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Space Regainers in Pediatric Dentistry: A Review

Aina Desmarani[1], Rosada Sintya Dwi[2], Ulfa Yasmin[2]

[1]Dentistry Study Program, Faculty of Medicine, Sriwijaya University, Indonesia
[2]Pediatric Dentistry, Dentistry Study Program, Faculty of Medicine, Sriwijaya University, Indonesia
(Corresponding author e-mail address: ainadesma@gmail.com)

Abstract

Introduction: Early loss of primary teeth can cause various problems, especially the loss of space required for permanent teeth eruption that leads to potential malocclusion. Space regainers are appliances that used to regain the space lost in some cases. **Purpose:** There are different designs of space regainers, depending on the patient's cases, and this article aims to summarize fixed and removable space regainers in pediatric dentistry. **Conclusion**: Fixed and removable space regainers have specific designs and advantages suitable for certain cases.

Keywords: Early loss; fixed space regainers; primary teeth; removable space regainers; space analysis

Introduction

Primary teeth have an important role, especially in muscle and skeletal development, as well as in occlusion, mastication, phonation, and aesthetics. Maintaining the arch of primary teeth is important to obtain the arch required for the eruption of permanent teeth. Premature loss of primary teeth is a condition where tooth loss occurs ± 1 year before exfoliation. This situation can result in loss of space in children with mixed dentition periods, resulting in irregular growth of replacement teeth.[1,2]

Early loss of primary teeth has many etiologies, including extensive dental caries, dental trauma, extraction of neonatal teeth, and premature root resorption. This condition can cause potential malocclusion, articulation difficulties, bad habits such as anterior or lateral tongue thrusting, disruption of the growth of replacement teeth, and reduced child's self-confidence. Dental treatments of early primary tooth loss can be done with a passive space maintainer, space regainer, or a combination of both.[1,3-4]

A space maintainer is a fixed or removable device that is used to maintain space after the premature loss of primary teeth. This device is important for preserving tooth alignment and preventing occlusal disharmonies. In cases where there is progressive loss

of space, a space regainer should be applied. A space regainer, also known as an active space maintainer, is an appliance designed to reclaim the space that has been lost due to a tooth drifting into the area created by the premature loss of another tooth. [5-6]

This literature review aims to provide a summary of space analysis methods and types of space regainers frequently used in pediatric dentistry that can be implemented in the patient's cases.

Space Analysis

Assessment of required space for unerupted permanent teeth is important in space management. It will determine whether a patient receives space maintainer or space regainer treatment. Space determination has various methods, such as Moyers, Tanaka-Johnson, and Huckaba analysis.[2]

Moyers mixed dentition analysis is a simple method with minimal systematic errors. In this method, no special equipment or radiography photos are needed. Calculations are carried out using the patient's dental casts or can be done directly in the patient's mouth by measuring the total width of the mandibular permanent incisors. The measurement is essential to determine the required space listed in the Moyers' chart (Table 1). The available space is measured using a wire starting from the mesial edge of the permanent first molar on one side of the jaw, passing through the incisal and buccal edge of the teeth, to the mesial edge of the permanent first molar on the contralateral side. Discrepancy is assessed by reducing the available space in the dental arch with the required space in the chart.[2]

Table 1. Moyers' space analysis chart.[2]

