

## **Background and Introduction**

The primary dentition has an important role in guiding the eruption of the permanent teeth. Premature loss of primary teeth can lead to undesirable tooth movements resulting in space loss in the permanent dentition. This can have detrimental effects on the developing occlusion including crowding, impaction or ectopic eruption, over-eruption of unopposed teeth and centre line discrepancies.<sup>1</sup>

It is important to try and maintain the primary dentition in the arch until exfoliation where possible,<sup>2</sup> however where early loss is unavoidable this should be managed to minimise the unwanted effects on the developing occlusion.<sup>3-6</sup> Space maintainers can be used for this purpose. There is limited evidence in the literature for or against the use of space maintainers,<sup>1,7-8</sup> a recent rapid response report carried out by the Canadian Agency for Drugs and Technologies found the evidence to be limited due to the poor quality and poor reporting of studies.<sup>9</sup> Nevertheless, despite the lack of high quality evidence,<sup>6</sup> common sense would indicate that in some clinical situations they are likely to be of benefit. The Royal College of Surgeons guidance on the extraction of primary teeth state that space maintainers would be most valuable in two situations: i) Loss of a primary molar where crowding is severe and where extraction of one premolar maybe insufficient to relieve resultant crowding. ii) Loss of a second primary molar except in spaced arches.<sup>10</sup> Therefore we will not consider the quality of the evidence further, instead the aim of this paper is to provide clear guidance as to when space maintenance should be considered and how patients should be assessed.

Prior to considering space maintenance, a thorough examination must be carried out to determine the patient's oral health status including caries risk and oral hygiene. Space maintainers accumulate plaque therefore patients must be able to maintain good oral hygiene. This will be especially relevant if the reason for early loss of the primary tooth is because of caries and the child is therefore at high caries risk. Some patients who have early loss of deciduous teeth simply may not be good candidates for space maintainers if they cannot maintain good oral health. In order to be able to consider space maintenance, patients must be dentally fit, have caries stabilised and motivated to maintain adequate oral hygiene and follow non-cariogenic diet advice. Patients must also be reliable and regular attenders and be engaged with the treatment. This is because if appliances remain in situ beyond their period of use or fail and are not repaired, they can become embedded in the soft tissues; impede the eruption of permanent teeth; or cause other harmful effects. Finally, any child considered for space maintenance must be able to cooperate with its placement.

## **Materials and methods**

### **Assessing a patient for space maintenance**

Assuming the patient meets the criteria described above then a more detailed assessment can be carried out to determine if a space maintainer will be of benefit. A number of factors

need to be taken into consideration when deciding the most appropriate space maintenance treatment option:

- Tooth/teeth lost in the arch;
- Time period since tooth loss;
- Presence and continued development of permanent successor;
- Current malocclusion;
- Individual arch space analysis;
- Amount of alveolar bone overlying permanent successor;

Early loss of primary molars in particular can result in reduction in arch length and thereby increase the severity of crowding/malocclusion and so, in the right patient, every effort should be taken to maintain the natural Leeway space. Unilateral loss of a primary canine or first molar can lead to a marked centreline discrepancy and mesial migration of the buccal segments and so is another important clinical scenario to maintain the space carefully or balance any extractions accordingly.<sup>10</sup> Primary upper incisors do not generally need to be space maintained.

Contraindications of using space maintainers include lack of space for the successor tooth as future orthodontic treatment may be indicated.

Whilst there are ways to manage the difficulties associated with space loss through careful Orthodontic treatment planning and mechanics - for many patients avoiding extractions by preventing space loss is important. Space maintenance can be especially important in managing and guiding developing dentitions in patients where lengthy Orthodontic treatment may not ever be appropriate. It may obviate the need for complex, comprehensive Orthodontic treatment and they have an important role in minimising the impact of early loss of primary teeth.

