Space maintenance treatment planning for pediatric patients

by

Jassica Kaur Sarai

D.M.D., The University of British Columbia, 2015

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Craniofacial Science)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

April 2020

The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

Space maintenance treatment planning for pediatric patients

submitted by Jassica Kaur Sarai in partial fulfillment of the requirements for the degree of Master of Science in Craniofacial Science

Examining Committee:

Dr. Jolanta Aleksejuniene, Department of Oral Health Sciences, Faculty of Dentistry, UBC
Supervisor

Dr. David B. Kennedy, Department of Oral Health Sciences, Faculty of Dentistry, UBC
Supervisory Committee Member

Dr. Shan Sun, Department of Oral Health Sciences, Faculty of Dentistry, UBC
Supervisory Committee Member

Dr. Nesrine Mostafa, Department of Oral Health Sciences, Faculty of Dentistry, UBC
Additional Examiner

Dr. Siddharth Vora, Department of Oral Health Sciences, Faculty of Dentistry, UBC
Additional Examiner

Abstract

Objective: The current study examined differences in treatment planning for space maintenance between pediatric dentists and general dentists.

Methods: Two online self-administered electronic questionnaires were developed and administered by the UBC Qualtrics Survey software. One was a 32-question questionnaire that was administered to 1640 general dentists, and the other was a 31-question questionnaire that was administered to 41 pediatric dentists registered with the College of Dental Surgeons of British Columbia, Canada. The questionnaires consisted of three clinical case scenarios regarding space management in pediatric patients. The assessments on space maintenance treatment planning were based on the following cases: 1. Extraction of tooth #7.4 in primary dentition; 2. Extraction of tooth #7.5 in primary dentition; and 3. Premature loss of tooth #7.3 in mixed dentition. The survey also acquired information about the practitioners` demographics and their knowledge, attitudes, and practices towards space maintenance for each specific case. Statistical analysis was conducted using the independent sample t-test, Mann Whitney U test, Chi-square test, and Fischer's exact test.

Results: The response rate for general dentists was 20.3% (n=320), and for the pediatric dentists it was 56.1% (n=23). The majority of general dentists (76.7%, n=244), and all pediatric dentists (100%, n=23) chose to place a band and loop appliance after extraction of tooth #7.4. The majority in both groups selected to place a distal shoe appliance after extraction of tooth #7.5 (59.2%, n=189 of general dentists and 78.3%, n=18 of pediatric dentists), and both general

(59.6%, n= 189) and pediatric (69.6%, n=16) dentists selected that they would consider an orthodontic consultation for the case about the premature loss of tooth #7.3. Differences in attitudes about their dental school/residency training were the strongest determinant associated with treatment planning. There were no statistically significant differences in mean total knowledge scores between the pediatric and general dentists.

Conclusions: Space maintenance treatment planning is multifactorial; however, differences in attitudes towards the practitioners' training strongly associated with their decision making.

Lay Summary

One of the functions of baby teeth is to maintain the space for the developing adult teeth. Baby teeth can be lost prematurely which can create concerns for future crowding of the adult teeth. Space maintainers are appliances placed in the mouth to prevent drifting of adjacent teeth, thus maintaining the space for the developing adult teeth. The present study compared space maintainer treatment planning between general dentists and pediatric dentists.

Both general and pediatric dentists were electronically surveyed using three case-based scenarios; each case was tailored to a different part of space maintenance and examined the practitioners` knowledge, attitudes, and practices.

Our results showed that there were only a few differences between the two dentist groups. Dentists' attitudes towards their clinical experience seemed to influence their treatment planning; moreover, the theoretical knowledge dentists acquired about space maintenance seemed to be similar in both types of dental practitioners.

Preface

This dissertation is the original work of the author Jassica Sarai with guidance from research committee members Dr. Jolanta Aleksejuniene, Dr. David B. Kennedy, and Dr. Shan Sun.

The ethics approval for the project was granted by the University of British Columbia Research Behavioural Ethics Board (H18-02774).

Table of Contents

List of Tables

List of Figures

List of Abbreviations

B&L: Band and loop

D+E space: Distance from the mesial midpoint of the permanent first molar (or distal midpoint of the primary second molar if the permanent molar is unerupted) and the distal midpoint of the primary canine

LLHA: Lower lingual holding arch

TPA: Transpalatal arch

Acknowledgments

I would like to extend my deepest gratitude to my committee members, Dr. David B. Kennedy and Dr. Shan Sun. Your advice and guidance have been invaluable, and it truly has been a pleasure to work alongside you. Both of you are the type people I hope to emulate as I start my career as a dental specialist, so I am grateful for the opportunity to learn from you both.

I am also extremely indebted to my supervisor Dr. Jolanta Aleksjuniene. I appreciate your patience, kindness, and willingness to go above and beyond to ensure my success. It truly has not gone unnoticed, and it's been a delight having you supervise this project.

Dedication

This thesis is dedicated to my family and friends for their unwavering support throughout my residency. It's been a challenging road, but it was made a bit easier knowing that I had a support team behind me.

Chapter 1: Introduction

As a former UBC dental undergraduate student, my space maintenance experience was quite limited as the pediatric patients that were treated by the dental students were referred to the pediatric graduate program for any space management treatment. After graduating from dental school and practicing in the lower mainland, I would encounter cases where space management may have been necessary; however, due to the lack of training in school, I was confused at times about what to do after extracting primary molars. I gained a new perspective on this topic once entering the UBC pediatric graduate program, which greatly expanded my space management theoretical knowledge and clinical experience. This change in perspective piqued my curiosity. If the undergraduate program is still referring pediatric patients to the graduate program for space management, how are general dentists in British Columbia managing potential space loss, and are treatment practices substantially different between general dentists and pediatric dentists?

1.1 Consequences of early loss of primary teeth

1.1.1 Early loss of the primary first molar

The consequences of early loss of a primary first molar after the eruption of the permanent first molars remain controversial. There seems to be a consensus that there is space lost; however, due to a lack of well-designed studies, the clinical relevance of this loss remains arguable. Lin and Chang (1998), however, did conduct one of the few prospective longitudinal studies to evaluate spatial changes after the premature loss of the primary mandibular first molar. In their split-mouth study of 21 subjects (average age of 6 years and 11 months), they found that the D+E space on the extraction side was significantly shorter (by approximately 1 mm) than the

contralateral control side during the 8-month observation period; however, there were no changes in the arch length, perimeter or width (Lin & Chang, 1998). Maximum space loss is reached in the first three months and tapers during the six to eight months post-extraction (Kaklamanos et al., 2017; Padma Kumari & Retnakumari, 2006). Thus, after the eruption of the first permanent mandibular molar, the space changes from the loss of the primary mandibular first molar is predominately due to the distal movement of the canine as the erupting permanent incisors push the primary canine into the edentulous space (Kaklamanos et al., 2017; Lin and Chang 1998; Padma Kumari & Retnakumari, 2006).

To establish if a premature loss of the primary maxillary first molar results in similar spatial changes, Lin et al. (2011) followed the same protocol, but for a longer 12-month observation period. Similar to the mandibular study, there was a statistically significant loss in the D+E space at the 12 months follow-up period, albeit not clinically relevant given only a small 1 mm change (Lin et al., 2011). Also, similar to the mandibular study, this study did not find significant differences in arch length and width. This indicates that the loss in the D+E space at twelve months may be from the distal movement of the anterior teeth with no positional changes of the permanent molars. Park et al. (2009) followed a protocol similar to this except that they used a 3D scanner. Their study further supported the idea that there are no clinically relevant D+E spatial changes from the extraction of a primary maxillary first molar after the eruption of permanent molars. Those included in this study presented with class I occlusion, which was not explicitly mentioned in the study by Lin et al. (2011); also, the age range included were older participants (5-10 years old vs. 4-7 years old) and the permanent maxillary incisors had erupted. Moreover, there were no significant differences in inclinations or angulations of the primary

canines, primary second molars or the permanent first molars, although there was some mesial and palatal tilting of the primary second molar (Park et al., 2009). Furthermore, the loss of the primary first molar does not result in any significant changes to the occlusal relationship of the permanent molars after their eruption (Kisling & Hoffding, 1979b; Kisling & Hoffding, 1979c).

The consequences of early loss of a primary first molar before the eruption of the permanent first molar are more detrimental than those from the loss of a primary first molar after the eruption of the permanent first molar. (Kisling & Hoffding, 1979b). From their split-mouth study involving 55 children aged 3-7 years old, Kisling and Hoffding (1979) found that the side with a space maintainer placed in the region of the primary first molar developed on average of 0.9 mm of space loss as compared to the average of 3 mm on the contralateral control. Also, the space maintainer side did not result in any significant changes to the occlusion. Kisling and Hoffding (1979) explained that these results were due to the movement of the adjacent teeth. Concerning the extraction of the primary maxillary first molar, the space loss is predominately due to the mesial movement of the primary second molar. As a result of the primary first molar loss, the steeper mesial incline of the primary second molar guides the first premolar into a more mesial position (Northway 2000). Since the space loss is relatively small, Northway (2000) suggested disking the primary second molar so that the first premolar does not erupt as mesially; consequently, it does not encroach on the space for the permanent maxillary canine. In the mandible, the space lost from the extraction of the primary first molar is mostly from the distal movement of the canine as the lateral incisors erupt, since the primary mandibular canines move a greater distance than their antagonists (Kisling & Hoffding, 1979c). The magnitude of this drifting depends on the degree of movement of the permanent mandibular incisors (Kisling &

Hoffding, 1979c). Moreover, midline shifting is also more prominent in the mandible than in maxilla and occurs on the side with the premature loss of the primary first molar (Kisling & Hoffding, 1979c).

1.1.2 Early loss of the primary second molar

The spatial changes to the arch are more pronounced with a premature loss of the primary second molar than of a primary first molar (Kisling & Hoffding, 1979c; Owen, 1971; Northway, 1984). Similar to the primary maxillary second molars, the permanent maxillary molars drift mesially, rotate along their palatal roots, and initially travel at a greater rate than the permanent mandibular molars (Kisling & Hoffding 1979c). However, after the first six months, the maxillary rate of closure usually slows down, yet the mandibular rate remains steady or varies (Owen, 1971). Since the mesial drifting is more significant with the loss of a primary second molar, it tends to result in changes to the sagittal occlusal relationship; however, there is less alteration to the teeth positioned more anteriorly (Kisling & Hoffding 1979b). Kisling and Hoffding observed distal molar occlusion at a higher prevalence when the primary maxillary second molar was lost prematurely, but more mesial molar occlusion with loss of the primary mandibular second molar. Also, in the mandibular arch, the permanent mandibular first molars tend to tip lingually (Kisling & Hoffding 1979b). The authors emphasized that drifting patterns can vary amongst individuals and are dependent upon multiple factors such as dental age at the time of the extraction, eruption path, intercuspation and muscular function (Kisling & Hoffding 1979b).

A few studies addressed the dimensional arch changes from the premature loss of both deciduous molars. Macena et al. (2011) evaluated these changes through a split-mouth study design of 55

Brazilian children between the ages of 6 and 9 years (early mixed dentition) with mild (< 4 mm) anterior crowding who exhibited unilateral loss of either a primary first or second molar in the maxilla or mandible in their early mixed dentition. During the 10-month observation period, there were significant changes only in arch measurements in those individuals with the extraction of the primary second molar (Macena et al., 2011). The primary maxillary second molar extraction showed a significant decrease in space from the initial evaluation to the three- and six-months follow-up periods; however, this lost space recovered in subsequent months, possibly due to the physiologic growth of the arch (Macena et al., 2011). The primary mandibular second molar extraction went through a significant reduction in space throughout the observation period, with the greatest reduction at three months and continued reduction until the 10-month evaluation, but to a lesser degree (Macena et al. 2011). Also, arch length and hemi-perimeter reduction were only seen after the loss of the primary mandibular second molar (Macena et al. 2011). Thus, Macena et al. (2011) concluded that space maintainers are not necessary after the premature loss of primary maxillary second molars when the permanent first molars have already erupted.

1.1.3 Early loss of the primary canine

Early loss of a primary canine can result from 1. Inadequate space for the permanent incisors resulting in its premature exfoliation; and 2. Extraction of the primary canine to alleviate the anterior crowding (Gianelly, 1995). Thus, the early loss of a primary canine is more of a consequence of crowding (Kisling & Hoffding 1979b).

According to Gianelly (1995), premature loss of primary mandibular canine results in a midline shift to the affected side and lingual movement of the mandibular incisors, which causes a loss in arch length. Premature loss of a primary maxillary canine also results in a loss in arch length (Sjogren et al., 2012). Hence, there is an increase in overbite and a decrease in overjet from the extractions of all four primary canines (Sjogren et al., 2012). Yet the shift in the midline is not as severe after a primary maxillary canine extraction as it is for a mandibular extraction since the median intermaxillary suture creates a barrier that prevents migration to the edentulous side (Profitt, 2018; Sjogren et al., 2012).

In a case-control study, Sayin and Turkkahraman (2006) observed the retrusion of the mandibular incisors using lateral cephalometric radiographs and dental casts after bilaterally extracting the primary mandibular canines in the early mixed dentition. However, no changes were observed between the control (no primary canine extractions) and treatment groups (primary canine extractions) regarding the arch length, intermolar width, and molar positioning (Sayin & Turkkahraman, 2006). It should be noted that the total observation period in this study was only one year (Sayin & Turkkahraman, 2006). Kau et al. (2004) conducted a randomized controlled study similar to that of Sayin and Turkkahraman (2006) and concluded that there was

a reduction in mandibular anterior crowding post-primary canine extraction. They also observed a decrease in arch perimeter and total arch length, but no changes in incisal inclination in the treatment group (Kau et al., 2004). Since they did not observe a difference in the mandibular incisor inclination between the extraction and non-extraction groups, they attributed the loss in arch perimeter to the greater mesial movement of the molars (Kau et al., 2004). The differences in the results from these two studies could be attributed to the differences in their experimental designs (Kau et al., 2004; Sayin & Turkkahraman, 2006). In Kau's study, the subjects presented with more severe anterior crowding (a minimum of 6 mm versus a minimum of 1.6 mm), thus the mesial movement of the molars may have been inevitable in these subjects. Furthermore, Kau's study had a longer observation period (2 years) and measured the angulation changes of the lower incisors using study models only.

1.1.4 Early loss of primary incisors

Dental trauma and early childhood caries are the main causes of premature loss of primary maxillary incisors (Holan & Needleman, 2013). A few studies of varying scientific quality argued about the effect or lack thereof of early loss of these incisors on speech impairment (Holan & Needleman, 2013). In 1995, Gable et al. tested this hypothesis in a controlled study of 26 children with premature loss of their maxillary incisors to 26 with normal exfoliation. They found that there was no significant difference between the two groups in speech development after the eruption of the permanent incisors (Gable et al., 1995). Thus, impairments noticed are usually temporary and resolve once the permanent incisors erupt (Gable et al., 1995; Holan & Needleman, 2013). Furthermore, space loss is only a concern if the primary canines are not in occlusion (Holan & Needleman, 2013). However, with little scientific evidence on the issue and

lack of feasibility of placing anterior space maintainers in such young children, anterior space maintenance is generally not needed (Holan & Needleman, 2013).

1.2 Indications for space maintainers

Before the eruption of the permanent first molar, a space maintainer placed in the region of the primary first molar prevents the mesial movement of the primary second molar in the maxilla, and the distal movement of the primary canine in the mandible (Kisling & Hoffding, 1979e). Also, in cases where children tend to have an inversion of the incisors, a space maintainer can prevent anterior crossbites (Kisling & Hoffding, 1979e). Concerning the loss of a primary second molar, a space maintainer will prevent the mesial drifting, rotating and tipping of the permanent first molar (Kisling & Hoffding, 1979c).

After the eruption of the permanent first molar, loss of a primary second molar will still need a space maintainer, since the loss of the primary second molar will likely lead to mesial drifting of the permanent first molar in both arches (Kisling & Hoffding, 1979e). Fortunately, teeth anterior to the primary second molar are not affected (Kisling & Hoffding, 1979e).

Treatment for the primary first molars after the eruption of the permanent first molars is not as straightforward, and more factors need to be considered (Kisling & Hoffding, 1979e). For loss of a primary maxillary first molar, since the crowding and the mesial drifting is minimal, a space maintainer is usually unnecessary (Kisling & Hoffding, 1979e). Kisling and Hoffding (1979) recommend that space maintainers are unnecessary for loss of a primary first molar after the age

of 7.5-8 years since the incisors should be erupted by that time. However, they do advise that in particular situations, a space maintainer should still be considered. A space maintainer is needed when there is a unilateral loss of a primary maxillary first molar, and the permanent first molars have a flush terminal plane relationship with moderate crowding. Furthermore, a space maintainer should also be considered in cases of distal molar relationships when the maxillary first molar is lost prematurely (Kisling & Hoffding, 1979e). In a mesial molar occlusal relationship, a space maintainer is not necessary as the drifting of the maxillary molars into space would improve the occlusion (Kisling & Hoffding, 1979e). For loss of a primary mandibular first molar after the permanent first molars erupt, a space maintainer should be considered before the age of 8 if there is moderate crowding, a deep bite and abnormal lower lip pressure (Kisling & Hoffding, 1979e).

Premature loss of a primary canine is an indicator of potential crowding (Giannelly, 1995). Thus to maintain symmetry, it is recommended to remove the contralateral primary canine followed by placing a lower lingual holding arch to prevent a loss in arch length (Brennan & Gianelly, 2002). It should be kept in place until the second molars erupt (Profitt, 2018). Giannelly (1995) reported that this is a better route than planning serial extractions for patients with a premature loss of a primary canine since future crowding is difficult to predict, and there are no differences in treatment outcomes between those that had serial extractions versus those that had conventional premolar extractions. Thus, maintaining the arch length until the premolars erupt and then deciding if extractions are necessary may reduce the chance for error (Gianelly, 1995).

Terlaje and Donly (2001) published an article in the Journal of Dentistry for Children that summarizes the recommendations for space maintainers.

Below is a modified version of the table:

A. Primary dentition

Maxilla		Mandible	
Missing tooth	**Treatment**	**Missing tooth**	**Treatment**
Unilateral loss of a primary 1st molar	Band and loop	Unilateral loss of a primary 1st molar	Band and loop
Unilateral loss of a primary 2nd molar	No treatment until the eruption of the 1st permanent molar, then a distal band and loop until both 1st permanent molars completely erupt and a transpalatal arch can be placed	Unilateral loss of a primary 2nd molar	Distal shoe until the eruption of 1st permanent molars and permanent incisors, then a lower lingual holding arch
Bilateral loss of primary 1st molars	Bilateral band and loops	Bilateral loss of primary 1st molars	Bilateral band and loops
Bilateral loss of primary 2nd molars	No treatment until the eruption of the 1st permanent molar, then a distal band and loops until both 1st permanent molars completely erupt and a Nance can be placed	Bilateral loss of primary 2nd molars	Bilateral distal shoe until the eruption of 1st permanent molars and permanent incisors, then a lower lingual holding arch
Multiple bilateral primary molar loss	Saddle appliance until 1st permanent molars completely erupt, and a Nance can be placed	Multiple bilateral primary molar loss	Saddle appliance until 1st permanent molars and permanent incisors erupt and a lower lingual holding arch can be placed

B. Early mixed dentition

Maxilla		Mandible	
Missing tooth	**Treatment**	**Missing tooth**	**Treatment**
Unilateral loss of a primary 1st molar	No treatment unless the leeway space needs to be preserved	Unilateral loss of a primary 1st molar	No treatment unless the leeway space needs to be preserved
Unilateral loss of a primary 2nd molar	Transpalatal arch	Unilateral loss of a primary 2nd molar	The band and loop until the eruption of permanent incisors, then a lower lingual holding arch
Bilateral loss of primary 1st molars	No treatment unless the leeway space needs to be preserved	Bilateral loss of primary 1st molars	No treatment unless the leeway space needs to be preserved
Bilateral loss of primary 2nd molars	Nance	Bilateral loss of primary 2nd molars	Bilateral band and loops until the eruption of permanent incisors, then a lower lingual holding arch
Multiple bilateral primary molar loss	Nance	Multiple bilateral primary molar loss	Saddle appliance until the eruption of permanent incisors, then a lower lingual holding arch

1.3 Types of lab-fabricated space maintainers

1.3.1 Band and loop

The band-and-loop space maintainer is a fixed appliance indicated in cases of unilateral loss of a primary molar, and in cases of bilateral loss of primary mandibular molars before the eruption of the permanent mandibular first molars and incisors (Laing et al., 2009). It consists of a band soldered to a heavy gauge 0.9 mm wire loop (Terlaje & Donly, 2009). The band is placed around a molar adjacent to the edentulous area, and the wire loop extends over the space and abuts to the next tooth (Laing et al., 2009; Profit, 2018). The wire loop is made wide enough buccolingually

such that it does not interfere with the eruption of the succedaneous tooth (Laing et al., 2009). Band and loop appliances do not restore masticatory function, and due to its limited strength, they are only recommended for space maintenance of a single tooth to avoid an extensive wire (Profitt, 2018). Also, due to its cantilevered design, which can pose a risk of dislodgement during mastication, the appliance can be modified with an addition of an occlusal rest soldered on the wire (Laing et al., 2009).