Possibility chart for predicting the sum of the widths of the **maxillary** cuspid and bicuspids from the sum of the widths of the mandibular central and lateral incisors																				
21/12 – (%)	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0
95%	21.6	21.8	22.1	22.4	22.7	22.9	23.2	23.5	23.8	24.0	24.3	24.6	24.9	25.1	25.4	25.7	26.0	26.2	26.5	26.7
85%	21.0	21.3	21.5	21.8	22.1	22.4	22.6	22.9	23.2	23.5	23.7	24.0	24.3	24.6	24.8	25.1	25.4	25.7	5.9	26.2
75%	20.6	20.9	21.2	21.5	21.8	22.0	22.3	22.6	22.9	23.1	23.4	23.7	24.0	24.2	24.5	24.8	25.0	25.3	25.6	25.9
65%	20.4	20.6	20.9	21.2	21.5	21.8	22.0	22.3	22.6	22.8	23.1	23.4	23.7	24.0	24.2	24.5	24.8	25.1	25.3	25.6
50%	20.0	20.3	20.6	20.8	21.1	21.4	21.7	21.9	22.2	22.5	22.8	23.0	23.3	23.6	23.9	24.1	14.4	24.7	25.0	25.3
35%	19.6	19.9	20.6	20.5	20.8	21.0	21.3	21.6	21.9	22.1	22.4	22.7	23.0	23.2	23.5	23.8	24.1	24.3	24.6	24.9
25%	19.4	19.7	19.9	20.2	20.5	20.8	21.0	21.3	21.6	21.9	22.1	22.4	22.7	23.0	23.2	23.5	23.8	24.2	24.3	24.6
15%	19.0	19.3	19.6	19.9	20.2	20.4	20.7	21.0	21.3	21.5	21.8	22.0	22.4	22.6	22.9	23.2	23.4	23.7	24.0	24.3
5%	18.5	18.8	19.0	19.3	19.6	19.9	20.1	20.4	20.7	21.0	21.2	21.5	21.8	22.1	22.3	22.6	22.9	23.2	23.4	23.7
Possibility chart for predicting the sum of the widths of the **mandibular** cuspid and bicuspids from the sum of the widths of the mandibular central and lateral incisors																				
21/12 – (%)	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0
95%	21.1	21.4	21.7	22.0	22.3	22.6	22.9	23.2	23.5	23.8	24.1	24.4	24.7	25.0	25.3	25.6	25.8	26.1	26.4	26.7
85%	20.5	20.8	21.1	21.4	21.7	22.0	22.3	22.6	22.9	23.2	23.5	23.8	24.0	24.3	24.6	24.9	25.2	25.5	25.8	26.1
75%	20.1	20.4	20.7	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.8	25.1	25.4	25.7
65%	19.8	20.1	20.4	20.7	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.7	24.0	24.3	24.6	24.8	25.1	25.4
50%	19.4	19.7	20.0	20.3	20.6	20.9	21.2	21.5	21.8	22.1	22.4	22.7	23.0	23.3	23.6	23.9	24.2	24.5	24.7	25.0
35%	19.0	19.3	19.6	19.9	20.2	20.5	20.8	21.1	21.4	21.7	22.0	22.3	22.6	22.9	23.2	23.5	23.8	24.0	24.3	24.6
25%	18.7	19.0	19.3	19.6	19.9	20.2	20.5	20.8	21.1	21.4	21.7	22.0	22.3	22.6	22.9	23.1	23.5	23.8	24.1	24.4
15%	18.4	18.7	19.0	19.3	19.6	19.8	20.1	20.4	20.7	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4	23.7	24.0
5%	17.7	18.0	18.3	18.6	18.9	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.3	21.6	21.9	22.2	22.5	22.8	23.1	23.4

Tanaka-Johnson analysis is a short method of Moyers analysis and requires no additional radiographs. The prediction of unerupted maxillary or mandibular canine and premolars corresponds to the 75% probability level in Moyers' chart.[6] First, determine the available arch length by measuring the distance from the mesial of the permanent first molar to the mesial of the contralateral permanent first molar and dividing the arch into several segments. The segments are measured over the contact points and incisal edges of the teeth, and the approximation of the total arch is provided by adding each segment. The next step is adding the width of four mandibular incisors. The mesiodistal width of unerupted mandibular canines and premolars is determined by dividing the value of four mandibular incisors by 2 and adding 10.5 mm. For the maxillary arch, 11 mm is substituted for 10.5 mm because unerupted permanent maxillary teeth are slightly larger. The last step of this analysis is to measure the space available by the following formula:[2]

$$space\ available = total\ arch\ length + [sum\ of\ mandibular\ incisors + (2 \times calculated\ canine\ and\ premolars)]$$

If the result is positive, the unerupted teeth have more space to erupt. If the result is negative, there is insufficient space for unerupted teeth.[2,6] Moyes and Tanaka-Johnson analyses have a fairly good accuracy for European children, due to the data developed for the analysis being based on the population. However, both analyses are less accurate and have systematic errors for other populations race and gender.[2]

Huckaba's analysis uses intraoral radiographs to predict the size. It requires dental casts and undistorted radiographic images, commonly periapical radiographs, to anticipate the erupting tooth size. Depending on the radiograph quality, Huckaba's analysis results are fairly accurate and can apply to any ethnic group in both maxilla and mandible.[2,6] This analysis uses the following formula:[2]

$$X = \frac{YX^1}{Y^1}$$

X: width of unerupted permanent teeth

Y: width of primary tooth in the dental cast

X^1: width of underlying successor tooth in the radiograph

Y^1: width of primary tooth in the radiograph

Space Regainers in Pediatric Dentistry

The Space regainer is a device used to address space narrowing caused by tooth shifting following the loss of primary teeth. Its purpose is to restore space, ensure proper arch width and circumference, and improve the eruption position of permanent teeth. The device can be used either bilaterally or unilaterally, achieving space gains of 2 mm and 3 mm per quadrant, respectively. It should be maintained until the permanent teeth have fully erupted or until an orthodontic treatment plan for the patient is established.[2,6]