### **Types of Space Maintainers**

Space maintainers can be fixed or removable, unilateral or bilateral, see Table 1.<sup>3-5,7</sup> The various types of space maintainers and their specific indications are shown in Table 2.

### **Figure 1: Table of different types of space maintainers**

Unilateral space maintainers comprise of a rigid component spanning the edentulous space and abutting the teeth either side. As long as a fixed unilateral space maintainer is retained intact there will be no space loss, therefore the efficacy of these space maintainers is directly related to their longevity.

Multiple fixed unilateral space maintainers can be used on the same patient where tooth loss occurs in different quadrants, however their use should be limited to single span edentulous areas as the risk of breakage and failures greatly increases where two adjacent teeth have been lost. Band and loop space maintainers are the most commonly placed.<sup>11</sup>

However, a recent critical appraisal of space maintainers <sup>12</sup> raised concerns about their longevity and recommended the use of crown and loop space maintainers (a variation of band loop) for the loss of primary first molars and Glass Fibre Reinforced Resin (GFRCR) space maintainers for the loss of primary second molars.

Removable appliances may include wire stops mesial and distal to the edentulous space, these are most commonly partial dentures but can include orthodontic appliances such as Hawley retainer. Their success is limited by patient compliance and complicated by loss of the appliance, exfoliation and/or eruption of teeth. Periods of poor compliance can lead to the appliance no longer fitting and loss of space (Figs 1, 2 and 3).

Figure 1 here

**Figure 1: Early loss of upper right second primary molar, removable space maintainer not worn. This has resulted in mesial migration of upper right first permanent molar resulting space loss in this quadrant and unilateral Class II molar relationship.**

Figure 2 here

**Figure 2: Clinical picture of right buccal segment demonstrating the Class II molar relationship due to mesial migration of upper right first permanent molar.**

Figure 3 here

**Figure 3: Clinical picture of left buccal segment demonstrating the Class I molar relationship on left side where the primary tooth is in situ.**

## **When to Space Maintain?**

### ***Early loss of second primary molars***

Preservation of the primary second molar space is key for guiding the eruption of the first permanent molar, otherwise mesial migration, space loss and reduction in arch length is likely to occur. It is particularly important when the leeway space is paramount to resolving any crowding or in order to preserve the centerline. Space maintenance should, at least, be considered following the loss of a primary second molar to assess its appropriateness, except in the presence of a spaced arch where it may not be required as space requirements are less or if there is hypodontia of the second premolars.<sup>10</sup>

Generally, second primary molar space should be maintained when the first permanent molars are erupted so they can be included in the space maintainer appliance.<sup>13</sup>

Bilateral loss of multiple primary teeth or failed fixed unilateral space maintainers would indicate the use of a transpalatal arch (+/- nance button) in the maxilla<sup>14</sup> or lingual arch in the mandible.<sup>15</sup> These appliances are especially useful when there is bilateral loss of multiple primary teeth. There is a risk of impeded eruption or proclination of the lower labial segment associated with the use of a lower lingual arch<sup>16</sup> and therefore should not be used prior to eruption the permanent incisor teeth.

Unilateral loss of primary second molars can be space maintained with a number of different methods. The decision of which to use depends largely on the dental health/restorative needs of the abutment teeth.

When the abutment teeth are non-carious or only minimally restored GFRCR or simple wire direct bonded space maintainers are indicated.<sup>17</sup> These can be used when there are teeth either side of the space to bond to and should be placed under rubber dam. When placed under rubber dam, GFRCR has been shown to have better failure rates than band and loop space maintainers.<sup>18-20</sup> If rubber dam cannot be used, GFRCR should be avoided. Simple Wire Direct bonded (DB) space maintainers have also been shown to be effective in maintaining space in this clinical situation when the abutment tooth is caries free or only minimally restored.<sup>17</sup> Band and loop space maintainers can be used with both permanent and primary dentitions when there is loss of a single molar tooth and a tooth available distal for banding.<sup>21-22</sup> However, the first permanent molars can tip mesially resulting in space loss which does not occur as much with palatal and lingual arches as they are fixed to two posterior teeth across the arch.