For loss of a primary second molar, a band and loop can be placed on either the primary first molar or on the erupted permanent first molar. The eruption sequence is an important factor in deciding which tooth to band; if the primary first molar will exfoliate before the eruption of the second premolar, then the banded abutment will be lost and the appliance will have to be replaced. Also, consideration needs to go into the likelihood of decalcification on the banded permanent molar, or in regards to the challenge with banding a primary first molar due to its occlusal morphology. (Profitt, 2018).

Figure 1. Photograph of a Band and Loop appliance. *Adapted from Ngan et al., 1999.*

1.3.2 Lower lingual holding arch (LLHA)

The lower lingual holding arch is a bilateral fixed appliance that maintains space following the premature loss of multiple primary mandibular posterior teeth (Laing et al., 2009). Since the permanent lower incisors erupt lingual to the primary teeth, the lingual arch is best inserted after their eruption into the arch to avoid interference of their eruption pathway (Laing et al., 2009). Bands are fitted on the permanent mandibular first molars, and a 0.9 mm thick heavy gauge wire is soldered onto the lingual aspect of the bands (Laing et al., 2009). The wire abuts against the cingulae of the lower incisors, which is located approximately 1 mm away from the soft tissue; this prevents the lingual tipping of the incisors (Laing et al., 2009; Profitt, 2018; Viglianisi, 2010). A semi-loop of wire is bent on either side so that the wire can be adjusted as the teeth drift (Laing et al., 2009). Its design helps to prevent posterior movement of the anterior teeth and anterior movement of the posterior teeth; however, there is a slight proclination of the incisors (Laing et al., 2009; Profitt 2018). The lingual arch should fit passively in the mouth to avoid any untoward movements of the teeth.

Lower lingual holding arches are also utilized orthodontically to maintain the Leeway space, which can thereby relieve approximately 5 mm of anterior crowding (Brennan & Gianelly, 2000). An LLHA can alleviate the moderate anterior crowding by utilizing the space mostly made available from the primary second molar exfoliation (Profitt, 2018).

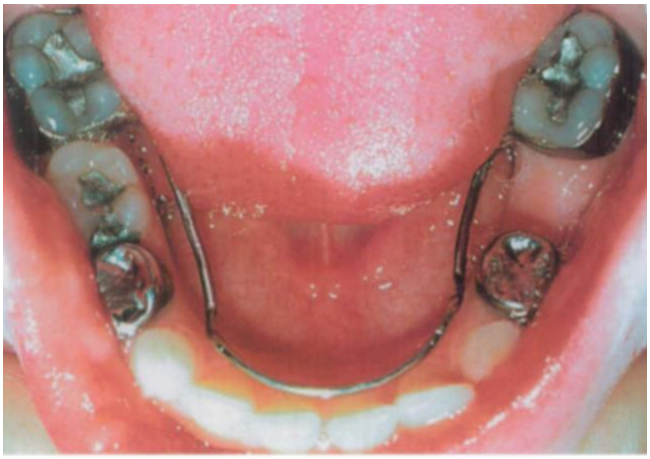


Figure 2. Photograph of a Lower Lingual Holding Arch (LLHA) appliance. *Adapted from Terlaje & Donly, 2001*

1.3.2.1 Effectiveness of the LLHA

The effectiveness of the LLHA has been extensively covered in the scientific literature (Viglianisi, 2010). Viglianisi (2010) conducted a systematic review to evaluate the effectiveness of a fixed lingual arch on the dimensions of the mandibular arch. Of the 262 articles found, only two case-controlled studies met the inclusion criteria for quality assurance; i.e. these were prospective or retrospective human studies having a control group (Viglianisi, 2010).

The study by Villalobos et al. (2000) compared the molar and incisor positional and angular changes on lateral cephalograms to measure the effectiveness of the lower lingual holding arch. The treatment group consisted of 23 Caucasian subjects with a lower lingual hold arch placed in the late mixed dentition and a control group of 24 subjects with similar characteristics (age, sex, ethnic origin, and mandibular plane angle) (Villalobos et al., 2000). The pre- and post- lateral cephalograms measured the drifting (mm) and tipping (°) of the molars and incisors (Villalobos

et al., 2000). In the 24-month observation period, Villalobos et al. (2000) showed statistically significant differences between the groups, that being less mesial drifting and tipping of the molars, and less posterior drifting and tipping of the lower incisors in the treatment group versus the control group.

In a similar case-controlled study by Rebellato et al. (1997), the lingual arch effectiveness was evaluated in 30 subjects of similar characteristics. Pre- and post- lateral cephalograms, sectional tomographic radiographs, and study models were evaluated, and the authors found statistically significant differences between the treatment and control groups (Rebellato et al. 1997). The subjects with the lingual arch showed backward tipping of the molars and forward tipping of the incisors, and the reverse was noted in the controls (Rebellato et al. 1997). Furthermore, a decrease in the arch length was found in the control group and a slight increase in the treatment group (Rebellato et al. 1997).

1.3.3 Nance appliance

The Nance appliance is useful for maintaining space following the bilateral premature loss of primary maxillary teeth (Laing et al., 2009). Similar to a lower lingual hold arch, bands are fitted on the permanent maxillary first molars, and a 0.09 mm heavy gauge stainless steel wire soldered to those bands runs anteriorly (Laing et al., 2009). Attached to the wire is an acrylic button that sits most superiorly and anteriorly on the palatal vault (Laing et al., 2009). Although the acrylic may irritate the palatal tissue, it provides extra anchorage, which prevents the mesial movement of the permanent first molars (Laing et al. 2009). One of the benefits of the Nance appliance is

that a 2nd wire can be soldered to the bands and acrylic pontic teeth can be attached to the wire to replace missing anterior teeth (Laing et al., 2009).

Figure 3. Photograph of a Nance appliance. *Adapted from Ngan et al., 1999.*

1.3.4 Transpalatal arch (TPA)

An alternative to the Nance appliance for maxillary space maintenance is the transpalatal arch (TPA). Bands are placed on the permanent first molars with a soldered wire that crosses the palate transversely to connect the bands (Laing et al., 2009). The wire follows the contours of the palate and rests 2 mm below the tissue to reduce irritation (Laing et al., 2009). Also, an omega loop is placed in the center of the wire so that the appliance can be constricted or expanded (Laing et al., 2009). An advantage of the TPA over a Nance is that it can place forces on the molars, such as de-rotating the permanent molars after the loss of a primary second molar (Laing et al., 2009). The TPA tends to distobuccally rotate the mesiobuccal cusp of the permanent first molar to regain the space lost (Laing et al., 2009; Terlaje & Donly, 2001). Due to its weaker anchorage ability though, it is best indicated in cases with a unilateral primary maxillary molar loss so that the contralateral side of the arch can provide more stability (Laing et al., 2009).

The Nance appliance is still recommended over the TPA in cases of bilateral maxillary tooth loss (Laing et al., 2009).

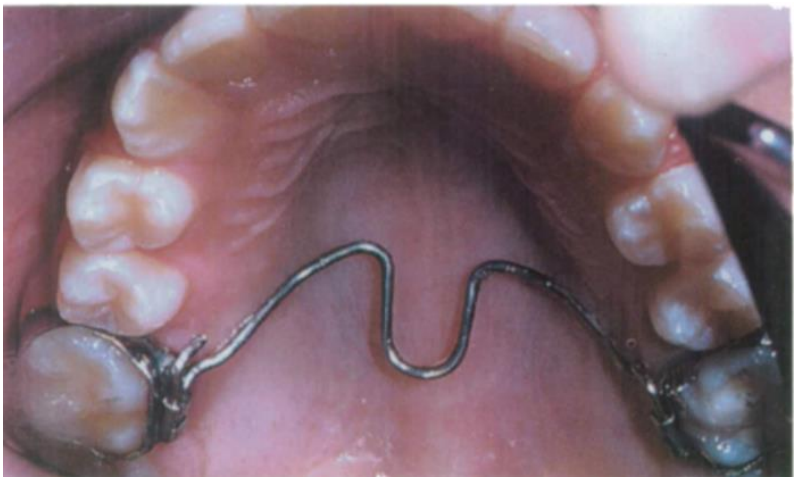


Figure 4. Photograph of a Transpalatal Arch (TPA). *Adapted from Terlaje & Donly, 2001.*

1.3.5 Distal shoe

The distal shoe is a fixed appliance used when the primary second molar is missing, and the permanent first molar has not yet erupted into the oral cavity (Profitt, 2018). Similar to a band and loop, it consists of a band attached to a wire loop that extends over the edentulous space (Profitt, 2018). However, attached to the distal end of the loop is a metal or plastic guide plane (Profitt, 2018; and Brill, 2002). This guide plane extends either 1 mm below the mesial marginal ridge of the first permanent molar or to the level of the alveolar bone if the permanent molar has not erupted (Profitt, 2018). The purpose of this guide plane is to assist in guiding the permanent first molar into occlusion as it erupts, thereby preventing mesial drifting into the primary second molar edentulous space (Brill, 2000). The procedure involves incising the gingiva just mesial to the permanent first molar to embed the guide plane in the tissue followed by taking a radiograph during its placement to verify its correct position (Brill, 2000; Laing et al., 2009). With regards to the success rate, Brill (2002) placed a total of 190 chair-side distal shoe appliances, and over

the 6-year study period, 86 of them (45%) were successful in guiding the first permanent molars into their correct position within the arch. It should be noted that Brill (2002) welded the wire attachment to a stainless steel crown fitted on the primary first molar versus placing a band. Furthermore, because of the incomplete epithelization around the intra-alveolar portion of the appliance, distal shoes are contraindicated in immunocompromised patients and cardiac patients because of a risk of subacute endocarditis (Brill, 2002; Profitt, 2018; Laing et al., 2009). It is recommended to replace the distal shoe with a band-and-loop once the first permanent molar has fully erupted since they can harbor bacteria and extend into the tissues (Laing et al., 2009).

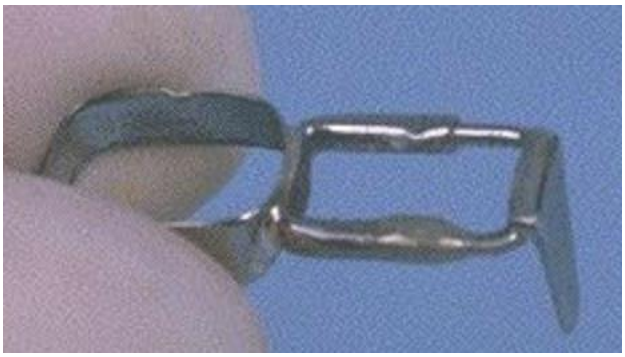


Figure 5. Photograph of a distal shoe appliance, accessed 8 April 2020, < https://depts.washington.edu/peddent/AtlasDemo/space128.html>

1.4 Contraindications of space maintainers

Severe space loss that would require space regaining is a contraindication for space maintenance as comprehensive orthodontic treatment may be needed, which may include extractions of permanent teeth (Terlaje & Donly, 2001, and Watt et al., 2018). Also, if the succedaneous tooth will erupt within the next 6 months (the root is greater than ½ to 2/3rd developed), then a space maintainer is unnecessary (Profitt, 2018).

1.5 Treatment planning for space maintainer appliances

According to the treatment guidelines by the American Association of Pediatric Dentistry (AAPD), the following factors should be considered when planning for space maintenance:

1. The specific tooth loss
2. Time elapsed since the tooth loss
3. Pre-existing occlusion
4. Favourable space analysis
5. Presence and root development of the permanent successor
6. Amount of alveolar bone covering the permanent successor
7. Patient's health status
8. Patient's cooperative ability
9. Active oral habits
10. Oral hygiene

1.5.1 Location of tooth loss

Space loss is the most important when the primary second molar is lost (Northway et al., 1984). The least concern for space loss is the loss of primary incisors (Holan & Needleman, 2014).

1.5.2 Time elapsed since the tooth loss

Space loss will occur within six months after the premature loss of the primary molar; however, the most dramatic loss is within the first three months (Terlaje & Donly, 2001; Macena et al.,

2011; Tulunoglu et al., 2005). Thus, a space maintainer should be placed immediately after the loss of the molar (Terlaje & Donly, 2001). In cases where this time has elapsed, and space has already been lost, a space maintainer alone is not an adequate treatment option (Profitt, 2018). Space analysis is then necessary for planning for space regaining (Profitt, 2018).

1.5.3 Pre-existing occlusion

As mentioned previously once the permanent first molars are in occlusion and the permanent laterals incisors have erupted, the premature loss of a primary first molar is clinically irrelevant because the molar relationship does not change substantially after the extraction of primary first molars (Kisling & Hoffding, 1979e). Therefore, a space maintainer is unnecessary in cases with class I molar occlusion. However, under certain circumstances, a space maintainer would be beneficial. One should consider a space maintainer in situations with a ½ cusp class II molar relationship with the moderate crowding and the presence of all tooth germs (Kisling & Hoffding, 1979e). This will prevent the maxillary permanent first molar from drifting further mesially, which would prevent a class II malocclusion (Kisling & Hoffding, 1979e).

1.5.4 Favorable space analysis

Normally there is generalized spacing in the primary dentition (Profitt, 2018). Noticeably it is around the primary canine region, which is known as the primate space (Profitt, 2018). In the maxillary arch, the primate space is mesial to the primary canine and in the mandibular arch, it is distal (Profitt, 2018). Without this generalized spacing in primary dentition, crowding of the permanent dentition will likely develop (Profitt, 2018). Since the premolars are smaller than their

deciduous counterparts, a physiologic space called the Leeway space is created (Profitt, 2018). Leeway space is the difference in mesiodistal widths between the primary molars and canine, and their permanent successors (Profitt, 2018). Per quadrant, 0.9 mm on average is available in the maxilla and 1.8 mm in the mandible (Profitt, 2018).

Space analysis is the process of comparing the space available to the space required to align the teeth properly into the dental arches (Profitt, 2018). It is from this analysis that proper management can be decided; whether the space is adequate, deficient or in excess will guide the treatment management (Profitt, 2018). This is accomplished by first calculating the space available by measuring the arch perimeter from the mesial contact points of the first permanent molars (Profitt, 2018). Thereafter, the required space is calculated by summing up the mesiodistal widths of all the erupted teeth, and the estimated widths of the unerupted permanent teeth (Profitt, 2018). These estimations are made through either undistorted radiographs or more through commonly used proportionality tables (Profitt, 2018). After measuring the widths of the permanent mandibular incisors, a proportionality table (such as the one prepared by Tanaka and Johnston) is used to estimate the sum of the width of both the maxillary and mandibular permanent canines and premolars (Profitt, 2018). There are three assumptions made from this analysis: 1. The anteroposterior position of the incisors will not change; 2. The space available will not change from growth or tipping; and 3. All teeth are of normal size and are present. From this analysis, potential space problems can be quantified and correctly managed (Profitt, 2018).

Space maintenance is indicated in cases where there is adequate space after the premature loss of a primary molar. In cases where there is a localized space loss of 3 mm or less, space regaining is

indicated instead. The idea is to regain the lost space and subsequently maintain the space with a space maintainer (Profitt, 2018). In the maxilla, a removable (for tipping and derotating) or fixed appliance with a coil spring (for bodily movement) is satisfactory to distalize molars to regain up to 3 mm of space; however, if the space lost is greater than 3 mm, then comprehensive treatment is warranted (Profitt, 2018). In the mandible, for unilateral space regaining, a fixed appliance with a coiled spring should be considered. However, for bilateral space regaining, a lip bumper or active lingual arch is a better choice (Profitt, 2018).

1.5.5 Root development and bone levels

There seems to be a positive association between the eruption of a tooth into the oral cavity and its root development (Terlaje & Donly, 2001). The permanent canine erupts when the root is almost three-quarters developed, whereas the premolars erupt when only the root is half to three-quarters developed (Terlaje & Donly, 2001). Moreover, the premature loss of a primary tooth can either delay or accelerate the eruption of the succedaneous tooth (Posen, 1965; Fanning, 1962). For primary molars lost before the age of 5 years, the eruption of the premolar is delayed. This eruption rate, however, becomes hastened when the primary tooth is lost later (Posen, 1965). If a primary molar is lost after the age of 8 years, the eruption of the succedaneous tooth becomes greatly accelerated (Posen, 1965). The reason for the delayed eruption is thought to be due to scar tissue that forms after the extraction of the primary tooth which becomes a mechanical barrier for the eruption of the premolar (Fanning, 1962). In accelerated cases, though, it is thought that the extraction of the primary molar facilitates the eruption of the permanent tooth by creating an eruption pathway (Fanning, 1962). In some cases, the permanent

tooth will erupt even with an immature root development if the deciduous tooth presents with an infection that destroys the alveolar bone (Fanning, 1962).

The eruption of the permanent tooth can be predicted radiographically by examining the level of bone overlying the tooth (Terlaje & Donly, 2001). Penetrating through 1 mm of bone will take approximately six months (Terlaje & Donly, 2001).

1.5.6 Eruption sequence

The AAPD reference manual provides a summary of the expected eruption sequence for the permanent teeth. Below is a modified version of this chart.

Type of Tooth	**Eruption Time**	
	Maxillary (eruption order)	Mandibular (eruption order)
Central incisors	7-8 y (3)	6-7 (2)
Lateral incisors	8-9 y (5)	7-8 y (4)
Canines	11-12 y (11)	9-11 y (6)
First premolars	10-11 y (7)	10-12 y (8)
Second premolars	10-12 y (9)	11-13 y (10)
First molars	5.5-7 y (1)	5.5-7 y (1a)
Second molars	12-14 y (12)	12-14 (12a)
Third molars	17-30 y (13)	17-30 (13a)

The eruption sequence may vary amongst individuals, so it is important to evaluate a patient's eruption sequence when determining if space maintainers are indicated. The most favourable eruption sequence in the maxillary arch is the following: first molar, central incisors, lateral incisors, first premolars, second premolars, canines and second molars (Ngan et al., 1998). In the mandible, the most favourable eruption order is a first molar, central incisors, lateral incisors, canines, first premolars, second premolars, and second molars (Ngan et al., 1998). The most unfavourable eruption sequence is when the primary second molar is lost prematurely, and the

permanent second molar is further along in its eruption than the second premolar. This will result in mesial migration of the teeth distal to this space and will create even more space loss (Terlaje and Donly, 2001). It is also unfavourable when the premolars erupt earlier than the canines (Ngan et al., 1998).