Space regainer treatment is indicated in the following conditions: loss of the maxillary or mandibular second primary molar, early loss of one or more primary teeth, permanent first molar ectopic eruption, and loss of space in the arch after the permanent first molar drifting mesially. Space regainers are not indicated if the distance between the permanent teeth that will erupt is sufficient, there are no signs of narrowing of the

space, and in cases when installing a regainer will worsen existing malocclusions such as overbite, class I type III and class III malocclusion.[2,6-7]

There are two types of space regainers: removable and fixed appliances. For mild to moderate space loss (less than 3 mm) due to mesial tipping, a removable appliance is recommended. Removable appliances tend to yield satisfactory results and provide better control over individual teeth in the maxilla compared to the mandible. However, lower removable plates lack palatal anchorage for support and are generally more fragile. The acrylic plates are usually small and offer limited space for spring construction due to the tenderness of the gingival tissue and lingual undercuts. In cases of moderate to severe space loss (more than 3 mm) or when bodily movement of the teeth is required, fixed appliances are preferred. Clinicians can achieve better precision and control with fixed appliances, eliminating the need for patient compliance. Additionally, fixed appliances typically have a shorter average treatment duration and can be more cost-effective, especially in single-visit cases. However, it is essential to note that fixed appliances may lead to difficulties in mastication, while removable appliances can affect speech and may cause soft tissue irritation.[3-4,8-9]

Fixed Space Regainers

Gerber space regainer

This fixed space regainer can be fabricated either directly in the patient's mouth or in a laboratory. An orthodontic band or stainless-steel crown is chosen for the abutment tooth, and a U-shaped assembly is either soldered or welded to the mesial side of the band. If the appliance is designed as a spring-loaded space regainer, a U wire is fitted into a tube with a coil spring. An open coil spring is placed between the tube and a tube stop, and occlusal rests are added to minimize the cantilever effect. As the migrated molar is pushed back, it is essential to ensure that the anchorage tooth can withstand the forces applied during this process.[4,6,10]

Hotz lingual arch

This appliance is indicated in cases where the mandibular first permanent molar has drifted mesially rather than the premolar drifted distally, and there is sufficient

space between the first molar and developing second molar in the dental radiograph. The lingual arch provides anchorage, and a horizontal spur is soldered in contact with the premolar or canine perpendicular to the archwire. A U loop is incorporated in the lingual side, and when it is activated once a month, it can aid in molar distalization (Fig. 1a).[2,5]

Open coil space regainer

It is also called Herbst space regainer and is used when the first premolar has erupted into the oral cavity. It uses a molar band fitted to the permanent first molar with soldered molar tubes. A stainless-steel wire is selected and bent into a U shape with a reverse bend in the distal aspect of the molar. The U shape is aimed toward the first premolar and placed below the convexity of the distal first premolar. The spaced coil spring is compressed, and the band is cemented.[2,5] Pradeep *et al.* combined NiTi open coil spring to distalization of a mandibular permanent first molar with lingual arch as the anchorage (Fig. 1b). It was used in a severe space loss case, and the results are exemplary.[9]

Lingual arch cross bow

Chalakkal et al. developed this space regainer to distalize the mandibular first premolar that erupted before the canine. It uses a lingual arch as anchorage and the activation via coil spring. (Fig. 1c).[5]

Nickel Titanium (NiTi) wire bonded space regainer

This space regainer is a modified and straightforward appliance that can be created chairside during a single visit. A composite dimple is bonded to the buccal side of the permanent first molar and premolar. An explorer is used to create a tunnel into the mesial side of the dimple. A 0.016” NiTi wire is bonded to the dimple of the first premolar, with the other end placed into the tunnel of the first molar, forming an active loop (Fig. 1d). Due to its memory properties, the NiTi loop will gradually return to its original shape, which will help distalize and upright the first molar over time (Fig 1.d).[5]

Figure 1. (a) Hotz lingual arch[2]; (b) Open coil with lingual arch[9]; (c) Lingual cross bow[5]; (d) NiTi wire bonded space regainer.[5]