When the first permanent molars are unerupted, it would be advantageous to be able to maintain the second primary molar space in order to guide the path of eruption of the first permanent molar into an ideal position. One study, graded very low quality reported on the success and longevity of the distal end shoe which is indicated following the premature loss of primary molar with an unerupted tooth distal to the primary molar space.<sup>23</sup> These can be made chairside or using prefabricated kits at the time of extraction and be crown or band retained. However, this can be lengthy and technically complex procedure that would require soldering equipment and excellent patient compliance with the treatment.

Compensatory extractions are not usually indicated during loss of a primary second molar so it may be wise to consider use of a simple modification of an occlusal bar to prevent overeruption of opposing dentition if they are to remain unopposed for any length of time, however these are not commonly used.<sup>24-25</sup>

### ***Early loss of first primary molars***

Space maintenance is not usually needed if premature loss of a primary first molar if the first permanent molar is erupted and in good occlusion as the resultant space loss and risk of centerline shift is less.<sup>26</sup>

Patients that are severely crowded and likely to need premolar extractions, the best management of this localised space loss is to accept the crowding and plan for extraction of the first premolars later. If space loss is of particular concern or a non-extraction plan is indicated, methods described above for extraction of second primary molars can be used.

However, where crowding is severe, i.e. more than 3.5mm (half a unit) per quadrants, maintaining the leeway space becomes particularly important.<sup>27</sup> One method is to place a stainless steel crown, with a lab-made soldered band and loop, on restored primary second molar to maintain the first primary molar space. This is because space loss due to drift may be so severe that the extraction of one premolar may be insufficient to relieve resultant crowding so that subsequent orthodontic treatment is more difficult.<sup>10</sup>

Figure 4 here

#### **Figure 4: Clinical photograph demonstrating early loss of lower first primary molar.**

Figure 5 here

#### **Figure 5: DPT radiograph demonstrating resultant space loss following early loss of lower first primary molars and severity of crowding, where fixed space maintainers could have been used to maintain space for the developing premolars.**

Crown (or band) and loop space maintainers can be used when there is loss of a single molar per quadrant with a carious or restored second molar distal to the edentulous space. Cement loss or cementation is the most common cause of failure in band retained space maintainers. Crown retained space maintainers have been shown to have better longevity than band and loop space maintainers and should ideally be used where possible.<sup>22</sup>

### ***Early loss of primary canines***

In the upper arch space maintenance not indicated following the loss deciduous canines, but if unilateral loss of a primary canine, balancing extractions are indicated to preserve the centreline.

In the lower arch, unilateral loss of primary canine should also be balanced with contralateral extraction of primary canine in order to maintain for centre line. Space maintainers are not generally indicated, however, there is a risk of lingual movement of lower incisors and distal movement developing permanent canines resulting in space loss.<sup>28</sup>

Therefore, whilst space maintenance is not indicated, development and eruption of the primary first molars and permanent canines should be monitored carefully following early loss of primary canines.

### ***Early loss of primary incisors***

Premature loss of primary incisors does not usually require any space maintenance as only minimal effects on the developing dentition.<sup>29</sup> Following eruption of the primary canines, early loss of the primary incisors results in minimal space loss.<sup>30</sup> Space maintenance could be considered if they primary incisors are lost before the eruption of the primary canines in unspaced primary dentition or deep overbite.<sup>31</sup>

The American Academy of Paediatric Dentistry suggest that a space maintainer could be considered following the premature loss of a primary incisor when the child has an active digit sucking habit which if intense and for long enough duration can reduce the space available for the erupting permanent incisor.<sup>8</sup> Counselling to encourage cessation of the habit should also be undertaken.

Aesthetic concerns from patients/parents is another reason to consider the use of a space maintainer in this region, but these are for aesthetics rather than true space management and are not indicated or necessary in the mixed dentition.