1.5.7 Active oral habits

Although the space loss from the loss of primary maxillary incisors is insignificant, an active digit habit can create a reduction in space for the permanent incisors so a space maintainer can be considered (AAPD 2019 reference manual; Watt et al., 2018). However, the emphasis should be placed on breaking the digit habit (AAPD 2019 reference manual).

1.6 Survival of fixed appliances

The survival rate for fixed appliances is believed to be better for fixed unilateral space maintainers versus bilateral appliances, and maxillary appliances than for mandibular ones (Fathian et al, 2006). However, the overall mean survival rate of these fixed space maintainers varies in the literature ranging from 7 months to longer than 20 months (Fathian et al., 2006; Tulunoglu et al., 2005; Qudeimat et al., 1998). The variation reported in the literature could be a result of the differences in the length of the follow-ups and the study designs. In 2006, Moore and Kennedy conducted a 7-year retrospective study to assess the survival rates and causes for failures for bilateral maxillary and mandibular space maintainers cemented in children aged 7-13 years old. Failure-related causes were categorized as follows: cement loss, solder breakage, bent archwire, split band, soft tissue lesions, eruption interference, complete loss, or other (Moore &

Kennedy, 2006). From the 482 appliances placed, they found that the success rate for the lingual arch was 71% and the mean survival time was 20 months, and for the Nance appliance it was 75% and 23 months, respectively (Moore & Kennedy, 2006). Of all, 24% failed and more than half of these failures (60%) were due to cement loss (Moore & Kennedy, 2006). Solder breakage and band splitting both resulted in another 10% of failures (Moore & Kennedy, 2006). There was, however, no significant difference in the failure rates between the lingual arch and Nance (Moore & Kennedy, 2006). Fathian et al., (2006) followed a similar protocol to that of Moore and Kennedy; however, they assessed the survival rates and causes of failures for both unilateral and bilateral lab fabricated space maintainers placed by one pediatric dentist in primary and mixed dentition over the 7-year study period. The success rates for all combined- the band and loop, lingual arch and Nance appliances-were slightly lower than those reported by Moore and Kennedy, and these ranged from 55-64% (Fathian et al, 2006). The mean survival time ranged within 26-27 months (Fathian et al, 2006). There were no significant differences amongst different types of appliances in terms of success rates or survival times. Similar to Moore and Kennedy (2006), the most frequent reason for failure was cement loss, surprisingly higher for the unilateral appliances (Fathian et al, 2006). Also, the overall failure rate was slightly higher (34%) (Fathian et al, 2006). This higher failure rate could be attributed to the fact that in the Fathian et al. study, subjects were in early mixed dentition, thus patients of this age could have been less cooperative, their molars may have been more difficult to band, and the appliances had to remain in their mouths for a longer period. Both studies observed that appliances that needed to be remade or recemented had a higher failure rate (Fathian et al, 2006; Moore & Kennedy, 2006).

1.7 Medical decision making

Understanding the decision-making process in health care can be quite daunting as multiple factors need to be considered when deciding a clinical course for a patient (Lipshitz & Strauss, 1977). However, this decision-making process can be made clearer when it is divided into three fundamental domains (Lingard et al., 2003). The first domain is scientific knowledge. This, although apparent, refers to the information published in the medical literature that is not dominated by subjective beliefs; in medicine, it is about understanding the relevant physiology and anatomy (Lingard et al., 2003). The second domain is a skill, which refers to developing the competence to perform specific procedures (Lingard et al., 2003). The last domain is attitude. Attitude is the stance a person has- it is our stored evaluations or feelings towards a specific object (the object being a person, goal, position, issue, behaviour or idea) (Lingard et al., 2003; Sanbonmatsu et al., 2004). Sanbonmatsu et al. (2004) explained that although attitude is a significant part of our decision making, there is a lack of familiarity with its effects on the process. He suggested that decisions that lead to action are made by evaluating and appraising the situation, the responses, and the outcomes of different choices. An attitude is a feeling that guides these individualized appraisals and assessments (Sanbonmatsu et al., 2004). These feelings can be affected by the accessibility of choices since options that are more readily accessible can be more favourable. Also, those options that are more routine, and more frequently have positive outcomes will have more favourable attitudes (Sanbonmatsu et al., 2004). Furthermore, feelings about the quality of one's thinking can alter a decision, since having a negative appraisal of one's thought process will force him/her to rethink and consider additional information (Sanbonmatsu et al., 2004). This leads us to uncertainty, a type of attitude extensively studied by medical sociologist Renee Fox (Fox, 1980). Uncertainty is the block or

delay of action due to a sense of doubt (Lipshitz & Strauss, 1977). Since medical knowledge is flooded with unknowns and is forever expanding, it is inherently uncertain (Fox, 1980). However, the source of this uncertainty is not only from our limitations with the present knowledge, but it is also from our inabilities to master the information that is present, and our difficulties with distinguishing between our lack of knowledge and the present medical knowledge (Fox, 1980; Katz, 1984). Fox examined medical uncertainty when medical residents started to apply the knowledge they acquired from school into clinical situations. Noting that the uncertainty rose from problems with diagnosis, ambiguous treatment, unpredictable patient responses, limited knowledge, and the difference in physician's values and attitudes (Fox, 1980; Geller et al., 1990). Thus, uncertainty does become an obstacle to medical decision-making (Lipshitz & Strauss, 1977).

1.8 KAP model

Relevant issues faced by health care practitioners can be measured through the use of surveys (Pit et al., 2014). "*Understanding and measuring GP's knowledge, attitudes, behaviours, practices and their views on solutions to health care issues are paramount to improve the quality of health care*" (Pit et al., 2014). The most widely utilized cross-sectional survey model is the Knowledge, Attitude, Practice (behaviour) or KAP model (Launiala, 2009). It has been used in population studies since the 1950s, and gained popularity for its use in health care in the 1970s to examine health care practices and behaviours, especially by the World Health Organization (WHO) (Launiala, 2009). Its popularity stems from the fact that it provides both qualitative and quantitative information (Gumucio et al., 2011). The KAP model can measure the extent of a

situation- identifying what is known about a subject, and how people behave, or as Kailyaperumal (2004) says: "[*It] serves as an educational diagnosis of a community*" (Gumucio et al., 2011). Thus, the survey allows for use in testing hypotheses (Gumucio, 2011). Furthermore, it can measure the effectiveness of health education and its effects on behaviour (Gumucio, 2011). It is also easy to design, interpret, and makes it possible to generalize the findings to larger populations (Launiala, 2009; Gumucio et al., 2011).

The knowledge aspect of the survey model assesses the understanding of the health-related topic (Gumucio et al., 2011). It is based on scientific facts and concepts (Gumucio et al., 2011). Next is the attitude aspect, which focuses on the position a person has towards a specific situation. It is the construct that cannot be observed directly and is considered the intermediate between the situation and the response (Gumucio et al., 2011). For a particular situation, multiple practices or responses are possible, but our attitude is what encourages one to choose one practice over another (Gumucio et al., 2011). Certainly, measuring attitude is the most difficult and most criticized since formulations of questions can potentially manipulate someone towards certain answers (guiding questions) (Launiala, 2009). Also, people may not answer truthfully, but instead respond based upon what is socially desirable (Launiala, 2009). Lastly, of course, is the practice, or the observable behaviour that will demonstrate both a person's knowledge and attitude (Gumucio et al., 2011; Kailyaperumal, 2004).

Study rationale

The rationale for the current study was to acquire a better understanding of space maintenance practices of dental practitioners in private practice using the KAP model since the emphasis was not placed on space maintenance during my dental school experience.

Study objectives

To examine if there are differences in planning space maintenance between pediatric dentists and general dentists.

Study hypotheses

H1: There are differences in treatment planning between pediatric dentists and general dentists.

H2: General dentists are reluctant to provide space maintenance treatment for pediatric patients.

Chapter 2: Methods

2.1 Study design

The present study was approved by the Behavioural Ethics Board at the University of British Columbia, Vancouver, Canada (H18-02774.).

An online survey was conducted to assess both general and pediatric dentists about space maintenance treatment planning for pediatric patients using the KAP (Knowledge, Attitudes, and Practices) model. General and pediatric dentists were surveyed over four months (February 2019 to May 2019) with a questionnaire that included a total of three case-based scenarios supported by both open- and closed-ended questions. Although the selected cases presented to both types of dental practitioners were identical, two separate surveys were developed; one for the general dentists and the other for the pediatric dentists.

2.2 Sample selection and its size

The census sampling framework (to invite all eligible) was chosen for the present study as data collection through online surveys does not incur any additional costs, and the data collected will be more representative. The 2018/2019 Annual Report generated by the College of Dental Surgeons of BC (CDSBC) has 3,110 general dentists and 66 pediatric dentists registered. All general dentists (n= 1,640) and pediatric dentists (n= 41) with publicly available email addresses on the CDSBC website were invited to participate. General dentists that do not treat children were excluded from the current study.

2.3 Questionnaire development and it's pilot testing

The questionnaire for the general dentists consisted of 32 questions; three of which were open-ended. The questionnaire for the pediatric dentists was similar, but it had one less question than the one designed for the general dentists. Since one of the exclusion criteria was to exclude dentists who do not treat pediatric patients, the first question in the questionnaire for general dentists was to inquire whether they treated children or not. Needless to say, this was not necessary for the pediatric dentist survey. The content of the questionnaire consisted of cases that are likely encountered by dentists in their private practices. The subsequent six demographic questions inquired about age, gender, practice experience (number of years in practice and type of practice), and different aspects of training (graduating dental school/residency, and orthodontic/pediatric study club membership).

Furthermore, three cases with corresponding questions were chosen. Originally four individual cases were developed: Case 1. Primary dentition with the loss of a left primary mandibular first molar (tooth#7.4); Case 2. Primary dentition with loss of a left primary mandibular second molar (tooth #7.5); Case 3. Late mixed dentition with premature loss of a left primary mandibular canine (tooth #7.3); and Case 4. Mixed dentition (permanent first molars, centrals, and laterals in occlusion) with loss of the left maxillary primary first molar and both mandibular primary first molars (teeth #6.4, 7.4 and, 8.4). Charts of patients that received space maintenance treatment by pediatric dental residents at the University of British Columbia from 2012-2018 were reviewed to find cases appropriate for the current study. The billing codes for extractions of primary canines and molars, and cementation of fixed unilateral and bilateral space maintainers were used to generate a spreadsheet of patients treated by the pediatric graduate program that received

space management. Subsequently, patient charts available in the electronic patient records at UBC were reviewed to select the cases for the current study.

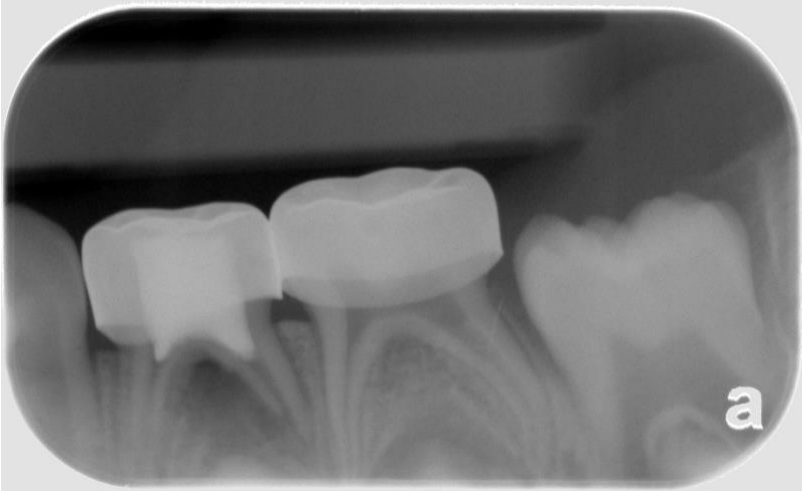
From the chart review, a primary dentition case was included in the study if a good quality periapical radiograph was taken. For the cases involving the loss of the primary first and second molars, it was necessary that the periapical radiographs exhibited both the developing succadaneous teeth and restorable or intact adjacent teeth. In the case of the loss of the primary second molar, the developing permanent first molar needed to be visible radiographically, showing no signs of ectopic eruption, and the occlusal surface needed to be around the alveolar bone level.

For the mixed dentition cases, a case was chosen from the chart review if a good quality panoramic radiograph was available. In both mixed dentition cases, the case was not included if the panoramic radiograph showed any congenitally missing teeth, ectopic eruptions, supernumeraries or any other dental anomalies. Also excluded were panoramic radiographs that may suggest the need for serial extractions.

The following cases were tested in the pilot study:

1. **Case 1** presented a patient in primary dentition who needed an extraction of a left primary mandibular first molar:

   "*A 4-year 5- month old healthy female presents to your office with deep decay on the left mandibular first primary molar (tooth #74). Her mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below. You have decided to extract the tooth."*



The dentist was then asked how they would manage the extraction space and the following response categories were presented:

a. I would not manage the space at this time (space does not need to be managed at this time).

b. Plan for a band-and-loop space maintainer.

c. Refer to a pediatric dentist for space management.

d. Consider an orthodontist for a consultation.

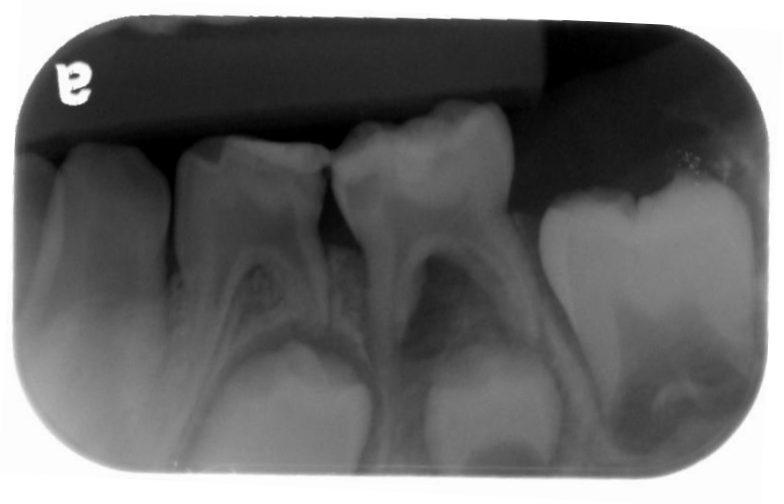
The next question was open-ended and asked the dentist about what clinical factors he/she will consider when planning the space management for this patient.

If the dentist decided to manage the space with a band-and-loop, they were asked how they would further proceed:

a. *Fit a band on the 75, and then send an impression for a lab fabricated space maintainer*
b. *Send an impression for a lab fabricated space maintainer without band fitting the 75*
c. *Place an in-office band and loop on the 75*

2. **Case 2** presented a patient in primary dentition who needed extraction of a left primary mandibular second molar:

   "A 4-year 8- month old healthy male presents to your office with deep decay on the left mandibular second primary molar (tooth #75). His mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below. You have decided to extract the tooth."



The dentist was then asked how they would manage the extraction space:

a. *I would not manage this space at this time*
b. *Immediately place a distal shoe space maintainer with a band on tooth #74*
c. *Wait for tooth #36 to erupt and place a band and loop with a band on tooth #36*
d. *Wait for tooth #36 to erupt and place a band and loop with a band on tooth #74*
e. *Wait for tooth #36 and #46 to erupt and place an LLHA*
f. *Refer to a pediatric dentist for space management*
g. *Consider an orthodontist for a consultation*

The dentist was then asked an open-ended question about the clinical factors they considered when planning the space management for this patient.

3. **Case 3** presented with a patient in mixed dentition with space loss in quadrant 3:

"A cooperative 10-year-old healthy male presents to your office for a new patient exam. He is in late mixed dentition, has class I malocclusion, 2 mm overjet, and 40% overbite. Concerning the mandibular anterior sextant, you notice the presence of all the lower permanent incisors, and the right permanent canine (tooth#43). You decide to take a panoramic radiograph, which appears below."

The dentist was asked how they would proceed:

a. *Never paid attention for a potential spacing concern*
b. *Place a Lower Lingual Holding Arch*
c. *Refer to a pediatric dentist for space management*
d. *Consider an orthodontist for a consultation*

4. **Case 4** presented with a patient in mixed dentition with the extraction of almost all the primary first molars:

"A 9- year 3- month old healthy female presents to your office with decay on the left and right mandibular first primary molars (teeth #74 and 84), left maxillary first primary molar (tooth #64) and left maxillary second primary molar (tooth #65). She has class I occlusion, with mild upper crowding. The panoramic radiograph appears below. All carious primary first molars are deemed unrestorable.

You have decided to extract teeth #64, 74, and 84, and to restore tooth #65."

The dentist was then asked how they would proceed to manage the space post-extraction:

a. *Immediately place Band-and-Loop space maintainers for all extracted spaced*
b. *Immediately place a Lower Lingual Holding Arch and a Band-and-Loop for quadrant 6*
c. *Immediately place a Lower Lingual Holding Arch, and a Nance appliance*
d. *Monitor space during regular recalls with no space maintainer*
e. *Refer to a pediatric dentist for space management*
f. *Consult an orthodontist for a consultation*

The dentist was then asked an open-ended question about the clinical factors they considered when planning this patient's space management

Each case also included three to four knowledge-testing questions pertaining to the specific case. To assess the influence of the dentists' attitudes towards space maintenance in their treatment planning, each case presented with a series of 5-point Likert scale questions assessing their level

of agreement to statements regarding diagnosis, treatment procedures, professional training, and other factors that may influence their decision making. To acquire reliable and valid data, the order of the cases in the questionnaire was randomized, and answering of questions was optional.

The questionnaire also included 4-point Likert scale questions inquiring about the dentists' general and space maintenance practices. More specifically, the frequency at which they treat different pediatric dentition types accepted insurance types, placed different space maintainers and band fitted those space maintainers. Respondents were also invited to write their comments at the end of the survey.

The questionnaire for the pediatric dentists was similar to the one for the general dentists. However, this questionnaire had some minor differences, such as asking questions about dental residency, and removal of the option to refer to a pediatric dentist for space management.

The research committee reviewed the potential cases selected through the chart review and assisted in deciding which four cases were suitable for the study. They also reviewed the questionnaire for content, completeness, and clarity. The UBC Qualtrics Survey Tool was used to develop an electronic questionnaire that also included a cover letter introducing the study to the dentists. The survey was piloted with ten general dentists and three pediatric dentists. Common comments from the pilot study were that dentists were losing motivation to complete the survey due to its length. Thus, with the guidance from the research committee, it was decided to remove one case to improve the likelihood of completion by the respondents. Subsequently, Case 4, the mixed dentition case with the loss of the primary first molars was removed. Also, to

entice respondents to participate and complete the survey, coffee gift cards were added as incentives.

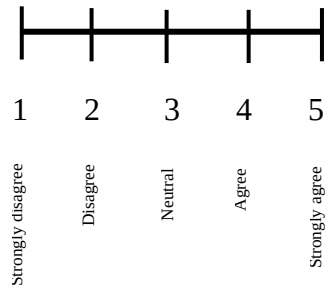
2.4 Data collection

Using the UBC Qualtrics Survey tool, questionnaire links were attached to each invitation email, which explained the purpose of the study, the estimated time of completion and the incentive to complete the survey. The initial emails were sent out in February 2019. For the dentists that did not respond to the survey, reminder emails were sent at four weeks and eight weeks. To improve the response rate, general dentists practicing in British Columbia were also recruited at the Pacific Dental Conference in Vancouver in March 2019 at the UBC Dentistry booth.