Double banded space regainer

This space regainer is used in conventional cases. Molar tubes are welded buccally and palatally to the banded permanent first molar. The primary first molar is also banded, and two wires are soldered buccally and palatally, then attached to the molar tubes (Fig. 2a). The activation is done via a coil spring that is incorporated into the wire between the stop anterior and posterior.[5]

Pendulum appliance

This appliance is used in cases of unilateral asymmetry molar correction or Class II. It can be used before the eruption of the second permanent molar to make the distalization more efficient. It consists of a Nance plate, two pairs of wires on premolar teeth for retention, and one pair of Titanium-Molybdenum alloy wires with coil springs in the molar lingual sheath (Fig. 2b).[11]

Distal jet

This device is designed for molar distalization in the maxillary arch and was developed to address the limitations of other appliances. It features bilateral tubes attached to an acrylic Nance button. Each tube is positioned over a screw clamp and a

coil spring. A bayonet-shaped wire extends from the acrylic base into the lingual groove of the molar band (Fig. 2c). Activation is performed monthly by sliding the screw clamp closer to the first permanent molar.[12-13]

Lip bumper

It is a semi-fixed type of myofunctional appliance used in the mandible for minimal molar distalization during the early primary dentition stage. Orthodontic bands are fitted to the mandibular permanent first molars. A U-loop is positioned in the buccal vestibule, either soldered to each molar band or in contact with the molar tube. The lip bumper is placed approximately 5–6 mm from the anterior teeth, allowing the pressure from lip function to be transferred to the molars as a distalizing force. Ben Mohimd et al. reported the successful use of a lip bumper in a patient with a slight Class III molar relationship, achieving desirable results within 9 months (Fig. 2d).[10,14-15]

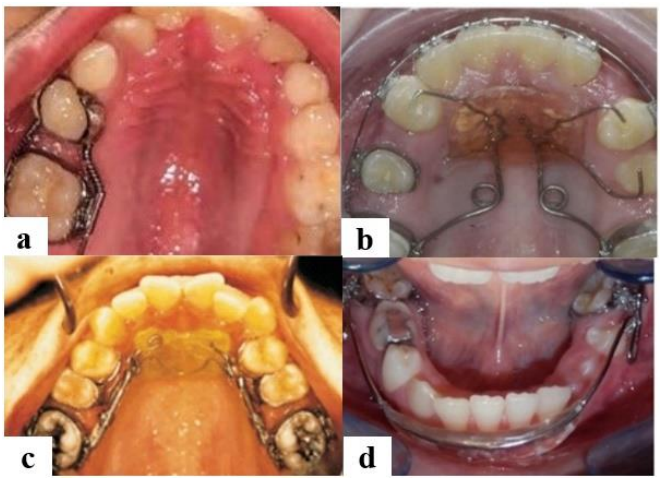

Figure 2. (a) Double banded space regainer[5]; (b) Pendulum appliance[11]; (c) Distal jet[13]; (d) Lip bumper.[15]

Removable Space Regainers

Free end loop space regainer

It is a maxillary unilateral appliance that utilizes a labial arch wire for retention and stability, along with a back-action loop and an acrylic resin base (Fig. 3a). Activation of the free end of the wire loop at specific intervals facilitates tooth movement. Regular checks and adjustments of the appliance are necessary to maintain

a consistent light force on the molar tooth. For the mandible, the appliance features a shorter wire loop to minimize distortion during insertion by the patient.[2,14]

Split saddle/split block space regainer

This space regainer consists of a buccolingually split acrylic block as the functional part. A buccal and lingual loop is constructed with wire and activated periodically to move the teeth (Fig. 3b).[14]

Sling shot space regainer

This space regainer is designed with elastic bands attached to buccal and lingual hooks, utilizing transmitted force to achieve molar distalization (Fig. 3c). The elastic bands are positioned outside the mouth, allowing the patient to insert the appliance and adjust the elastic into place independently.[14]

Maxillary Cetlin plate

This space regainer is used in cases requiring distalization of one or two maxillary molars. It consists of a 0.022 × 0.028 wire covered with acrylic resin, which serves as an anterior screen, and Adam's clasps on the primary first molars. A wire with helical loops is embedded in the acrylic of the palate and terminates at the mesial aspect of the permanent molars (Fig. 3d). A wire or elastic separator can be inserted if the interproximal space is insufficient to accommodate the wire.[6]