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### **Review and Removal of Space maintainers**

A number of appointments maybe required in order to make an impression and fabricate space maintainers. Once the space maintainer is fitted, they should be followed up regularly - initially for oral hygiene reasons as there is an increase risk plaque accumulation until the patient is able to clean the appliance. This is especially important during the first few weeks. Patients should then be reviewed after a month to ensure the appliance is intact and there are no major problems with wear of the appliance.

The failure rates for all space maintainers are high, therefore, clinicians should expect repairs and maintenance. Instructions should be given to patients to inspect their own appliances, attend review appointments regularly and return as soon as any breakages, loss or slippage occurs. It is advisable to change the method of space maintenance if repeated failures occur.

Generally, the patient should be reviewed at six monthly review appointment to ensure the appliance is intact and to monitor the eruption and development of the permanent

dentition. Once the permanent successors begin to erupt the space maintainer can be removed.

### **What to check for at review appointments?**

- Oral hygiene
- Signs of wear of appliance
- Integrity of appliance and component parts
- Eruption of permanent teeth

### **Conclusion**

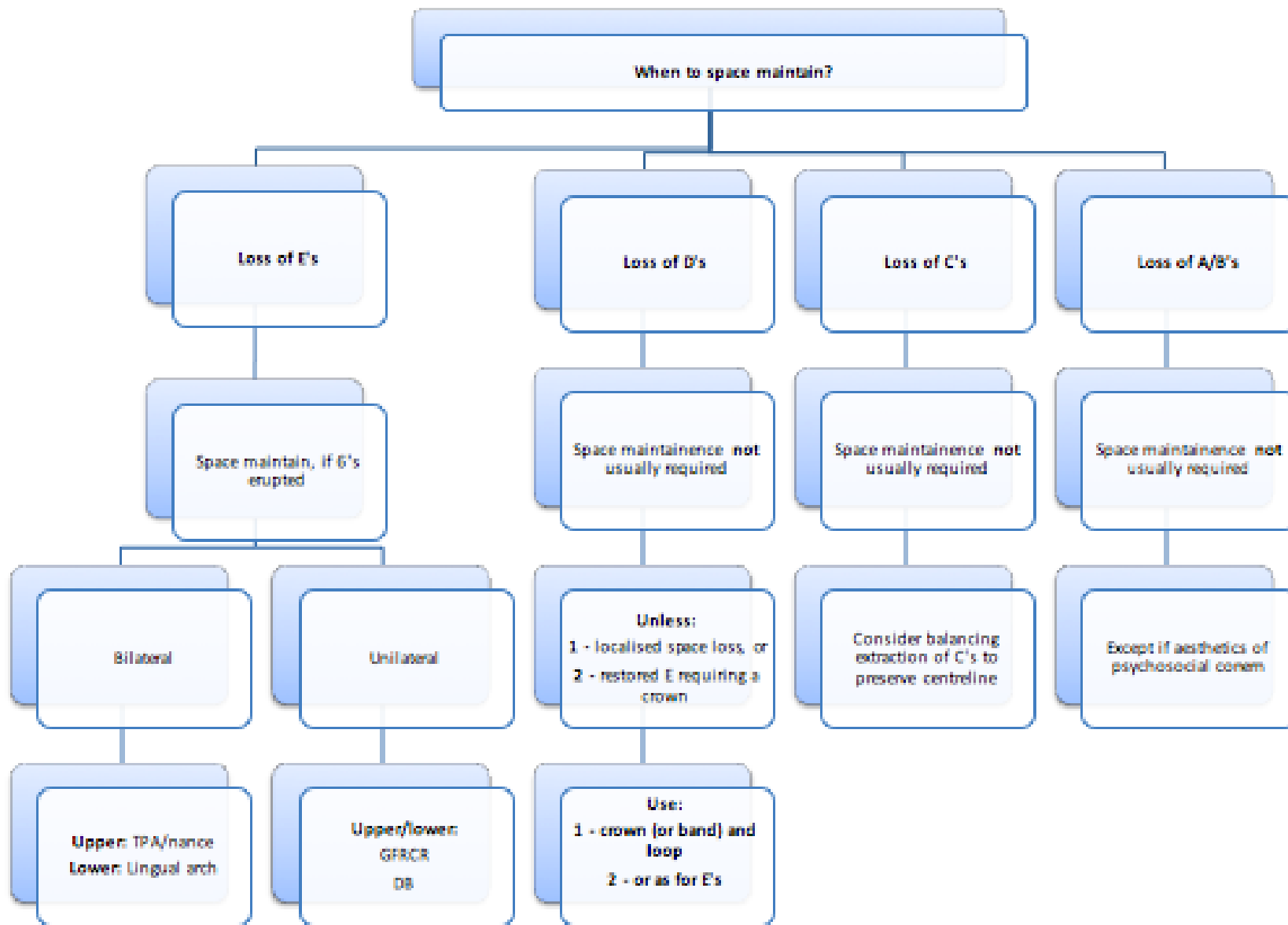
This clinical paper aims to outline the benefits of using space maintainers when there has been early loss of the primary dentition. These include a reduction in the prevalence and measure of crowding, ectopic eruption or impaction of teeth, increased overjet, crossbite, increased overbite and poor molar relationship.