2.5 Statistical analyses

Both descriptive and statistical analyses were performed using the IBM SPSS Version 25.0 Software. Dependent variables (study outcomes) were total knowledge and attitude score, and the space management plan for each case (i.e. Case 1, Case 2 and Case 3). The mean total knowledge score was acquired as an average from the total of 10 correctly answered knowledge questions. Each question had a correct answer, and added a score of one to the dentists' total score, with a maximum score being ten. For the mean attitude agreement score, each dentist selected their level of agreement on the 5-point Likert scale to the statements presented separately for each case (image below). The average of the numbers selected for a particular statement calculated its mean attitude agreement score. The independent variable was the type of dentist (general vs. pediatric dentists). Chi-square or Fischer's exact for categorical variables and

independent sample t-test or its non-parametric equivalent Mann Whitney U test for numerical variables were used for the bivariate quantitative analyses. The level of statistical significance for all tests was set at $p<0.050$.



Likert scale responses for the attitude-related statements

Chapter 3: Results

3.1 Description of the study sample

3.1.1 Demographic characteristics of the general and pediatric dentists

A total of 1640 emails were sent to general dentists registered by the College of Dental Surgeons of British Columbia, and of those emails, 1585 successfully reached their recipients. Five of the recipients either emailed directly to opt-out of the survey since they did not treat children, or responded in the survey that they do not treat children in their private practices. Thus, they were excluded from the study sample. Additionally, a total of 25 general dentists were recruited at the 2019 Pacific Dental Conference in Vancouver, British Columbia. The final response rate for the general dentists was 20.3 % (n=320). As participants were permitted to leave questions unanswered, and due to the length of the questionnaire, 53 respondents (16.6%) had some missing responses. For our pediatric dentist study sample, a total of 41 emails were sent to pediatric dentists whose emails were also made available by the College of Dental Surgeons of British Columbia. All emails were accepted by the Qualtrics survey tool and 23 pediatric dentists completed the questionnaire. Their response rate was 56.1% (n=23). All pediatric dentists answered all questions, except for one missing response from one of the respondents. Analyses were conducted on questionnaires with less than 5 missing responses.

Table 1 shows the demographic and general practice characteristics for both the general and pediatric dentists included in our study. In the general dentists' group, more than half of the respondents were males (60.6%, n=192), and graduated from Canadian dental schools (75.3%, n=241). The age distribution was almost comparable amongst the age groups (approximately

20%), except a smaller portion of respondents were over 66 years old (8.1%). From the 2018/2019 CDSBC Annual Report, the gender (64.1 % males), and age distributions across the province of British Columbia were similar to those of our sample (CSDBC Annual Report, 2019). In terms of general practice characteristics, the majority of respondents were either solo practitioners (40.1%, n=128) or associates (39.7%, n=127), and almost half of them (48.4%, n=155) had over 20 years of clinical experience. Most of the respondents were not members of any orthodontic or pediatric study clubs (84.1%, n=269). In comparison, almost half of the pediatric study group was within the 25 to 35 years old (43.5%, n=10), or 36 to 45 years old (39.1%, n=9) age range. The majority were females (60.9%, n=14) and had less than ten years of clinical experience (69.5%, n=16). In terms of the practice type, almost half of the respondents were either associates (43.5%, n=10) and a smaller proportion were solo practitioners (34.8%, n=8). Similar proportions of pediatric dentists were trained in Canada (43.5%, n =10) and the United States (52.2%, n=12), and almost all of the respondents were not members of pediatric or orthodontic study clubs (91.3%, n=21).

Table 1. Demographic and practice-related characteristics of the study sample

Demographic characteristics	General dentists	Pediatric dentists
	n (%)	n (%)
Age	n= 320 (100)	n=23 (100)
25-35	70 (21.9)	10 (43.5)
36-45	77 (24.1)	9 (39.1)
46-55	81 (25.3)	3 (13.0)
56-65	66 (20.6)	0 (0)
66+	26 (8.1)	1 (4.3)
Gender	n=317 (100)	n=23 (100)
Male	192 (60.6)	9 (39.1)
Female	125 (39.4)	14 (60.9)
Years of practice	n=319 (100)	n=23 (100)
<5	55 (17.2)	9 (39.1)
5-10	35 (10.9)	7 (30.4)
10-20	74 (23.1)	3 (13.0)
20+	155 (48.4)	4 (17.4)
Practice type	n=319 (100)	n=23 (100)
Solo	128 (40.1)	8 (34.8)
Partnership	47 (14.7)	2 (8.7)
Associate	127 (39.7)	10 (43.5)
Other	17 (5.3)	3 (13.0)
Dental school location	n=318 (100)	n=23 (100)
Canada	241 (75.3)	10 (43.5)
US	26 (8.1)	12 (52.2)
Other	51 (15.9)	1 (4.3)
Members of an orthodontic or pediatric study club	n=320 (100)	n=23 (100)
Yes	51 (15.9)	2 (8.7)
No	269 (84.1	21 (91.3)

3.1.2 Pediatric practices of the general and pediatric dentists

Figure 6 illustrates that the general dentists mainly provided dental care for pediatric patients with private insurance coverage (72.5%), but only occasionally for those with a ministry plan (39.1%). In contrast, the majority of the pediatric dentists provided dental care for pediatric patients with the ministry (78.3%) or private insurance plans (87.0%) (Figure 7). Figures 8 and 9 display the proportions of pediatric patients seen by general and pediatric dentists, respectively. More than half of general dentists reported that they frequently provide dental care for pediatric patients in primary (60.3%), early mixed (63.8%) and late mixed (64.4%) dentition. All pediatric dentists reported that they frequently provide dental care for all dentition types.

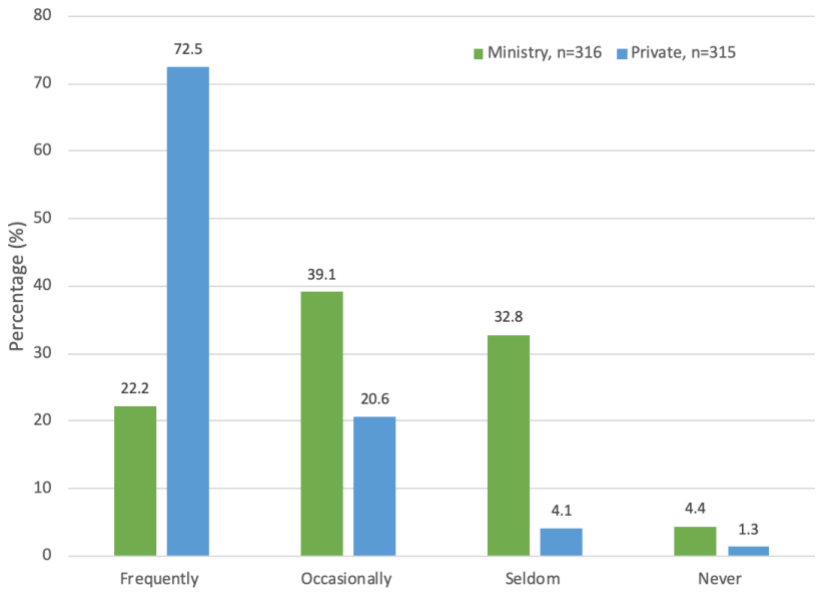


Figure 6. Insurance coverage of the pediatric patients treated by the general dentists

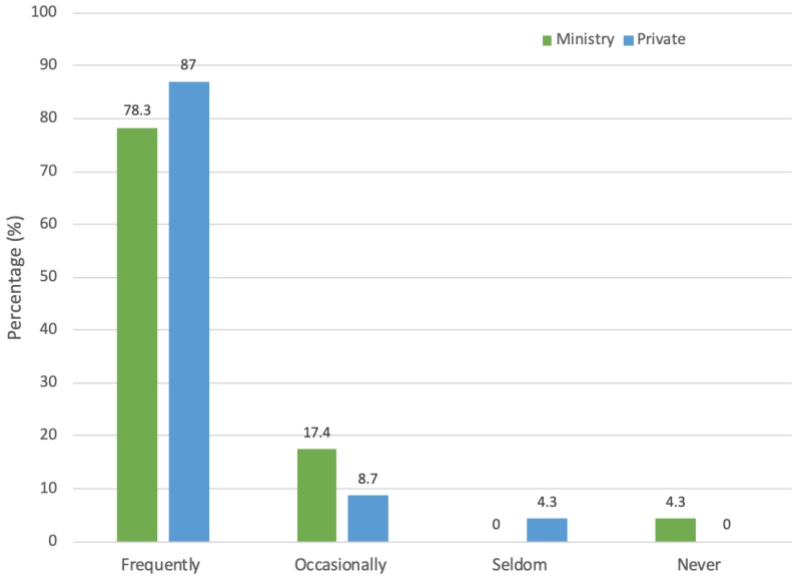


Figure 7. Insurance coverage of the pediatric patients treated by the pediatric dentists (n=23)

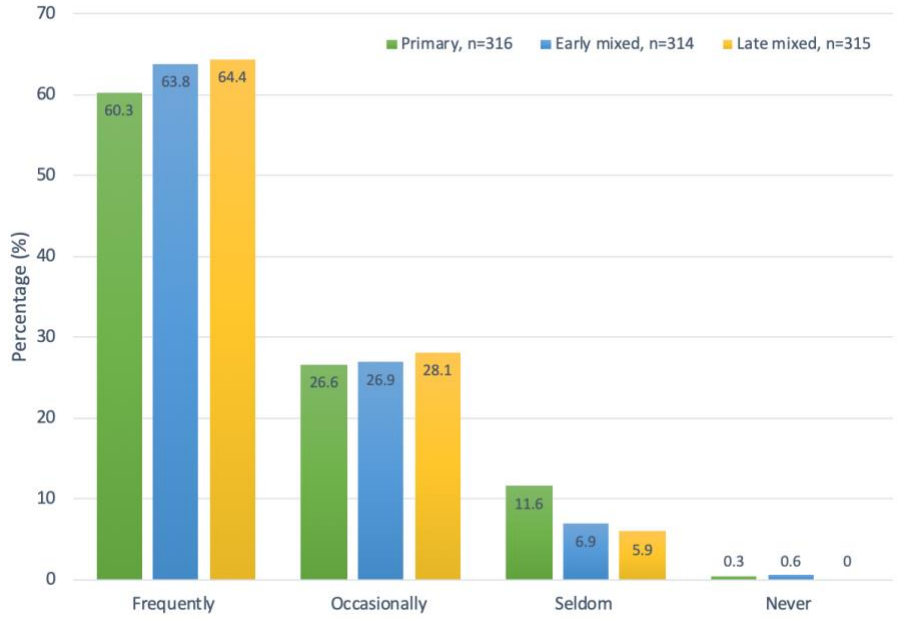


Figure 8. Proportions of pediatric patients seen by general dentists in an average month

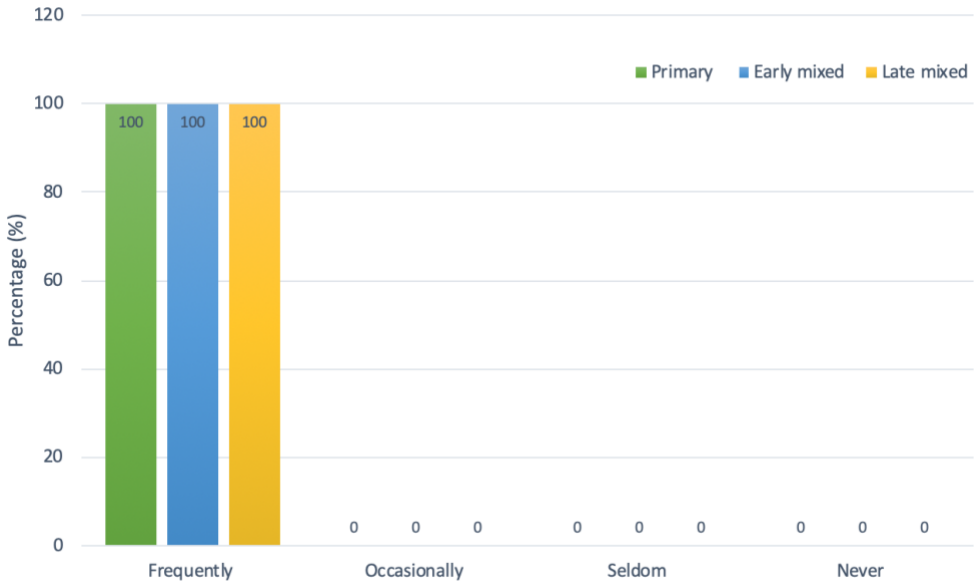


Figure 9. Proportions of pediatric patients seen by pediatric dentists in an average month, n=23

3.1.3 Space maintenance practices of the general and pediatric dentists

Figures 10 to 14 compare the space maintenance practices between general and pediatric dentists; each figure focusing on a particular type of space maintenance. In terms of space loss discussions with a patient's guardian after a primary molar extraction, the majority of general dentists (81.2%) and all pediatric dentists have these discussions (Figure 10). Concerning the band and loop space maintainer placement when the permanent molars have not erupted, almost a third of general dentists frequently place band and loops (27.2%), whereas almost half of the pediatric dentists frequently (43.5%) or occasionally (47.8%) place these appliances (Figure 11). Figure 12 shows the frequency of banding fitting between the groups. Almost two-thirds of the pediatric dentists (60.9%) band fit their space maintainers as compared to less than a quarter of general dentists that frequently (19.0%) fit bands either on their own or by a staff member.

Furthermore, as presented in Figure 13, less than a quarter of general dentists frequently (5.8%) or occasionally (15.7%) place distal shoe appliances in contrast to almost half of the pediatric dentists that frequently (26.1%) or occasionally (21.7%) place these appliances for their patients when the permanent first molar is unerupted. Lastly, pediatric dentists more frequently place lower lingual holding arch appliances than general dentists (Figure 14).

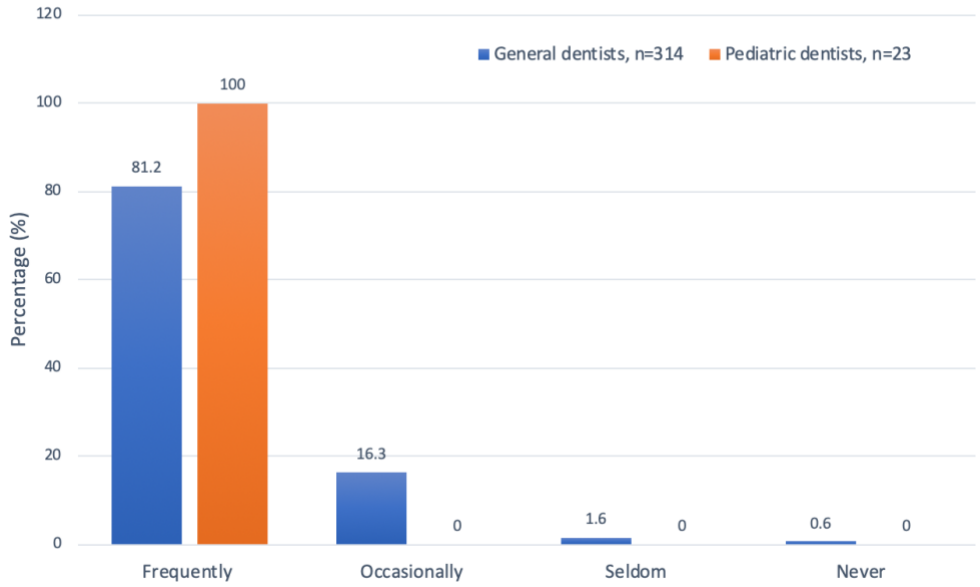


Figure 10. Comparison between general and pediatric dentists on the frequency of discussing space loss with the patients' guardian after extraction of a primary molar

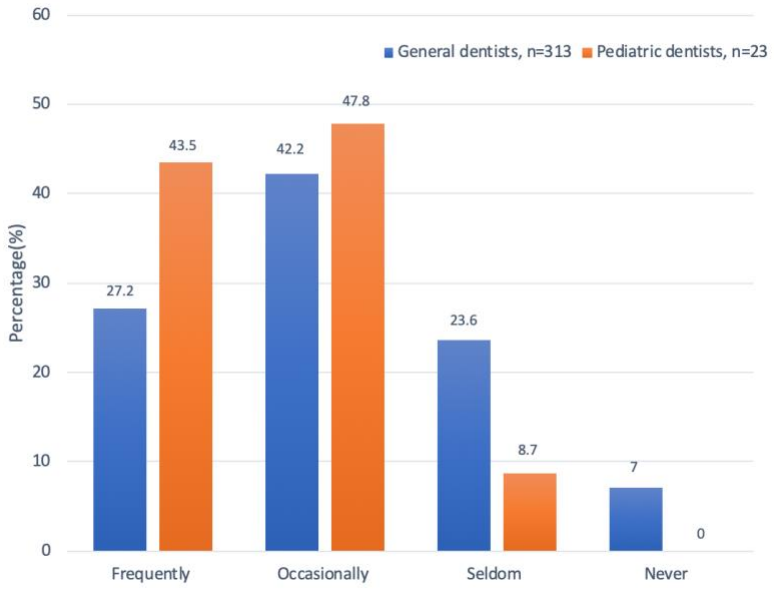


Figure 11. Comparison between general and pediatric dentists on the frequency of placing a band and loop appliance when the permanent first molar is unerupted

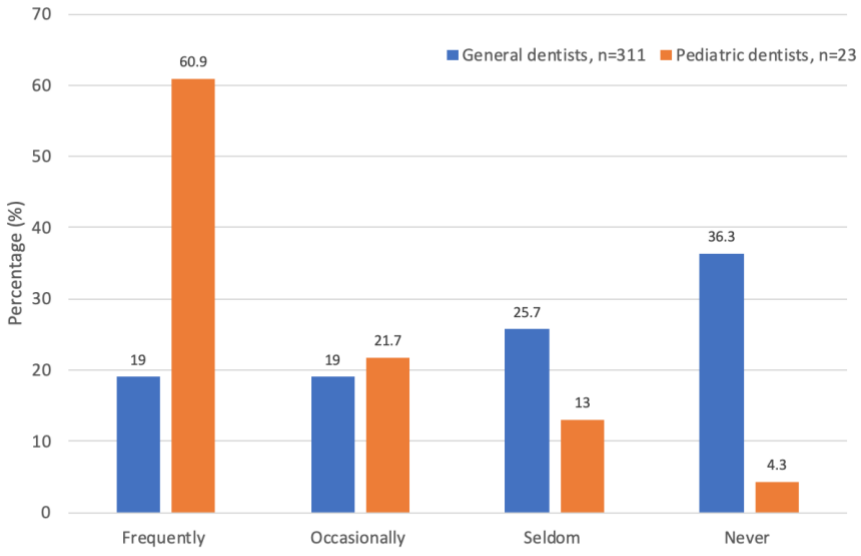


Figure 12. Comparison between general and pediatric dentists on the frequency of band fitting space maintainers (by dentists or their staff)

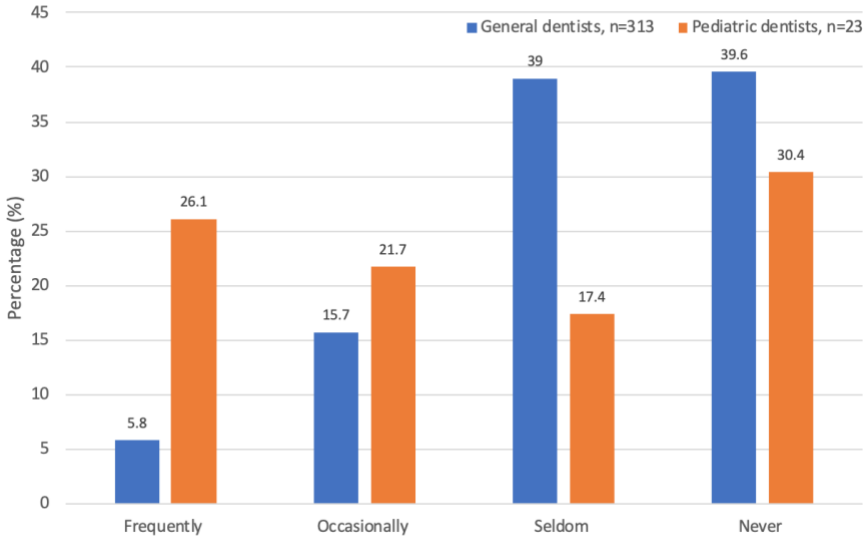


Figure 13. Comparison between general and pediatric dentists on the frequency of placing a distal shoe appliance when the permanent first molar is unerupted

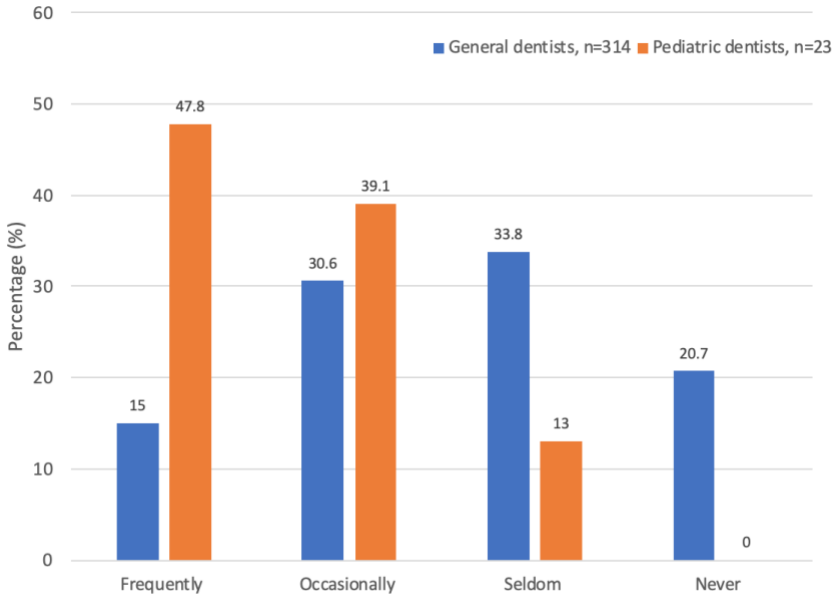


Figure 14. Comparison between general and pediatric dentists on the frequency of placing a lower lingual holding arch appliance

3.2 Mean total knowledge scores

As presented in Table 2, there was a marginally non-significant difference (p=0.051) in the mean total knowledge scores between general dentists (5.5 $\pm$ 1.6) and pediatric dentists (6.2 $\pm$ 1.4).