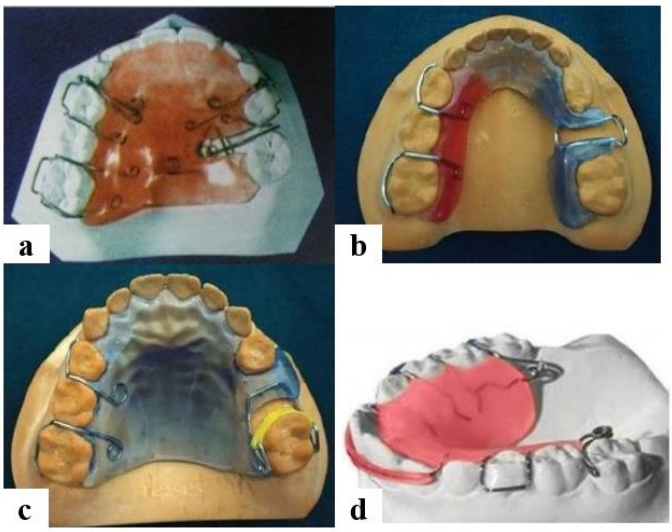

Figure 3. (a) Free end loop[2]; (b) Split saddle[4]; (c) Sling shot[4]; (d) Maxillary Cetlin plate.[6]

Space regainer with jack screw/expansion screw

This space regainer incorporates an expansion screw positioned between a split acrylic plate. The expansion screw is aligned with the edentulous space and oriented perpendicular to the midline (Fig. 4a). Activation is achieved by expanding the plates anteroposteriorly to facilitate transverse expansion of the arch.[10,16]

Space regainer with finger/cantilever spring

It consists simple finger springs in acrylic removable appliance, and is retained using Adam's clasp (Fig. 4b). Activation of finger springs can result in molar distalization.[16]

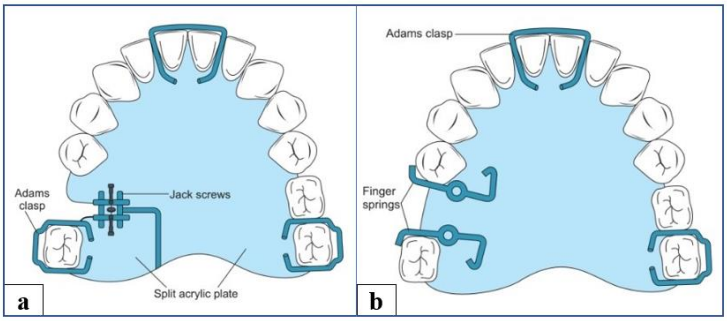

Figure 4. Space regainer with (a) Expansion screw; and (b) Finger springs.[16]

Anterior Space Regainer

Anterior space retainers are designed to facilitate the mesiodistal movement of migrated anterior teeth. Finger springs or split labial bows are recommended for these cases and must be properly anchored using suitable clasps. When a central incisor is lost, causing mesial migration of the adjacent central incisor, a finger spring appliance is used to apply a distal force (Fig. 5a). In cases where migration of the central incisor results in inadequate space for the lateral incisor and subsequent crowding, a single split labial bow appliance is used (Fig. 5b). When both central incisors are lost, leading to the migration of the lateral incisors, a two-split labial bow appliance is employed to retract the lateral incisors and create space for prosthesis placement (Fig. 5c).

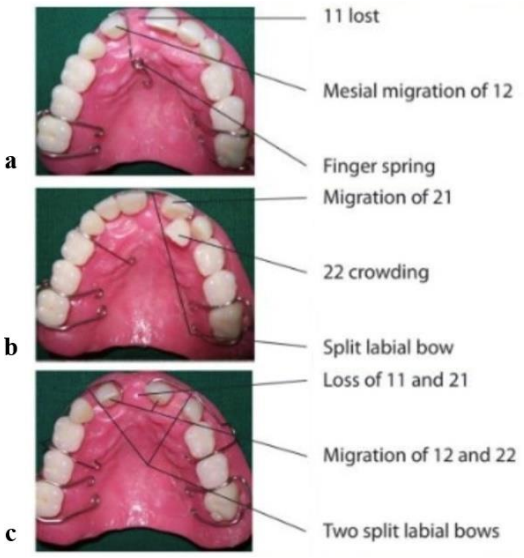

Figure 5. Anterior space regainer designs for (a) central incisor loss, (b) migration of central incisor, and (c) loss of central incisors.[10]