There are a small number of contraindications for use of space maintainers (see Table 2), but generally they are well tolerated in most patients. All space maintainers will accumulate plaque and are therefore contraindicated in children with poor oral hygiene, poor attenders and ongoing high caries risk.

However, maintaining the space may reduce the need for further, lengthy and more complex orthodontic treatment. If in any doubt, practitioners should refer for specialist orthodontic opinion for the need of provision of a space maintainer and assessment of the developing malocclusion.

Further research is required into the most effective methods in order to support the clinical advantages of this simple interceptive measure, but this paper should aid clinicians in deciding when and how to space maintain (Figure 6).

**FLOWCHART:**



**Figure 7: Flowchart to aid clinical decision making for when and how to space maintain.**



**Figure 8 Appendix 1: Types of space maintainers – clinical indications, advantages and disadvantages.**

Space Maintainer	Clinical Indication	Advantages	Disadvantages
<b>Band and Loop</b> <sup>7, 22</sup>	Premature loss of either the first or second primary molar, with a distal abutment tooth available for banding and a loop of wire across the edentulous space.	Can be used with permanent and primary molar banding	Two visits required for fabrication, laboratory expenses, frequent cementation failures, potential to cause soft tissue injury from fixed appliances, first permanent molars can tip mesially more than in bilateral space maintainers
<b>Crown and Loop</b> <sup>22</sup>	Premature loss of primary first molar with a carious primary second molar in need of a crown to restore. Crown is used on abutment tooth instead of band.	Good survival rates and lengths compared to other space maintainers, allows use of heavily restored abutment tooth.	Two visits required for fabrication, laboratory expenses, if failure occurs conversion to band and loop space maintainer over crown is possible, first permanent molars can tip mesially more than in bilateral space maintainers
<b>Glass Fibre Reinforced Composite Resin</b> <sup>20</sup>	Non-carious/restored surface for bonding either side of a primary molar space.  But these SM show high failures when placed with no rubber dam.	Single visit placement, easy to repair/replace, eliminates laboratory expenses, reduced potential for soft tissue damage compared to metal space maintainers, increased patient acceptability	Technique sensitive, good isolation and cooperation is required, risk of bonding failures, relatively new technique, long term use has not been evaluated
<b>Simple Wire Direct bonded</b>	Non carious/restored surface of enamel for bonding of mesh pads either side of a primary molar space. Space maintainer tube is		