The boxplots in Figure 15 illustrate that the distribution of total knowledge scores ranged from 2 to 9 for the general dentists and from 4 to 9 for the pediatric dentists. One-quarter of the general dentists (a lower quartile in a box plot) had a wider distribution of lower knowledge scores than those of the pediatric dentists; 25% in both groups had knowledge scores below 5. None of the pediatric dentists had a total knowledge score of less than 4. The range of the overall distribution of the total knowledge scores for the pediatric dentists was narrower than that of the general dentists.

Figure 16 also shows the overall distribution of the correctly answered knowledge questions for each case and compares knowledge between general and pediatric dentists. Case 1 was the most poorly answered by both dentist groups. Case 2 had the most correctly answered knowledge questions by the pediatric and general dentists. For the majority of the questions, pediatric and general dentists had similar proportions of correct answers.

Table 2. Comparison of mean total knowledge scores between general dentists and pediatric dentists

Total Knowledge Scores		Significance#
General dentists n=304 mean (sd)	**Pediatric dentists n=23 mean (sd)**	
5.5 (1.6)	6.2 (1.4)	0.051

Independent sample t-test

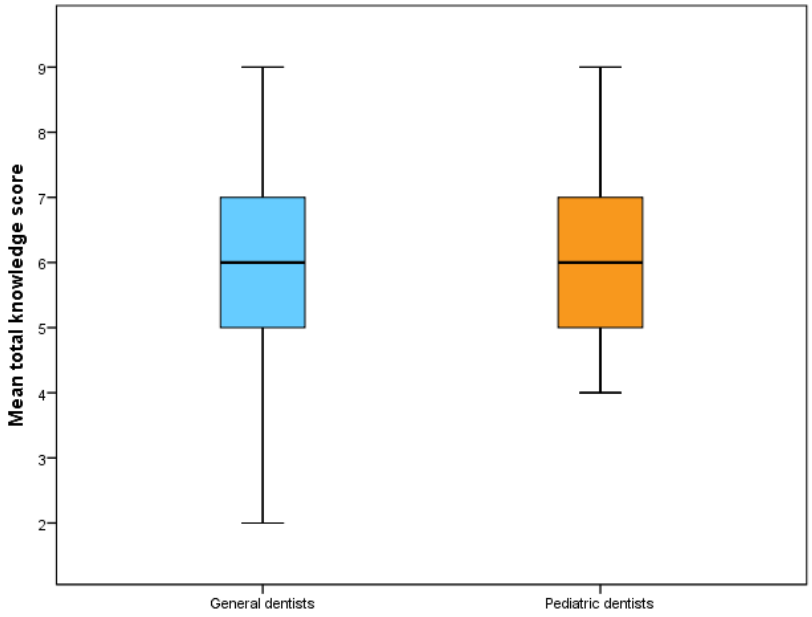


Figure 15. Comparison of the mean total knowledge scores between general and pediatric dentists

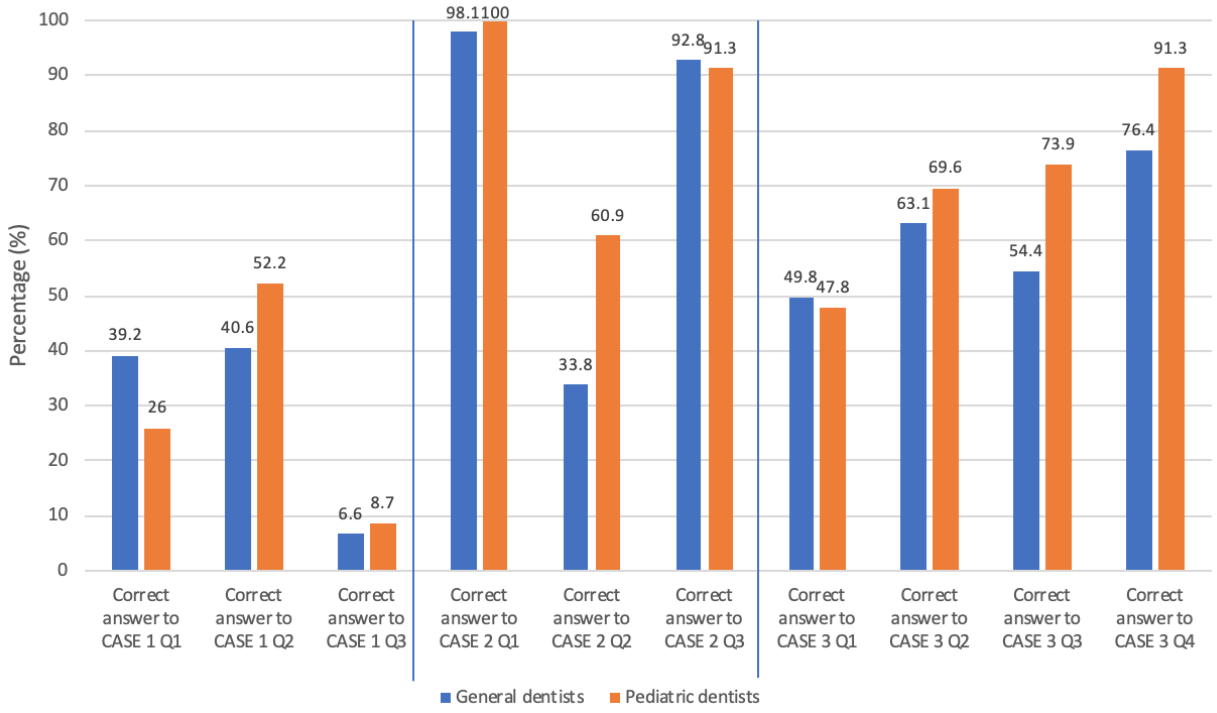


Figure 16. Comparison of correctly answering the knowledge questions for all 3 cases between general and pediatric dentists

3.3 Space maintenance cases

3.3.1 Case 1: Loss of tooth #7.4 in primary dentition

As shown in Figure 17, the majority of the general dentists (76.7%) and all pediatric dentists (100%) chose to manage the space from the extraction of tooth #7.4 with a band and loop appliance. Although there were statistically significant differences between the general dentists and pediatric dentists for managing the space post extraction of tooth #7.4 (Table 3). General dentists were significantly less likely to manage the 7.4 space after the tooth extraction (p=0.003) as compared to the pediatric dentists who were significantly more likely to place a band and loop appliance (p=0.007). Of those dentists that decided to place a band and loop appliance (Table 4),

there were statistically significant differences between the two groups of practitioners in regards to placing a band fitted in-office band and loop on the tooth #7.5 ($p < 0.001$), and a lab fabricated space maintainer without band fitting ($p < 0.001$). Figure 18 illustrates that pediatric dentists were more inclined to place the in-office space band and loop appliances (52.2%), whereas the general dentists tended to insert lab fabricated space maintainers without band fitting (43.3%).

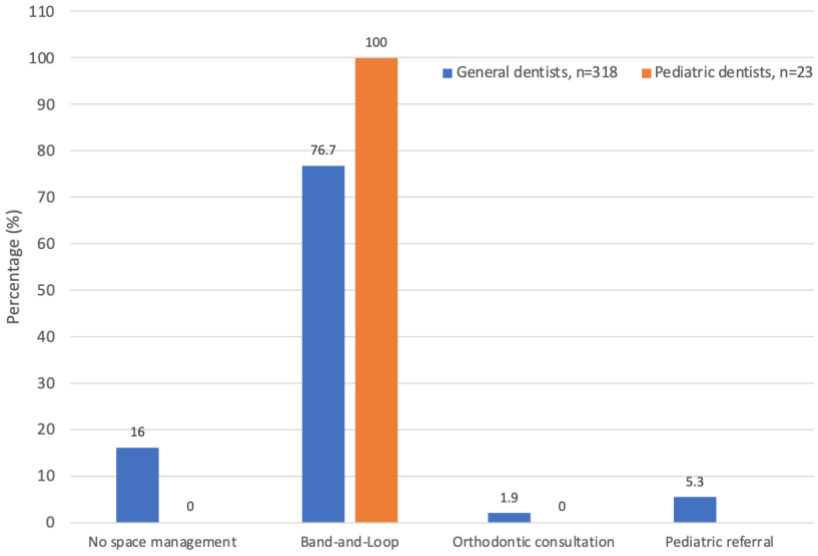


Figure 17. Comparison between general and pediatric dentists regarding their management of the tooth #7.4 space in primary dentition

Table 3. Comparison between general and pediatric dentists of managing the tooth #7.4 space in primary dentition

Case 1 management treatment plan	General dentists	Pediatric dentists	Significance#
	Yes n (%)	Yes n (%)	
Loss of tooth #7.4 in primary dentition	n= 318 (100.0)	n= 23 (100.0)	
No space management	51 (16.0)	0 (0.0)	0.033
Band and loop on tooth #7.5	244 (76.7)	23 (100.0)	0.007
Orthodontic consultation	6 (1.9)	0 (0.0)	1.000
Refer to a pediatric dentist	17 (5.3)	No response	N/A

#Chi square test with Yates correction or Fischer's Exact test. N/A: Not applicable

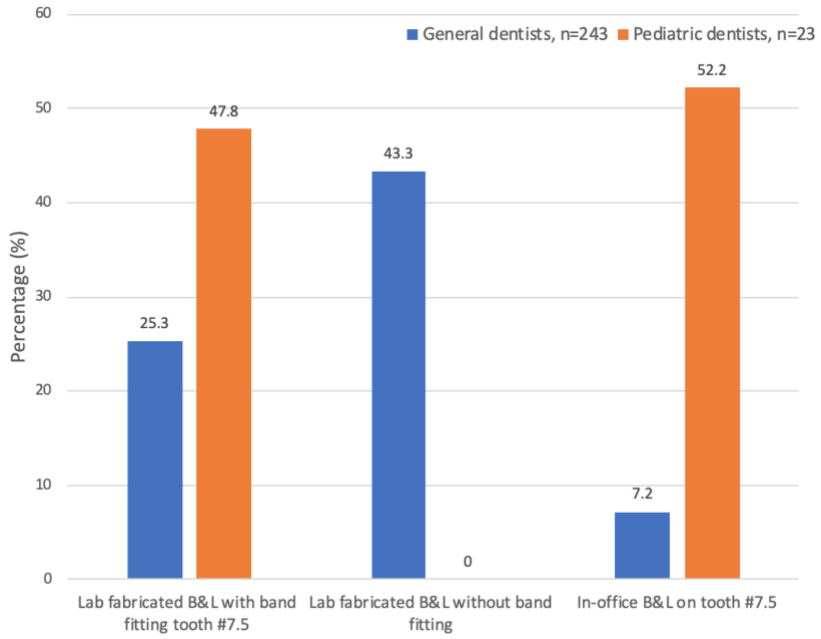


Figure 18. Comparison between general and pediatric dentists regarding their band fitting technique if a band and loop (B&L) is chosen

Table 4. Comparison between general and pediatric dentists with regards to band fitting techniques

Case 1 management treatment plan	General dentists	Pediatric dentists	Significance#
	Yes n (%)	Yes n (%)	
Band fitting technique if band-and-loop was chosen	n= 243 (100.0)	n= 23 (100.0)	
Band fit on the 75 and place a lab fabricated SM	81 (25.3)	11 (47.8)	0.243
Send impression for a lab fabricated SM without band fitting the 75	139 (43.3)	0 (0.0)	< 0.001
Place an in-office band and loop on the 75	23 (7.2)	12 (52.2)	< 0.001

#Chi square test with Yates correction or Fischer's Exact test

3.3.1.1 Knowledge regarding case 1

Table 5 compares both groups with regards to their answers to the knowledge questions pertaining specifically to this case. An asterisk was placed next to each correct answer. There were no statistically significant proportional differences concerning any of the three knowledge-related questions (p>0.050). More than half of the pediatric dentists (65.2%, n=15) and 42.9% (n=137) of the general dentists selected 9-11 years for the estimated eruption of a mandibular first premolar, which differs from the AAPD's estimation of 10-12 years. Almost half of both dentist groups (40.6%, n=128 for general dentists and 52.2%, n=12 for pediatric dentists) correctly identified that early extraction of the primary first molar would delay the eruption of the succedaneous permanent tooth. Only 6.6% (n=21) of pediatric dentists and 8.7% (n=2) of general dentists identified that the distal movement of the primary canine leads to most of the space loss after the extraction of the primary mandibular first molar. The percentages for both groups correctly answering the three knowledge questions for case 1 are illustrated in Figure 19.

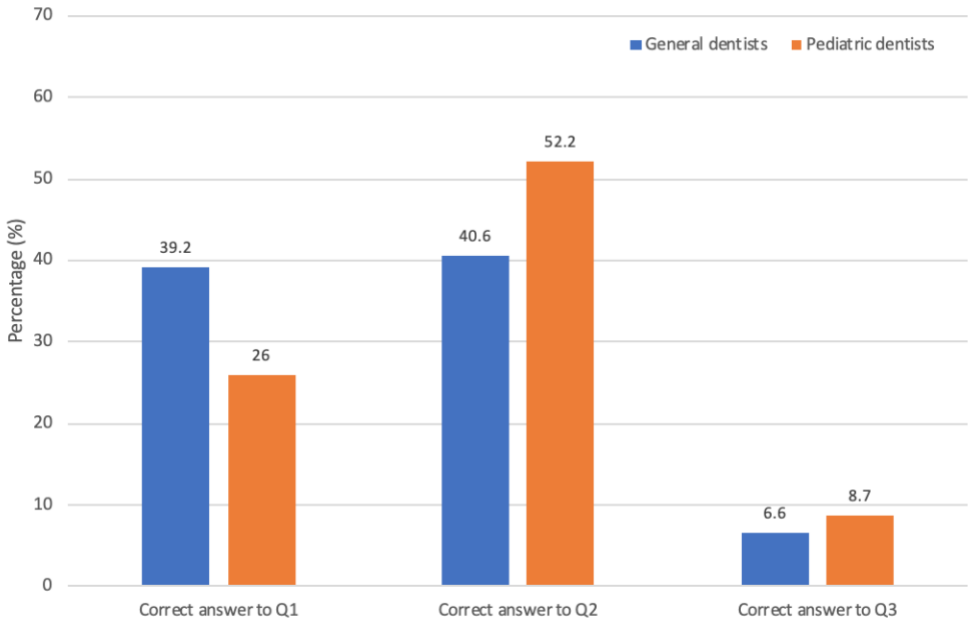


Figure 19. Comparison of correctly answering the knowledge questions for case 1 between general and pediatric dentists

Table 5. Knowledge regarding Case 1 – comparisons between general and pediatric dentists

Case 1: Knowledge	General dentists	Pediatric dentists	Significance#
	n (%)	n (%)	
Q1. At what age is it expected for a lower first premolar to erupt?	n = 319 (100.0)	n= 23 (100.0)	
8-10 years old	52 (16.3)	2 (8.7)	0.503
9-11 years old	137 (42.9)	15 (65.2)	0.063
10-12 years old*	125 (39.2)	6 (26.0)	0.305
11-13 years old	5 (1.6)	0 (0)	1.000
Q2. Will extracting a non-restorable first primary molar in the primary dentition affect the eruption of the successor permanent tooth?	n= 318 (100.0)	n = 23 (100.0)	
Yes, it will accelerate its eruption	155 (48.7)	11 (47.8)	0.932
Yes, it will delay its eruption*	128 (40.6)	12 (52.2)	0.367
No, it will not affect the eruption of the succedaneous tooth	34 (10.7)	0 (0.0)	0.147
Q3. Space loss from the extraction of a mandibular primary first molar in primary dentition is mostly the result of:	n= 319 (100.0)	n= 23 (100.0)	
Mesial movement of the primary second molar	249 (78.0)	21 (91.3)	0.215
Distal movement of the primary canine*	21 (6.6)	2 (8.7)	0.696
Space loss is insignificant for loss of a primary first molar in primary dentition	49 (15.4)	0 (0.0)	0.057

#Chi square test with Yates correction or Fischer's Exact test.

* Correct answer

3.3.1.2 Attitudes regarding case 1

Table 6 compares the mean attitude scores between the general and pediatric dentists regarding specific attitudes that may influence their space management treatment planning decision for case 1. The most statistically significant differences in the means for the attitude determinants and those with the greatest differences between those means were organized at the top of the table. Pediatric dentists (4.8 ± 3.8) had a significantly higher level of confidence ($p<0.001$) with their residency training to manage a case with a loss of a primary first molar in primary dentition than general dentists (3.8 ±1.0). They were also more concerned about losing this patient to regular follow-up care necessary for such an appliance ($p<0.001$). Moreover, pediatric dentists had a significantly higher mean agreement score regarding their comfort level with the band and loop procedure (4.7±0.5 vs. 4.0± 1.0, $p<0.001$). Figures 20, 21 and 22 compare the distributions in the dentists' level of agreement to these most significant attitude-related statements. Furthermore, pediatric dentists had a significantly higher mean attitude score, however to a lesser degree for the following: 1. Their belief that space management for this case was the responsibility of the dentist extracting the tooth; 2. Their concerns with the patient's oral hygiene status; 3. Their confidence in diagnosing the need for management; and 4. Their beliefs on the importance of space maintenance for this patient's dental care ($p=0.018$, $p=0.013$, $p=0.010$, and $p=0.010$, respectively).