In 1986, Bayardo developed a form of anterior space regainer that utilizes direct bond procedure. A labial tube is bonded to the enamel surface of central and lateral incisors adjacent to the edentulous space, resulting in space regaining.[5]

Space Regainer Maintenance and Recall

The recall period for fixed space regainers is crucial for examining the appliance's condition and preventing damage to band material or soldered joints. The cementation should also be checked whether it is still intact to avoid tooth caries or food impaction. Every 6 months to one year, fixed appliances can be removed to inspect the abutment teeth for carious lesion. Before re-cementation, polishing and fluoride application to the abutment tooth is necessary. Periodic recall for removable space regainers is aimed at evaluating patient compliance, soft tissue and erupting tooth condition, and to identify any breakage or distortion of the appliance. Additionally, periodic dental radiography is recommended examination for both fixed and removable space regainers to monitor the developing permanent dentition. Furthermore, once the permanent teeth have fully erupted into the dental arch, the appliance can be removed, marking the completion of the space regainer treatment. [14,17]

Conclusion

The loss of primary teeth can lead to various dental problems, particularly the loss of space required for the proper eruption of permanent teeth, potentially resulting in malocclusion. Space regainers are used in such cases to reposition teeth that have drifted due to the premature loss of primary teeth.

Fixed and removable space regainers are designed with specific features and advantages suited to particular situations. Fixed appliances are preferred when more than 3 mm of space has been lost or when bodily movement of a tooth is required. Removable appliances are typically used when space loss is due to mesial tipping and measures less than 3 mm. In the maxilla, removable appliances are more commonly used than in the mandible because of their superior retentive properties.

A recall period is essential to evaluate the condition of the appliances and ensure that the succedaneous teeth are erupting properly into their intended positions.

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No sources of support

Conflicts of Interest

No conflicts of interest

REFERENCES

1. Nadelman P, Magno MB, Pithon MM, Castro ACR, Maia LC. Does the premature loss of primary anterior teeth cause morphological, functional and psychosocial consequences? Braz Oral Res 2021;35:1-11.
2. Muthu MS, Sivakumar N. Pediatric Dentistry: Principles and Practice 3rd ed. New Delhi: Elsevier; 2022:627-37.
3. Enteghad S, Golfeshan F, Sardarian A, Navaei H. A comparison of lower dental arch changes using two types of space regainers: a removable appliance with a distalizing screw and a fixed double-banded appliance. Int J Dent 2022:1-10.

4. Dean JA. McDonald and Avery's Dentistry for the Child and Adolescent 2nd South Asia ed. New Delhi: Elsevier; 2019:278.
5. Marwah N. Textbook of pediatric dentistry 4th ed. New Delhi: Jaypee; 2019:442-5.
6. Premkumar S. Textbook of Orthodontics. New Delhi: Elsevier; 2015:43-5.
7. Rachmadani A, Jeffrey. Perawatan *space regainer* pada premature loss gigi molar sulung rahang atas dan bawah—Laporan kasus. Oceana Biomed J 2020;3(2):21-37.
8. Premkumar S. Orthodontics: Prep Manual for Undergraduates 3rd ed. New Delhi: Elsevier; 2016:519-21.
9. Pradeep S, Srinath SK, Krishnan H, Anu VF. Spring back the lost space: Fixed space regainer for e space loss—A case report. RJDS 2023;15(2):124-7.
10. Chockolingam PR. Illustrated paediatric dentristry. New Delhi: Wolters Kluwer; 2014:459-61.
11. Halim H. The application of pendulum as a space regainer in orthodontic treatment. Open Dent J 2021;15:501-4.
12. Ali F, Soni S, Kaur R. Molar distalization: A review. Int J Health Sci 2021;5(S2):6-22.
13. Sharma S, Yadav V, Choudary N. Molar distalization—A review. HTAJOCD 2019:1-4.
14. Chandak P, Baliga S, Thosar N. Space regainer in pediatric dentistry. Int Dent Med J Adv Res 2015;1:1-5.
15. Ben Mohimd H, Benyahia H, Taleb B, Zaoui F. Management of space in the mixed dentition: The use of lip bumper. Int J Pediatr Res 2016;3(6):440-5.
16. Rao JJ. Quick review series for BDS 4th year 2nd ed. New Delhi: Elsevier; 2017:159-60.
17. Jaai R, Jasmin W. Space regainer – a review. Euro J Biomed Pharm Sci 2018;5(7):212-7.