	welded to mesh and wire is welded anterior.		
<b>Distal End Shoe</b> <sup>32</sup>	Premature loss of a primary molar with an unerupted tooth distal to the primary molar space. Crown fitted on first primary molar and L-shaped bar with an intra-alveolar extension soldered to crowns distal surface to guide first permanent molar.	Potential for use prior to first permanent molar eruptions	Lengthy and technically complex procedure, requires soldering equipment and excellent patient compliance.
<b>Transpalatal Arch</b> <sup>14</sup>	Maxillary arch only.  Multiple loss of primary teeth, failed fixed unilateral SMs. Stainless steel wire attached to molar bands	Useful when loss of multiple adjacent teeth, preserves transverse intermolar distance	Need to await first permanent molar eruption, potential risk of soft tissue irritation to tongue, no effect on distal drift of canines, does not prevent anteroposterior movement of first permanent molars
<b>Nance Appliances</b> <sup>14</sup>	As for TPA. Stainless steel wire attached to molar bands with acrylic pad adapted to anterior aspect of palate	Maxillary arch only	Potential risk of acrylic pad embedding in palatal soft tissues, careful cleaning instructions to be given, soft tissue irritation to tongue
<b>Lingual Arch</b> <sup>15</sup>	Mandibular arch only.  Stainless steel wire attached to bands and adapted to lingual aspect of mandibular arch	First permanent molars must be erupted.	Can impede eruption of mandibular incisors so contraindicated prior to their eruption

<b>Removable Appliances</b>	Multiple loss of primary teeth		Two visits required for fabrication, laboratory expenses, long term compliance is often poor.



## REFERENCES:

1. Brothwell D J. Guidelines on the use of space maintainers following premature loss of primary teeth. *J Can Dent Assoc* 1997; **63**(10): 753-766.
2. Northway W M. The not-so-harmless maxillary primary first molar extraction. *J Am Dent Assoc* 2000; **131**(12): 1711-1720.
3. Ngan P, Alkire R G, Fields H W Jr. Management of space problems in the primary and mixed dentitions. *J Am Dent Assoc* 1999; **130**(9): 1330-1339.
4. Terlaje R D, Donly K J. Treatment planning for space maintenance in the primary and mixed dentition. *J Dent Child* 2001; **68**(2): 109-114.
5. Bell R A, Dean J A, McDonald R E, Avery D R. Management of the developing occlusion. In Dean J A, Avery D R, McDonald R E (eds) *McDonald and Avery's Dentistry for the Child and Adolescent*. 9th ed. pp550-613. Maryland Heights, Mo: Mosby Elsevier; 2011.
6. Littlewood S, Tait A, Mandall N, Lewis D. Orthodontics: the role of removable appliances in contemporary orthodontics. *Br. Dent. J* 2001; **191**: 304-310.
7. Laing E, Ashley P, Farhad B N, Dalgit S G. Space Maintenance. *Int J Paediatr Dent* 2009; **19**: 155-162.
8. Guideline on Management of the Developing Dentition and Occlusion in Paediatric Dentistry. *Pediatr Dent* 2016; **38** (6), 289-301.
9. Dental Space Maintainers for the Management of Premature Loss of Deciduous Molars: A Review of the Clinical Effectiveness, and Guidelines. Ottawa (ON): Canadian Agency for Drugs and Technologies in Health; 2016. Online information available at: <https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0090125/> (accessed August 2017).
10. A Guideline for the Extraction of First Permanent Molars in Children Royal College of Surgeons of England Guidelines; 2014. Online information available at: <https://www.rcseng.ac.uk/-/media/files/rcs/fds/publications/extractp.pdf?la=en> (accessed August 2017).
11. Qudeimat M A, Fayle S A. The longevity of space maintainers: a retrospective study. *Pediatr Dent* 1998; **20**: 267-272.
12. Ahmaad A J, Parekh S, Ashley P. Methods of Space Maintenance for Premature Loss of a Primary Molar: A Review [Accepted *Eur J Paediatr Dent*]
13. Proffit W R, Fields H W, Sarver D M. *Contemporary Orthodontics*. 4th ed. St Louis: Mosby, 2006.
14. Kupietsky A, Tal E. The Transpalatal Arch: An Alternative to the Nance Appliance for Space Maintenance. *Pediatr Dent* 2007; **29**: 235-238.
15. Burstone C J. Precision lingual arches. Active applications. *J Clin Orthod* 1989; **23** (2): 101-109.
16. Letti H C, Rizzato S M, de Menezes L M, Reale C S, de Lima E M, Martinelli F L, Sagittal changes in lower incisors by the use of lingual arch. *Dental Press J Orthod* 2013; **18** (3): 29-34.
17. Tunc E S, Bayrak S, Tuloglu N, Eglimez T, Isci D 2012 Evaluation of survival of 3 different fixed space maintainers. *Pediatr Dent* 2012; **34**: 97-102.