There was no statistically significant difference (Table 6) between the general and pediatric dentists with respect to their concerns about the patient's discomfort with the space maintainer procedure, influences that a patient's dental coverage carries, the significance of the 7.4 space loss, and on the need for future orthodontic treatment ($p >0.050$).

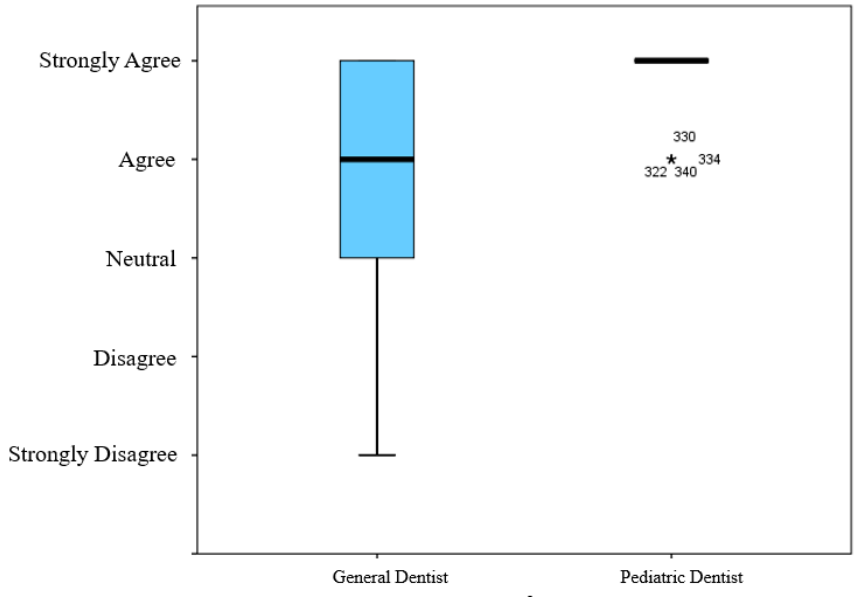


Figure 20. Agreement to the following statement: "I received adequate training in dental school/residency about managing space for this case."

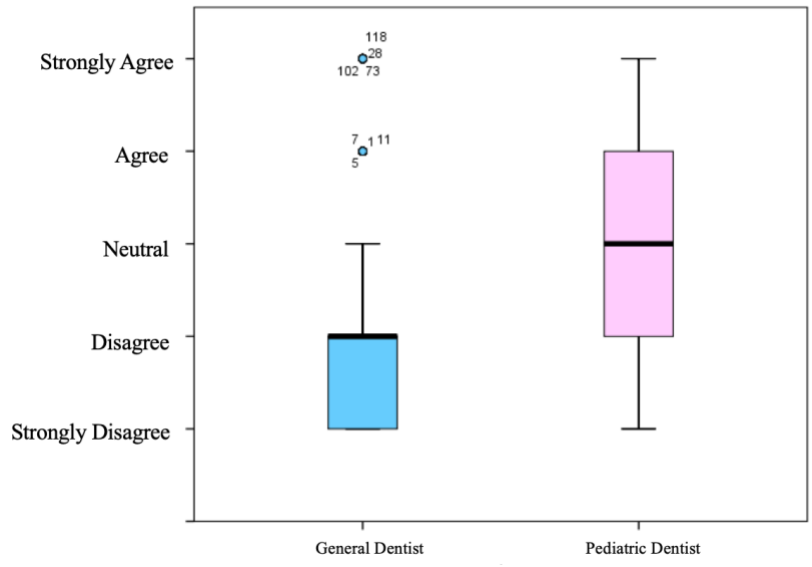


Figure 21. Agreement to the following statement: "I am concerned about losing this patient to regular follow-up if a fixed appliance was placed".

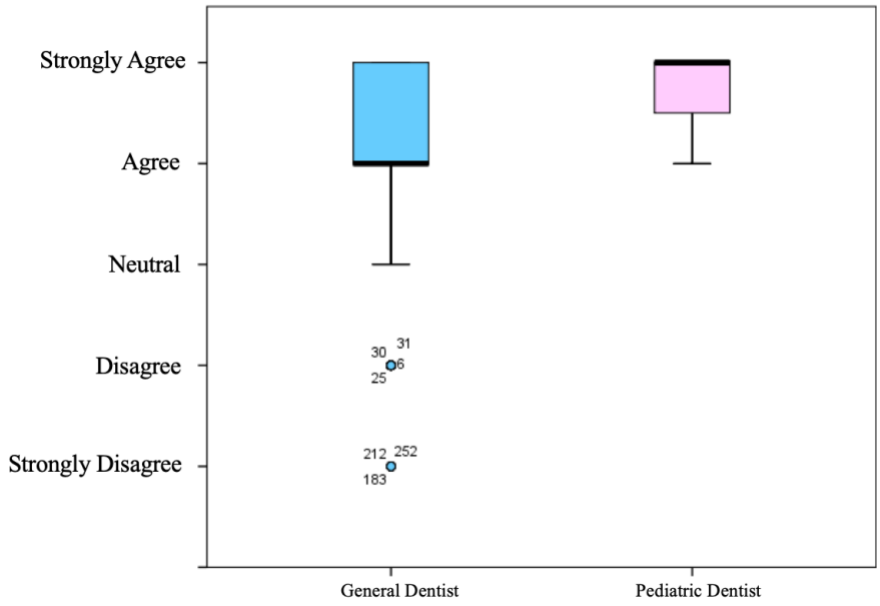


Figure 22. Agreement to the following statement: "I am comfortable with placing a band and loop fixed appliance for a patient of this dental age".

Table 6. Comparison of attitude agreement scores related to Case 1 between general and pediatric dentists

Attitude Determinants	General dentists n=313-316 Mean (sd)	Pediatric dentists n=23 Mean (sd)	Significance#
"I received adequate training in dental school/residency about managing space for this case."	3.8 (1.0)	4.8 (0.4)	<0.001
"I am concerned about losing this patient to regular follow-ups if a fixed appliance was placed."	2.1 (1.1)	3.0 (1.1)	<0.001
"I am comfortable with placing a band and loop fixed appliance for a patient of this dental age."	4.0 (1.0)	4.7 (0.5)	<0.001
"Space management for this case is the responsibility of the practitioner extracting the tooth."	3.5 (1.1)	4.1 (1.0)	0.018
"I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth."	3.2 (1.2)	3.8 (1.2)	0.013
"I am confident with diagnosing if it is necessary to manage the #74 space with a fixed appliance."	4.2 (0.7)	4.7 (0.6)	0.010
"I believe space maintenance, in this case, is an important part of their pediatric dental care."	4.1 (0.9)	4.6 (0.6)	0.010
"The patient will feel discomfort with the space maintainer procedure."	2.6 (0.9)	2.2 (0.8)	0.054
"The patient's dental coverage would strongly influence my decision to place a fixed appliance."	1.9 (1.0)	2.2 (1.3)	0.260
"The space loss from the extraction of tooth #74 is insignificant."	2.1 (1.1)	1.7 (0.7)	0.117
"The patient will most likely need orthodontic treatment in the future, so space management is unnecessary at this time."	1.9 (0.9)	1.8 (0.7)	0.449

Mann Whitney U test

3.3.1.3 Clinical factors considered for Case 1

Clinical factors considered by the general dentists and pediatric dentists were comparable, among which chronological/dental age, a patient's behaviour, and oral hygiene status were most frequently mentioned (Table 7). Pediatric dentists considered the compliance for regular follow-ups for the space maintainer as more important than the general dentists.

Table 7. Comparison of clinical factors most frequently considered for managing the space of tooth #7.4

General dentists	Pediatric dentists
1. Chronological/dental age 2. Behaviour 3. Oral hygiene status 4. Developmental stage of tooth #3.4 5. Eruption stage of tooth #3.6 6. Status/prognosis of tooth #7.5 7. Caries risk 8. Level of crowding 9. Level of remaining bone 10. Radiographic evidence of a developing tooth #3.4 11. Occlusion 12. Size and shape of tooth #7.5 13. The clinical condition of a contralateral arch, follow-up and maintenance visits, the financial status of a patient, medical history.	1. Chronological/dental age 2. Oral hygiene 3. Behaviour 4. Recall compliance, eruption stage of tooth #3.6 5. Caries risk 6. Finances 7. Malocclusion, presence of succedaneous tooth, medical history

3.3.2 Case 2: Loss of tooth #7.5 in primary dentition

As shown in Table 8, pediatric dentists (13.0%, n=3) were significantly more likely (p=0.031) to place a band and loop on tooth #7.4 after the eruption of tooth #3.6 in contrast to general dentists. General dentists were more likely to place a band on tooth #3.6 (7.2%, n=23). Otherwise, there was no significant difference (p>0.050) between the two groups in managing the space after extracting tooth #7.5 in the primary dentition. The majority of the pediatric (78.3%, n=18) and general dentists (59.2%, n=189) chose to place a distal shoe space maintainer immediately post-extraction- albeit this proportion was almost 10% higher in the pediatric dentist group. This is also illustrated in Figure 23. Only 1.9% of general dentists chose not to do any space management; this percentage was 15 percent lower than those that chose not to manage the space for case 1.

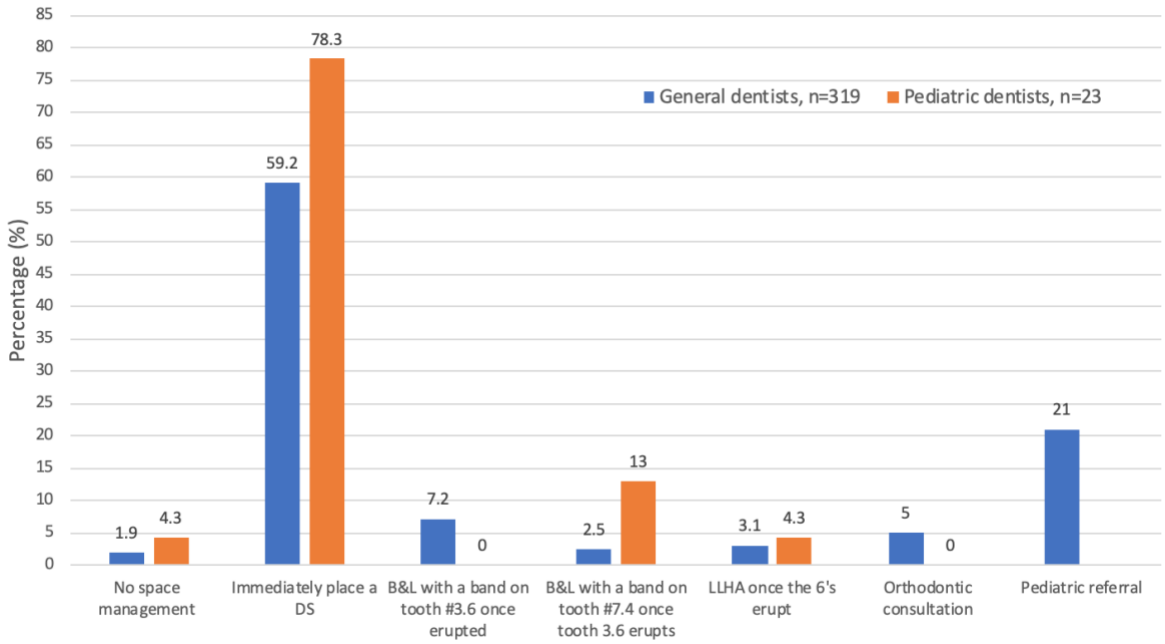


Figure 23. Comparison between general and pediatric dentists regarding their management of the tooth #7.5 space in primary dentition. DS= distal shoe, B&L= Band and Loop, LLHA= Lower lingual holding arch.

Table 8. Comparison between general and pediatric dentists of managing tooth #7.5 space in primary dentition

Case 2 management treatment plan	General dentists	Pediatric dentists	Significance#
	Yes n (%)	Yes n (%)	
	n= 319 (100.0)	n= 23 (100.0)	
No space management	6 (1.9)	1 (4.3)	0.964
Immediately place a distal shoe space maintainer with a band on tooth #74	189 (59.2)	18 (78.3)	0.114
Wait for tooth #36 to erupt and place a band and loop with a band on tooth #36	23 (7.2)	0 (0)	0.385
Wait for tooth #36 to erupt and place a band and loop with a band on tooth #74	8 (2.5)	3 (13.0)	0.031
Wait for tooth#36 and #46 to erupt and place an LLHA	10 (3.1)	1 (4.3)	0.750
Consider and orthodontic consultation	16 (5.0)	0 (0.0)	0.613
Refer to a pediatric dentist for space management	67 (21.0)	No response	No response

#Chi square test with Yates correction or Fischer's Exact test

3.3.2.1 Knowledge regarding case 2

Table 9 compares the answers to the knowledge questions that were presented to both groups of dentists for this specific case. Similar to Table 7, the asterisk represents the correct answers. There was a statistically significant difference (p=0.017) in responses between the general and pediatric dentists regarding the time at which most of the space loss occurs after the extraction of tooth #7.5. The majority of pediatric dentists (60.9%, n=14) selected three months, whereas almost half (41.6%, n=132) of the general dentists reported six months. There was no statistically significant difference in responses regarding the cause of space loss or the purpose of the primary second molar (p>0.050). All pediatric dentists (n=23) and 98.1% of general dentists (n=313) knew that the mesial movement of the permanent molar results in most of the space loss.

Also, the majority of dentists in both groups (91.3% of pediatric, 92.8% of general dentists) recognized that the primary second molar holds a dual function. Lastly, when comparing Figure 24 to Figure 19, there were more correct answers to the knowledge questions for case 2 than for case 1.

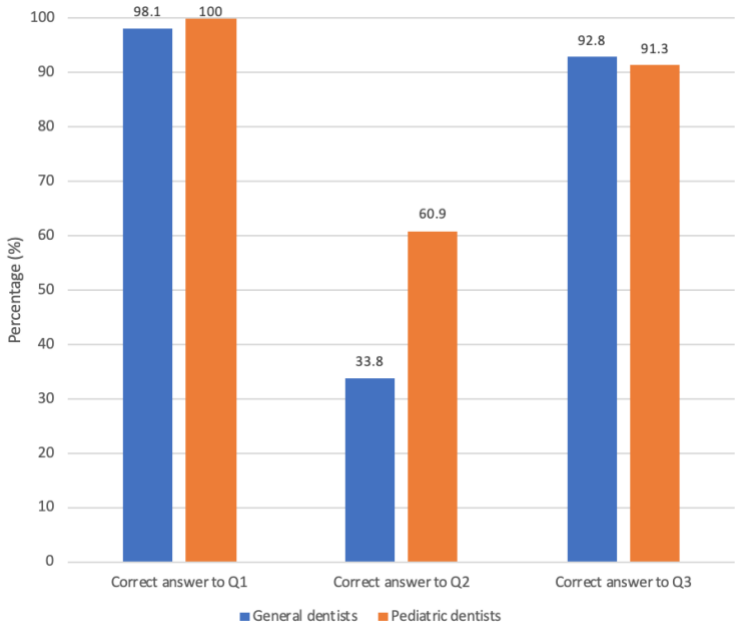


Figure 24. Comparison of correctly answering the knowledge questions pertaining to case 2 between general and pediatric dentists

Table 9. Knowledge about the loss of tooth #7.5 in primary dentition - comparisons between pediatric and general dentists

Case 2: Knowledge	General dentists	Pediatric dentists	Significance#
	n (%)	n (%)	
Q1. Space loss from the extraction of a primary second molar in primary dentition is mostly the result of:	n= 319 (100.0)	n= 23 (100.0)	
Mesial movement of the erupting permanent first molar*	313 (98.1)	23 (100.0)	1.000
Distal movement of the primary first molar	3 (0.94)	0 (0.0)	1.000
Space loss is insignificant after loss of a primary second molar in primary dentition	2 (0.62)	0 (0.0)	1.000
Q2. The majority of the space closure, if any, happens within how many months after extraction of a primary molar?	n= 317 (100.0)	n= 23 (100.0)	
3 months*	107 (33.8)	14 (60.9)	0.017
6 months	132 (41.6)	6 (26.1)	0.213
9 months	21 (6.6)	0 (0.0)	0.380
12 months	57 (18.0)	3 (13.0)	0.752
Q3. Which is/are purposes of the primary second molar?	n= 319 (100)	n= 23 (100)	
A. Maintain space for the permanent second premolar	15 (4.7)	0 (0.0)	0.611
B. Guide the eruption of the permanent first molar into place	8 (2.5)	2 (8.7)	0.289
Both A and B*	296 (92.8)	21 (91.3)	0.792

#Chi square test with Yates correction or Fischer's Exact test
*correct answer

3.3.2.2 Attitudes regarding case 2

Table 9 compares the mean attitude agreement scores between pediatric and general dentists that may influence their space management decisions regarding the loss of tooth #7.5. Similar to table 5, the determinants that were statistically significant and had the largest differences in means are organized at the top of this table. The most substantial difference in means was between their concerns about losing this patient to follow up. Similar to case 1, pediatric dentists were significantly more concerned ($p<0.001$) than general dentists with a 1.5 point difference in their means. The next two largest differences in means were dentists' beliefs on the adequacy of their dental training (3.3 ± 1.2 vs. 4.4 ± 0.8) and their beliefs on the discomfort the patient would encounter from the distal shoe procedure (3.0 ± 1.0 vs. 2.4 ± 0.8). General dentists believed they were trained less adequately and felt more strongly that the patient would feel discomfort ($p<0.001$, and $p=0.007$ respectively). Figures 25-27 illustrate the dentists' distribution according to the aforementioned attitudes. Although to a lesser degree, pediatric dentists were more comfortable with the distal shoe procedure, and more confident with diagnosing whether a fixed appliance was necessary ($p=0.036$, and $p=0.004$, respectively). There were no significant differences in mean attitude scores ($p >0.050$) between both groups regarding their beliefs on the necessity for future orthodontic treatment. Nor was there a significant difference in the level of responsibility they felt about managing the space post-extraction, the caries risk around a banded tooth, or the influence the patient's dental coverage carries. Lastly, there was also no significant difference between the importance of space management in this particular case ($p=0.440$) which contrasts to case 1; in case 2 their beliefs that space management was important is comparable.

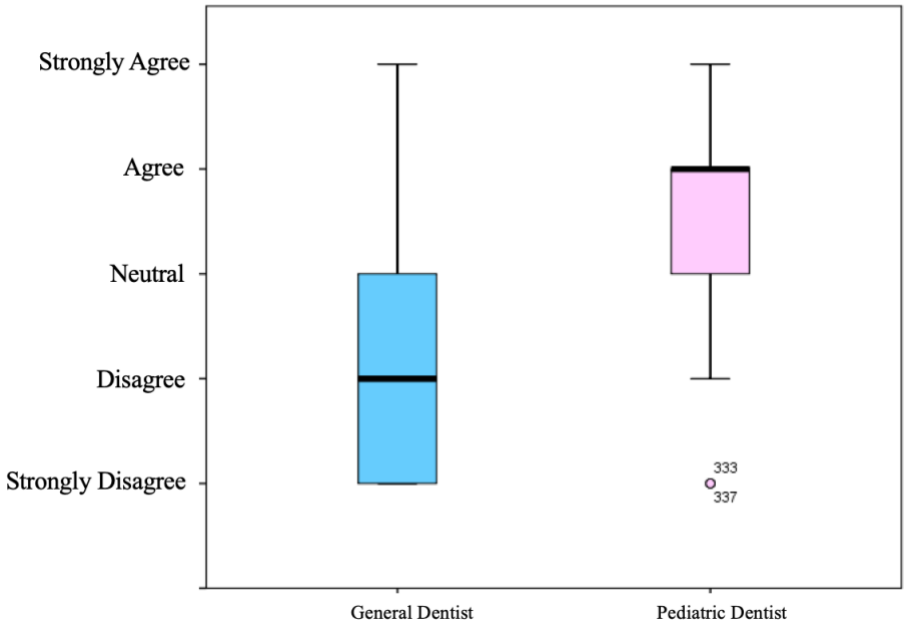


Figure 25. Level of the agreement to the following statement: "I am concerned about losing this patient to regular follow up if a fixed appliance was placed."

