely solely on the biomechanism. Another key factor is patient compliance when maintaining the appliance. The appliance should be cleaned daily with a soft-bristle brush [16,17]. Apart from appliance hygiene maintenance, it is also important to maintain oral hygiene which will be evaluated in every dental visit. Wearing the appliance and attending dental appointments are also crucial parts of this treatment, as the active components must be reactivated to exert force so that the teeth can move into their ideal positions [18].

Patient negligence in wearing the appliance is caused by various factors, such as feeling ashamed of the voluminous appearance and having difficulty speaking or swallowing. In this case, movements of 33, 41, and 43 were seen, however, the patient admitted not wearing the appliances as instructed during the specified times, hence the treatment outcome was not optimal.

CONCLUSSION

The case of a 26-year-old female with mandibular anterior crowding was successfully managed using a removable orthodontic appliance combined with interproximal reduction (IPR). Clinical and radiographic evaluations, along with space analysis such as ALD and Carey analysis, indicated mild space discrepancies that could be effectively addressed through IPR without the need for extraction. The removable appliance was carefully designed with springs and clasps to facilitate targeted dental movements, particularly for teeth 33, 41, and 43. After six months of treatment, significant improvement was observed in the alignment of the mandibular anterior teeth, indicating that the applied orthodontic forces were effective in generating controlled tipping movements based on the pressure-tension theory. Despite the positive clinical outcome, the final results were suboptimal due to inconsistent patient compliance in wearing the appliance as instructed. This case highlights the importance of patient cooperation in removable appliance therapy, as inconsistent usage limits the potential success of the treatment. Furthermore, the study supports the use of removable appliances as a cost-effective and less complex alternative to fixed orthodontics, particularly for minor to moderate malocclusions. However, it also underscores the need for patient education, motivation, and regular follow-up to achieve optimal outcomes in orthodontic treatment.

REFERENCES

1. Consolaro A, Cardoso M de A. Mandibular anterior crowding: Normal or pathological? Dental Press J Orthod. 2018 Mar 12;23(2):30–6.
2. Cenzato N, Nobili A, Maspero C. Prevalence of dental malocclusions in different geographical areas: Scoping review. Dent J (Basel). 2021 Oct 11;9:117.
3. Yuvashree CS, Jain RK, Prasad AS. Severity of mandibular arch crowding in different sagittal malocclusions. J Adv Pharm Technol Res. 2022 Nov 30;13:S45–9.
4. Patano A, Malcangi G, Inchingolo AD, Garofoli G, De Leonardis N, Azzollini D, et al. Mandibular Crowding: Diagnosis and Management—A Scoping Review. J Pers Med. 2023;13:774.

5. Cabrera-Domínguez ME, Domínguez-Reyes A, Pabón-Carrasco M, Pérez-Belloso AJ, Coheña-Jiménez M, Galán-González AF. Dental Malocclusion and Its Relation to the Podal System. Front Pediatr. 2021 Jun 22;9.
6. Arif AN, Rasheed TA, Ali AJ. Dental crowding and its relationship to tooth size and arch dimensions. Journal of Natural Sciences Research. 2014;4(10):133–6.
7. Kolawole KA, Folayan MO. Association between malocclusion, caries and oral hygiene in children 6 to 12 years old resident in suburban Nigeria. BMC Oral Health. 2019 Nov 27;19(1):262.
8. Adindaputri Z, Suparwitri S. Removable orthodontic appliance for extrusion of single upper anterior tooth and crowding lower anterior in adult: a case report. Journal of Dentomaxillofacial Science. 2020 Apr 1;5(1):66–8.
9. Pindoria J, Fleming PS, Sharma PK. Inter-proximal ename. Br Dent J. 2016 Dec;221(12):757–63.
10. Stăncioiu AA, Motofelea AC, Hușanu AA, Vasica L, Nagib R, Popa A, et al. Associations of Digital Measurements: Analysis of Orthopantomography Versus Lateral Cephalograms for Evaluation of Facial Asymmetry. J Clin Med. 2025 Feb 1;14(4).
11. García-Boedo L, Burgueño-Torres L, de Nova-García MJ. Application of Orthopantomography in the Analysis of Bone Mineral Density in Patients with Osteogenesis Imperfecta. Applied Sciences (Switzerland). 2024 Mar 1;14(5).
12. Isaacson K, Muir J, Reed R. Removable Orthodontic Appliances. Wright; 2002.
13. Asiry MA. Biological aspects of orthodontic tooth movement: A review of literature. Saudi J Biol Sci. 2018 Sep 1;25(6):1027–32.
14. Wu J lei, Liu Y feng, Peng W, Dong H yue, Zhang J xing. A biomechanical case study on the optimal orthodontic force on the maxillary canine tooth based on finite element analysis. J Zhejiang Univ Sci B. 2018 Jul 1;19(7):535–46.
15. Tsolakis IA, Christopoulou I, Sitaras S, Lyros I, Rontogianni A, Dalampira M, et al. Molecular and Biological Aspects of Orthodontic Tooth Movement: Possibilities for Bioengineering Intervention: A Narrative Review. Bioengineering. 2023 Nov 1;10(11):1275.
16. Yordan B. Tingkat Keberhasilan Perawatan Ortodontik Crowding Anterior dengan Rotasi yang Menggunakan Alat Removable Kombinasi Sederhana. Denta. 2016 Aug;10(2):182–7.
17. Batra P, Agarwal I, Katyal S. Anterior Crossbite Correction Using a Removable Orthodontic Appliance: A Case Report. Journal of Dentistry Oral Health & Cosmesis. 2022 Feb 14;7(1):1–4.
18. Hafiz A, Haneem A, Ikram M. Patient's Compliance on Removable Orthodontic Appliance. JMDSR. 2021;8(4):6–10.