18. Subramaniam P, Babu G K, Sunny R. Glass fibre-reinforced composite resin as a space maintainer: A clinical study. *J Indian Soc Pedod Prev Dent* 2008; **26**: 98-103.
19. Nidhi C, Jain R L, Neeraj M, Harsimrat K. Evaluation of the clinical efficacy of glass fibre reinforced composite resin as a space maintainer and its comparison with the conventional band and loop space. *Minerva Stomatol* 2012; **61**: 21-30
20. Garg A, Samadi F, Jaiswal J N, Saha S. 'Metal to resin': A comparative evaluation of conventional band and loop space maintainers with the fibre reinforced composite resin space maintainer in children. *J Indian Soc Pedod Prev Dent* 2014; **32**: 111-116.
21. Sasa I S, Hasan A A, Qudeimat M A. Longevity of Band and Loop Space Maintainers Using Glass Ionomer Cement: A Prospective Study. *Eur Arch Paediatr Dent* 2009; **10**: 6-10
22. Qudeimat M A, Sasa I S. Clinical success and longevity of band and loop compared to crown and loop space maintainers. *Eur Arch Paediatr Dent* 2015; **16**: 391-396.
23. Brill, W A. The distal shoe space maintainer: chairside fabrication and clinical performance. *Pediatr Dent* 2002; **24**: 561-565.
24. Bijoor R R, Kohli K. Contemporary space maintenance for the pediatric patient. *N Y State Dent J* 2005; **71**: 32-35.
25. Gill D S. *Orthodontics at a Glance*. 1st ed. Oxford, England: Blackwell Munksgaard, 2008.
26. Yin Y T J, Lin Y T. Long-term space changes after premature loss of a primary maxillary first molar. *JDS* 2017; **12**(1): 44-48.
27. Terlaje R D, Donly K J. Treatment planning for space maintenance in the primary and mixed dentition. *ASDC J Dent Child* 2001; **68**: 108-114.
28. Foley, T F, Wright G Z, Weinberger S J. Management of lower incisor crowding in the early mixed dentition. *ASDC J Dent Child* 1996; **63**: 169-174.
29. Andreason J O, Andreason F M, Andersson L. *Text-book and Colour Atlas of Traumatic Injuries to Teeth*. 4<sup>th</sup> ed. UK: Blackwell Munksgaard, 2007.
30. Fricker J, Kharbanda O P, Dando J. Orthodontic diagnosis and treatment in the mixed dentition. In A Cameron and R Widmer (eds) *A Handbook of Pediatric Dentistry*. 3<sup>rd</sup> ed. London: Mosby Elsevier; 2013.
31. Moyers R E, Riolo M L. *Handbook of orthodontics*. 4<sup>th</sup> ed. pp361. Chicago, Il: Yearbook medical publishers. Inc. 1988
32. Barberia E, Lucavechi T, Cardenas D, Maroto M. Free-end Space Maintainers: Design, Utilisation and Advantages. *J Clin Pediatr Dent* 2007; **31** (1): 5-8.