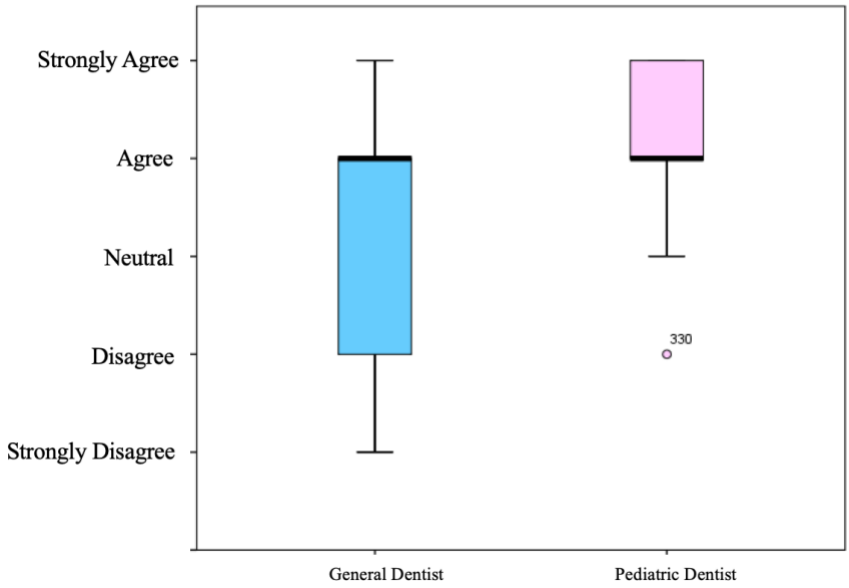


Figure 26. Level of the agreement to the following statement: "I received adequate training in dental school/residency about managing space for this case."

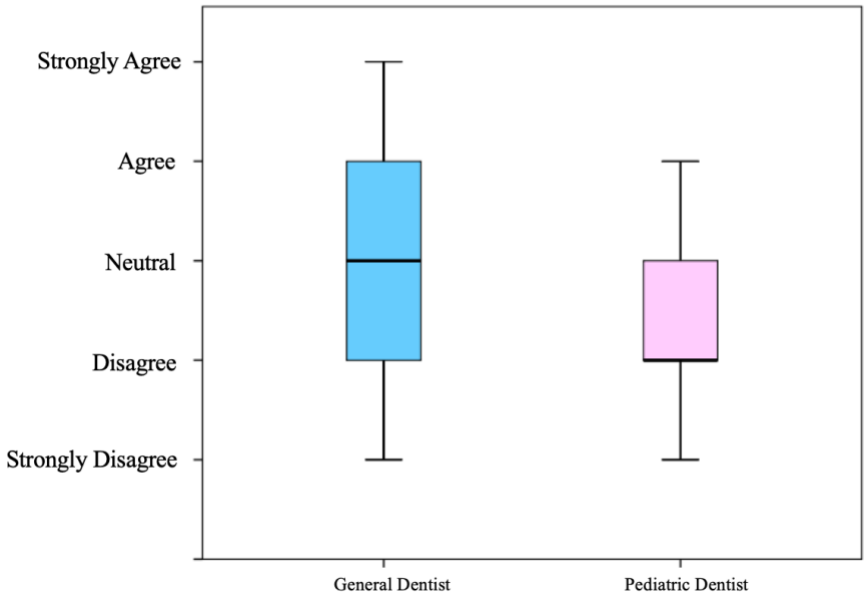


Figure 27. Level of the agreement to the following statement: "The patient will feel discomfort with the space maintenance procedure."

Table 10. Comparison of mean attitude agreement scores for case 2 between general and pediatric dentists

Attitudes	Case 2 Attitudes		Significance#
	General dentists n=313-316	Pediatric dentists n=23	
	Mean (sd)	Mean (sd)	
"I am concerned about losing this patient to regular follow-ups if a fixed appliance was placed."	2.2 (1.1)	3.7 (1.2)	<0.001
"I received adequate training in dental school/residency about managing space for this case."	3.3 (1.2)	4.4 (0.8)	<0.001
"The patient will feel discomfort with the space maintainer procedure."	3.0 (1.0)	2.4 (0.8)	0.007
"I am comfortable with placing a distal shoe fixed appliance for a patient of this dental age."	3.4 (1.3)	4.0 (1.2)	0.036
"I am confident with diagnosing if it is necessary to manage the #75 space with a fixed appliance."	4.2 (0.9)	4.7 (0.5)	0.004
"The space loss from the extraction of tooth #75 is insignificant."	1.7 (1.0)	1.3 (0.5)	0.004
"The patient will most likely need orthodontic treatment in the future, so space management is unnecessary at this time."	2.0 (1.0)	1.8 (0.7)	0.562
"Space management for this case is the responsibility of the practitioner extracting the tooth."	3.5 (1.1)	3.9 (1.0)	0.114
"I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth."	3.3 (1.2)	3.7 (1.1)	0.064
"The patient's dental coverage would strongly influence my decision to place a fixed appliance."	1.9 (1.0)	2.3 (1.3)	0.135
"I believe space maintenance, in this case, is an important part of pediatric dental care."	4.4 (0.7)	4.5 (0.6)	0.440

Mann Whitney U test

3.3.2.3 Clinical factors considered for case 2

Several clinical factors identified by both groups were comparable (Table 11); general and pediatric dentists more frequently considered the chronological/dental age, oral hygiene status and the eruption status of the permanent first molar. Pediatric dentists were more concerned than general dentists about patient follow-up.

Table 11. Comparison of clinical factors most frequently considered for managing space of tooth #7.5

General dentists	Pediatric dentists
1. Eruption level and position of tooth #3.6 2. Chronological/dental age 3. Patient cooperation 4. Oral hygiene status 5. Prognosis of tooth #7.4 6. Crowding 7. Eruption time/bone level covering tooth #3.5 8. Caries risk 9. Level of follow-up/parent motivation 10. Medical history 11. Presence of developing premolars	1. Chronological/dental age 2. Patient cooperation 3. Follow-up compliance 4. Oral hygiene, eruption level of 6 5. Presence of a succedaneous tooth 6. The difficulty level of correctly positioning the appliance, caries risk, prognosis of tooth #74

3.3.3 Case 3: Premature loss of tooth #7.3 in late mixed dentition

There were no statistical differences (p>0.050) in treatment planning between general and pediatric dentists concerning case 3 (Table 12). Both general (59.6%, n= 189) and pediatric (69.6%, n=16) dentists reported that they would consult an orthodontist for this case. Figure 28 also shows that almost equal proportion (27.0%, for general dentists, and 26.1% for pediatric dentists) indicated that they would place a lower lingual holding arch.

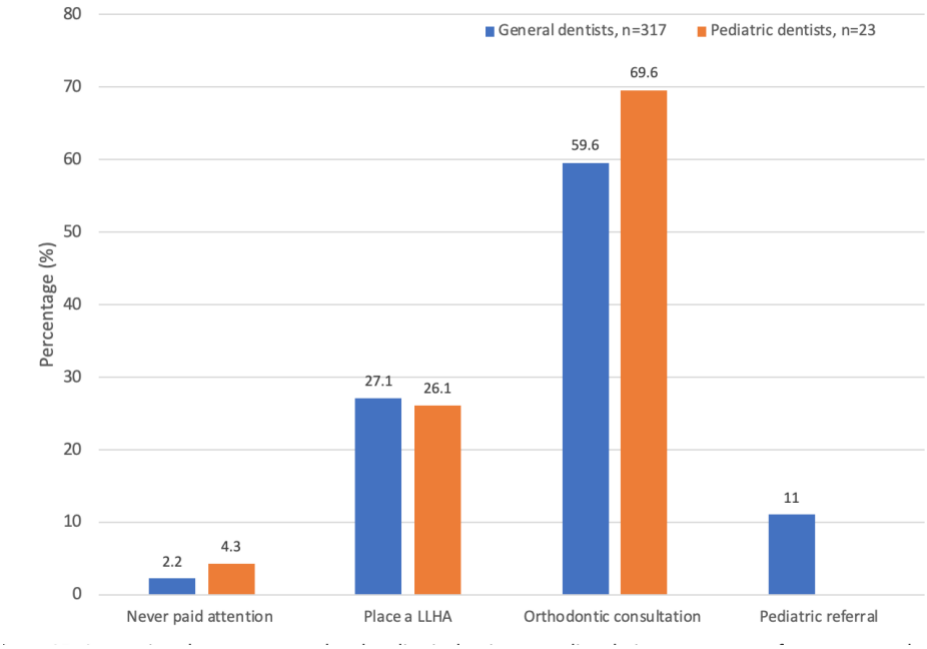


Figure 28. Comparison between general and pediatric dentists regarding their management after premature loss of tooth #7.3. LLHA= Lower lingual hold arch

Table 12. Comparison between general and pediatric dentists of managing the space from the premature loss of tooth #7.3

Case management treatment plan	General dentists Yes n (%) n= 317 (100.0)	Pediatric dentists Yes n (%) n=23 (100.0)	Significance#
Never paid attention to the potential spacing concerns	7 (2.2)	1 (4.3)	0.513
Place an LLHA	86 (27.1)	6 (26.1)	0.914
Consider an orthodontic consultation	189 (59.6)	16 (69.6)	0.471
Refer to a pediatric dentist for space management	35 (11.0)	No responses	No responses

#Chi square test with Yates correction or Fischer's Exact test

3.3.3.1 Knowledge regarding Case 3

As shown in Table 13, there were no statistically significant differences ($p>0.050$) between the general and pediatric dentists regarding their knowledge about this case. Approximately half of the general dentists (49.8%, n=157), and pediatric dentists (47.8%, n=11) selected the correct answer for the definition of leeway space. More than half in each group (63.1%, n=198 for general dentists, and 69.9%, n=16) correctly chose 1.8 mm as the answer for the normal maxillary leeway space available, and the majority chose the correct answer for the earliest time to place an LLHA (76.4%, n=239 for general dentists and 91.3%, n=21 for pediatric dentists). Although there was no significant difference for the correct answer regarding the mandibular leeway space available, the majority of pediatric dentists (73.9%, n=17) and only about half of the general dentists (54.4%, n=171) selected the correct answer. The answers to the knowledge questions in case 3 were correctly answered (Figure 29) less often than in case 2, but more often than case 1.

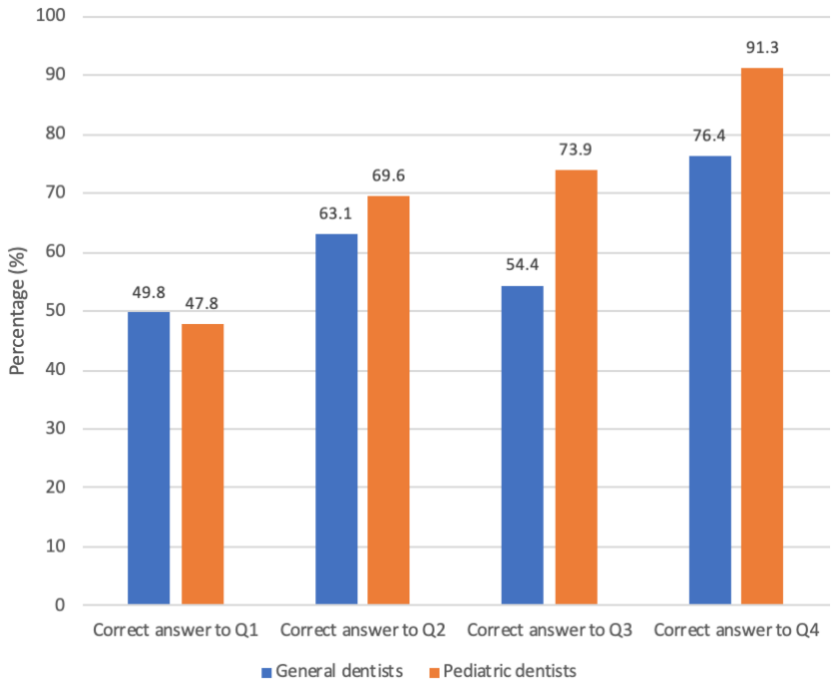


Figure 29. Comparison of correctly answering the knowledge questions pertaining to case 3 between general and pediatric dentists

Table 13. Knowledge about the premature loss of tooth #7.3 in late mixed dentition -comparison between pediatric and general dentists

Case 3: Knowledge	General dentists n (%)	Pediatric dentists n (%)	Significance#
Q1. What is the Leeway space?	n= 315 (100.0)	n= 23 (100.0)	
Physiologic space between the primary lateral incisors and primary canine	11 (3.5)	0 (0.0)	1.000
Physiologic space between the primary canine and primary first molar	23 (7.3)	1 (4.3)	0.923
Difference between the D/E and succedaneous premolars	124 (39.4)	11 (47.8)	0.530
Difference between the C/D/E and the succedaneous permanent canine, and premolars*	157 (49.8)	11 (47.8)	0.898
Q2. What is the normal Leeway space available for the maxilla?	n= 314 (100.0)	n= 23 (100.0)	
0.9 mm in total	41 (13.1)	1 (4.3)	0.372
1.8 mm in total*	198 (63.1)	16 (69.6)	0.688
3.6 mm in total	75 (23.9)	6 (26.1)	0.812
Q3. What is the normal Leeway space available for the mandible?	n= 314 (100.0)	n= 23 (100.0)	
0.9 mm in total	17 (5.4)	2 (8.7)	0.849
1.8 mm in total	126 (40.1)	4 (17.4)	0.052
3.6 mm in total*	171 (54.4)	17 (73.9)	0.111
Q4. What is the earliest time LLHA should be considered?	n= 313 (100.0)	n= 23 (100.0)	
Permanent molars have fully erupted, and lower permanent central incisors have not erupted.	24 (7.7)	1 (4.3)	0.862
Permanent molars and centrals have fully erupted, lower permanent laterals have not erupted.	50 (16.0)	1 (4.3)	0.231
Permanent molars, lower centrals, and lower laterals have erupted. *	239 (76.4)	21 (91.3)	0.163

#Chi square test with Yates correction or Fischer's Exact test
*correct answer

3.3.3.2 Attitudes regarding Case 3

Table 14 was organized similarly to the mean attitude agreement tables for cases 1 and 2. The greatest difference in the means (difference of 1.2 points), and the most significant difference in attitudes ($p<0.001$) between the groups was their attitudes towards their dental school/residency training; pediatric dentists believed more strongly that they were adequately trained for this leeway space management case. Subsequently, pediatric dentists felt more confident about diagnosing this case for space management and felt more confident with placing a lower lingual holding arch for a patient of this age and behavior ($p<0.001$, and $p=0.003$ respectively). Figures 30, 31 and 32 illustrate the distributions for these attitude determinants. There were no other significant differences ($p>0.050$) in the mean attitude agreement scores for the remaining attitude determinants.

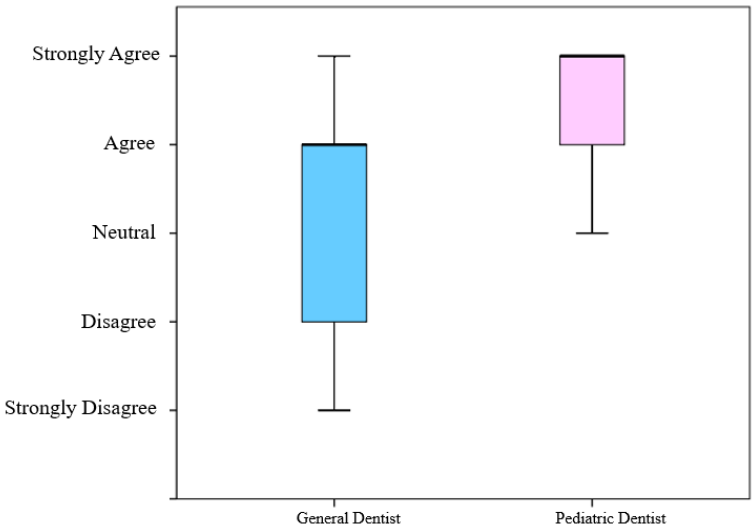


Figure 30. The level of agreement to the following statement: "I received adequate training in dental school about diagnosing whether space management is needed for such case."

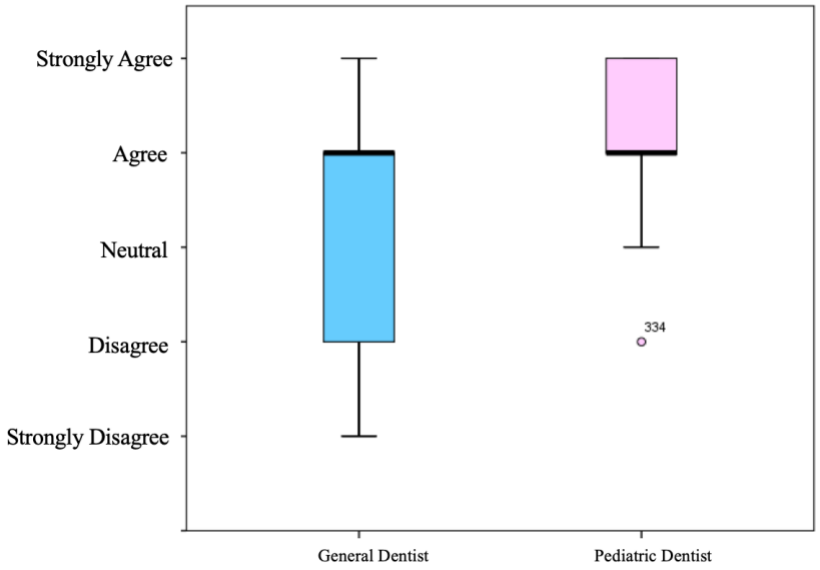


Figure 31. The level of agreement to the following statement: "I am confident with diagnosing if it is necessary to manage this case with a fixed appliance."

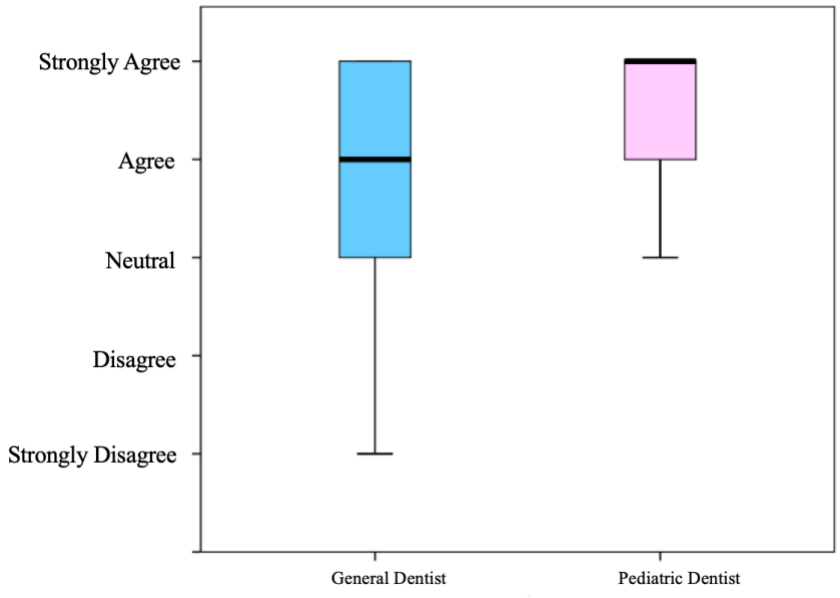


Figure 32. The level of agreement to the following statement: "I am comfortable with placing a lower lingual holding arch fixed appliance for a patient of this age and behaviour."

Table 14. Comparison of mean attitude agreement scores for case 3 between general and pediatric dentists

Attitude Determinants	Case 3 Attitudes		Significance#
	General dentists n=313-316	Pediatric dentists n=23	
	Mean (sd)	Mean (sd)	
"I received adequate training in dental school/residency about managing space for this case."	3.3 (1.1)	4.5 (0.6)	<0.001
"I am confident with diagnosing if it is necessary to manage this case with a fixed appliance."	3.4 (1.2)	4.1 (0.9)	<0.001
"I am comfortable with placing a lower lingual holding arch fixed appliance for a patient of this age and behaviour."	3.7 (1.2)	4.4 (0.7)	0.003
"I believe space maintenance, in this case, is an important part of their pediatric dental care."	4.3 (0.9)	4.6 (0.6)	0.059
"The patient's dental coverage would strongly influence my decision to place a fixed appliance."	1.9 (1.0)	2.4 (1.3)	0.087
"I lack a personal interest in space management."	2.1 (1.0)	1.9 (1.1)	0.305
"Immediate space management intervention will improve the ease of future orthodontic treatment for this case."	3.9 (1.0)	3.7 (1.0)	0.336
"I lack a personal interest in space management."	2.1 (1.0)	1.9 (1.1)	0.305
"Intervention with a fixed appliance to manage space is time-consuming."	2.3 (1.0)	2.5 (1.1)	0.401
"The patient will feel discomfort with the space maintainer procedure."	2.5 (1.0)	2.6 (0.8)	0.761

Mann Whitney U test

Chapter 4: Discussion

Understanding growth and development is a critical component of comprehensive pediatric dental care. As space management is part of this care, we would expect general and pediatric dentists to have adequate knowledge on this topic as well as appropriate diagnostic and management skills. As mentioned by Pit et al. (2014), surveying health care professionals is crucial as surveys give us a sense of how patients are being managed in the community. This information can only improve our quality of care. If there are indications for instance that management varies from the ideals, we can better understand potential reasons for these deviations, and thus implement necessary improvements. Our study made comparisons between general and pediatric dentists to assess differences in space management for common cases encountered in private practice, and to discover possible explanations for those differences.

4.1 Major findings

4.1.1 Mean total knowledge scores

It is interesting to note that there were no statistically significant differences in mean total knowledge score between general and pediatric dentists. We expected pediatric dentists to have a significantly higher score. Our assessment of knowledge was made similarly to Yellowitz et al. (2000) who devised a knowledge measurement assessing the US general dentists' knowledge of oral cancer risk factors and diagnostic procedures. A correct answer for each of 14 questions produced a score of 1, and a knowledge index (range 0-14) was created (Yellowitz et al., 2000). Of course, relatively small indices such as ours and those of similar studies (Kapoor et al., 2018; Rivazi et al., 2013; Yellowitz et al., 2000) may not accurately represent the total knowledge

levels for the topic of interest; however, there must be a balance between testing their theoretical knowledge without jeopardizing the completeness of surveys, since response rates for general practitioners are usually low (Pit et al., 2014). In the study by Yellowitz et al. (2000), the general dentists' mean knowledge score on oral cancer was higher than expected and the authors explained this by their sample specifics, i.e. recruiting respondents that may have more interest in this particular topic. The same assumption could be made for our study as well. It's possible that dentists who decided to participate in the current study are those that are more interested in space maintenance, which could explain why there was no significant difference in mean knowledge scores between them and the specialists. Also, as almost all of the general and pediatric dentists reported that they do not participate in orthodontic or pediatric study clubs, it's fair to assume that the theoretical knowledge we observed was mainly acquired through dental school and residency.

Duruk and Erel (2020) evaluated the knowledge of Turkish general dentists and dental specialists about their management of an avulsed tooth. Their survey had three parts: 1. Sociodemographic questions; 2. Twenty questions testing their emergency and clinical management where the correct answers were based on the IADT trauma guidelines; and 3. Their perspective of their dental knowledge (Duruk & Erel, 2020). The authors found that the mean total knowledge score was significantly larger for the pediatric dentists in comparison to general dentists and other dental specialists (Duruk & Erel, 2020). They also found that 59% of the dentists rated their dental knowledge as "sufficient enough but incomplete" and 87% would attend educational programs on dental trauma management (Duruk & Erel, 2020). In our study, we expected to find a similar trend. A possible explanation for why the pediatric dentists' knowledge was not

significantly better in our study may be due to our survey having a relatively small number of knowledge questions. Additionally, there may have been some ambiguity in our questions. The correct answers for the questionnaire by Duruk and Erel (2020) were based on IADT trauma guidelines which are readily available to dentists, whereas the answers for our questions do not have such a guideline, which would have allowed for better standardization. Thus, our knowledge assessment might not have accurately estimated the true knowledge of the pediatric dentists. But of course, both surveys are testing different aspects of pediatric dentistry so we should avoid any direct comparisons. To our best knowledge, there are no previous studies specifically testing dentists' knowledge of space management. It is interesting to note that although the total knowledge scores between general dentists and pediatric dentists were comparable, the variation in these scores was larger for the general dentists than for pediatric dentists.

4.1.2 Case 1: Loss of tooth #7.4 in primary dentition

Although the majority of general and pediatric dentists chose to place a band and loop for Case 1, general dentists were significantly less likely to manage this space than pediatric dentists. This could be the result of differences in their attitudes, in particular their attitudes towards their dental school training, and their beliefs on the importance of space management for this case. Since there was no significant difference between the mean total knowledge scores, we can assume that understanding the dentists' level of theoretical knowledge is insufficient to explain why general dentists were less likely to manage the space as compared to pediatric dentists.

Of all the attitudes we evaluated that may influence the dentists' decision making, differences in attitudes towards their training seemed to be the most associated with this case's management. The UBC dental graduates participating in our study possibly felt inadequately trained since according to the UBC pediatric undergraduate director, only three hours are allocated for space management education for their dental students, none of which are hands-on clinical based experiences.

Similarly, the American Journal of Orthodontic and Dentofacial Orthopedics (AJODO) conducted two parallel studies to assess the level of orthodontic treatment provided by pediatric dentists (Higlers et al., 2003) and general dentists (Galbreath et al., 2006). According to the Hilgers et al. (2003) study, 48% of pediatric dentists stated that they received the majority of their orthodontic training in school, in comparison to 28.9% of the general dentists. Also, from a rating of 1-5, 36.7% of pediatric dentists rated their orthodontic training in residency as average (3), versus 55.2% general dentist who rated their training in school as poor (1) (Galbreath et al., 2006; Hilgers et al., 2003). Generally, it seems as though the orthodontic training in dental school is more limited for general dentists, which paralleled our findings towards space maintenance training. Thus, in this particular case, it seems as though the effects of the general dentists' attitudes towards their training influenced their decision making to a higher degree than their theoretical knowledge. We found that pediatric dentists had more positive feelings towards their clinical training, and this could explain why the specialists felt significantly more confident with performing this procedure and chose to place a band and loop for this case more frequently.

Another difference we want to draw attention to is the differences in their beliefs on the importance of space management for this case. Pediatric dentists believed more strongly that space management was important, which could also be contributing to why they were more likely to place a band and loop appliance.

4.1.3 Case 2: Loss of tooth #7.5 in primary dentition

For Case 2, we anticipated that the general dentists would choose not to manage the space as often as pediatric dentists since the space management procedure from the loss of a primary second molar is more difficult to manage than that of the primary first molar (Terlaje & Donly, 2001). Interestingly in our study, there were no significant differences between the two types of practitioners regarding the placement of a distal shoe appliance. This was surprising since as shown in Figure 8 only 21.5% of the general dentists in our study stated that they frequently or occasionally placed a distal shoe appliance when the permanent first molars are unerupted in private practice. This proportion is almost three times lower than the percentage of general dentists that reported placing band and loop appliances in private practice (Figure 6). Yet in our study pediatric dentists were significantly more likely to place a band and loop than general dentists. What we also noticed was that the knowledge questions for case 2 were answered correctly more often than for case 1 by the general dentists. So, it seems as if the general dentists have grasped the theory, however, they cannot apply this knowledge. These unexpected results related to case 2 could be partly explained by social desirability (SD) bias. Social desirability bias is the tendency for respondents to answer questions in a manner that will be viewed favourably to others (Chung & Monroe, 2003; Krumpal, 2013). The concept is divided into two

dimensions: 1. Individual personality characteristics; and 2. Survey design (Krumpal, 2013, and Gittleman et al., 2015). The first dimension explains that certain individuals are more prone to behave in a socially desirable manner, and thus will more likely to choose responses that seem more favourable (Gittleman et al., 2015; Krumpal, 2013). The second dimension describes that the specific design of the survey may create bias; for example, the wording of statements or questions, their ordering, or the data collection method can all influence the responses (Gittleman et al., 2015; Krumpal, 2013). Social desirability bias may have played a role in both groups, especially for general dentists in selecting to place distal shoe appliances for Case 2. In contrast to Case 1, there were no significant differences in the attitudes of space maintenance being important in Case 2- both groups not only agreed that space maintenance was important for this case, but they also agreed that the space loss was more significant than the case 1. The differences in the importance of space loss between the primary first and second molars have also been emphasized in the literature. So, it's fathomable that the general dentists selected to place a distal shoe since they are aware that there will be more significant space loss, and consequently chose the "right" answer. We tried to reduce the risk of social desirability bias by informing the respondents that their responses will be confidential. Additionally, for this particular case, many management options were available to the dentists, so that they could select the option that most closely resembled the treatment they would provide in private practice.

Another possible explanation for why we observed a discrepancy between the frequency of placing these distal shoes in private practice to the frequency of selecting the distal shoe for this case could be due to the lack of accessibility for the equipment needed to perform this procedure.

Distal shoe appliances are chairside appliances, and so a practitioner needs in-office equipment to place them. Our study indicated that very few general dentists do chairside appliances, so it is possible that if they had the equipment readily available in their offices, then the frequency of placing these appliances in private practice would have been higher, and similar to the frequency of selecting a distal shoe for this case.

4.1.4 Case 3: Loss of tooth #7.3

In Case 3, although pediatric dentists were significantly more comfortable with the space management diagnosis and the placement of an LLHA, the majority of pediatric and general dentists chose to consult an orthodontist for this late mixed dentition, which was unexpected. We did expect that the pediatric dentists would be more comfortable with the diagnosis and procedure itself; hence we assumed that the majority would choose to place an LLHA. Similar to our study, Batarse et al. (2019) compared the orthodontic referral patterns of general and pediatric dentists for late mixed and permanent dentition cases by presenting 20 cases to 20 pediatric and 21 general dentists. ABO DI scores were used to evaluate case complexity, and a visual analog scale ranging from 0 mm (simple case) to 100 mm (difficult case) was used to evaluate the level of difficulty assessed by the respondents (Batarse et al., 2019). They found that there was no difference in complexity evaluation by general and pediatric dentists; however pediatric dentists were more likely to refer late mixed and permanent dentition cases to an orthodontist regardless of the DI score. This trend was also observed by Aldrees et al. (2014), who found that pediatric dentists orthodontically treated primary and early mixed dentition stages more frequently, and referred out late mixed dentition and permanent dentition cases more often. In contrast, Koroluk et al. (1988) found that pediatric dentists provided more

comprehensive orthodontic treatment than general dentists, and treated more complex cases. Our results and those of more recent studies possibly differ from older studies since the demand for pediatric dentists has increased; thus, it is less necessary to provide as much orthodontic care for a successful and busy practice (Casamassimo, 2001). Dental caries has become more prevalent, and parent expectations for a positive dental experience are on the rise, so more parents are seeking specialty care for their children (Casamassimo, 2001). Thus, pediatric dentists are possibly feeling less pressure to provide orthodontic care for late mixed and permanent dentition cases, and are focusing more on care for primary and early mixed dentition. With that being said, possibly many of these pediatric dentists may have understood that an LLHA was necessary, yet wanted to consult an orthodontist before the placement of the appliance. Choosing multiple answers was not permitted in our study. So, it's plausible that the study might underestimate the frequency of selecting the LLHA in this case for pediatric dentists since their frequency of correctly answering the knowledge questions for this particular case are higher than the general dentists, and they are more comfortable with the procedure. So, they might have chosen to consult an orthodontist to only confirm their treatment plan, since orthodontists and pediatric specialists usually work closely together.

4.1.5 Similarities across study cases

The act of providing space maintenance care for pediatric patients depends on the dentists' knowledge level, and attitudes. From our study, it seemed as though the theory behind space maintenance is similar between both pediatric and general dentists as evident by comparable mean total knowledge scores. This was further supported when comparing the responses to managing the cases to the frequency at which they place these fixed appliances in private

practice. General dentists had lower frequencies of placing these fixed appliances in practice; however, the frequencies of choosing to place them for all three cases were comparable to those of pediatric dentists. So, there is a discrepancy between general dentists' understanding of ideal space management and their actual practice. This could be due to differences in their attitudes. The most striking of course was the difference in attitudes towards their professional training. In comparison to general dentists, pediatric dentists had a more positive attitude towards their training which did correspond to a higher level of confidence with diagnosing the need for space management, and a higher level of confidence with placing fixed appliances.

Casamassimo and Seale (2015) assessed the adequacy of undergraduate pediatric dental training provided in US schools by interviewing 49 of the 57 pediatric predoctoral program directors. Thirty-three of the directors (67%) reported that their pediatric patient pool was inadequate to meet the program competencies (Casamassimo & Seale, 2015). They attributed this to less decay, insufficient patient volume, and their dental school location (Casamassimo & Seale, 2015). In terms of space management treatment, 71% of the directors reported that their students were inadequately trained to provide this treatment (Casamassimo & Seale, 2015). Other studies from 1980-2017 additionally supported the inadequacies in pediatric predoctoral training (Casamassimo et al., 2018). Furthermore, Rich et al. (2006) assessed whether dental school experiences influenced general dentists' attitudes and practice characteristics concerning providing pediatric treatment; similar to our study they also used the mean values from a 5 point Likert scale to assess their attitudes. They found that general dentists with more positive educational experiences in treating children were more likely to work in practices that treated pediatric patients, and overall these dentists generally had more positive attitudes towards

providing treatment for children. Also, general dentists with more positive predoctoral training were more likely to provide pediatric care such as dental examinations, restorative and endodontic treatment; yet in this particular study, there was no specific mention on orthodontic care such space maintenance (Rich et al., 2006). Our study, which focused on this missing element, resembled their findings.

4.2 Study Limitations

Our response rates were relatively low, which was also encountered by other studies that surveyed general dentists and dental specialists. (Bowen et al., 2012; Dunlop et al., 2013; Patel et al., 2011). Another study limitation was that we could only include dentists with publicly available email addresses. Furthermore, the study is also subject to information bias since dentists that may be interested in space maintenance might be more likely to respond. Although the response rate by pediatric dentists was more than twice that of general dentists, since the sample size of the pediatric dentists was relatively small, this hindered our ability to perform sub-analyses. However, according to the CDSBC 2018/2019 annual report, there are only 66 pediatric dentists registered and not all of them have publicly available email addresses. Lastly, as the chosen cases were found from those previously treated at the UBC graduate program, this limited our selection for cases and intraoral photographs were not available.

4.3 Recommendations/suggestions for future research

4.3.1 Recommendations

It seems that the positive or negative experiences from a dentists' professional training are important in determining the likelihood of providing space maintenance treatment. Thus, providing more clinical experience in dental schools or more continuing education courses with an emphasis on hands-on experience may improve space maintenance practices in our community. This is especially important as the majority of general dentists reported that they are frequently providing dental treatment for their pediatric patients in all the different dentition types. It is up to the schools to ensure that their students are comfortable with their training so that they can provide patients in the community with the highest standard of care. Implementing small changes in the dental school curriculum can only help to ensure that pediatric patients' needs are being met.

4.3.2 Future research

Our study limited respondents to those in British Columbia; however future research could be more expansive so that we can understand if there is a difference between provinces or countries. Also, future research could focus on the space maintenance training provided in dental schools across the country, and possibly evaluate the undergraduate dental students' acceptability of this training after adding more hands-on experiences with space maintainers.

It would be also interesting to see if we can better understand space maintenance practices in private practice through more clinical research. If possible, it would be interesting if a few group practices- general and pediatric- participated in a prospective study whereby they documented

their indications for providing space maintenance for their active patients. This could avoid any type of response bias.

Chapter 5: Conclusion

Our study found that the theory related to space maintenance is comparable between both general and pediatric dentists. The similar responses to the management of all three cases yet the differences in the frequency at which space maintainers are placed in private practice support this finding. The most noticeable difference across cases was the difference in attitudes towards their professional training; pediatric dentists felt more adequately trained. Since the majority of general dentists reported that they do frequently treat pediatric patients in all dentition types, we do believe that more emphasis should be placed on clinical hands-on experiences for space maintenance in undergraduate dental school programs.

Bibliography

1. American Academy of Pediatric Dentistry. (2008) Guideline on management of the developing dentition and occlusion in pediatric dentistry. (*Reference manual* (2019-2020 ed., pp 289)
2. American Academy of Pediatric Dentistry. (2019). Dental growth and development. *Reference manual* (2019-2020 ed., pp 505)
3. Aldrees, A. M., Tashkandi, N. E., Al Wanis, A. A., Al Sanouni, M. S., & Al-Hamlan, N. H. (2015). Orthodontic treatment and referral patterns: A survey of pediatric dentists, general practitioners, and orthodontists. *The Saudi Dental Journal, 27*(1), 30-39. doi:10.1016/j.sdentj.2014.11.001
4. Annika Launiala. (2009). How much can a KAP survey tell us about people's knowledge, attitudes and practices? some observations from medical anthropology research on malaria in pregnancy in Malawi, *Anthropology Matters.*
5. Baroni, C., Franchini, A., & Rimondini, L. (1994). Survival of different types of space maintainers. *Pediatric Dentistry, 16*(5), 360. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7831141
6. Batarse, A. (2019). Referral patterns of pediatric dentists and general practitioners to orthodontists based on case complexity. *American Journal of Orthodontics and Dentofacial Orthopedics, 156*(1), 61-66.
7. Bowen, J. L., Mathu-Muju, K. R., Nash, D. A., Chance, K. B., Bush, H. M., & Li, H. (2012). Pediatric and general dentists' attitudes toward pulp therapy for primary teeth. *Pediatric Dentistry, 34*(3), 210.
8. Brennan, M. M., & Gianelly, A. A. (2000). The use of the lingual arch in the mixed dentition to resolve incisor crowding. *American Journal of Orthodontics & Dentofacial Orthopedics, 117*(1), 81-85. doi:10.1016/S0889-5406(00)70252-6
9. Brill, W. A. (2002). The distal shoe space maintainer chairside fabrication and clinical performance. *Pediatric Dentistry, 24*(6), 561. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12528949
10. Casamassimo, P. S. (3). Are U.S. dentists adequately trained to care for children? *Pediatric Dentistry, 40*(2), 93-97.
11. Casamassimo, P. S. (2001). Pediatric dentistry: Today and tomorrow. *American Journal of Orthodontics & Dentofacial Orthopedics, 120*(3), 234-236. doi:10.1067/mod.2001.116542
12. Casamassimo, P. S., & Seale, N. S. (2015). Adequacy of patient pools to support predoctoral students' achievement of competence in pediatric dentistry in U.S. dental schools. *Journal of Dental Education, 79*(6), 644.
13. Chung, J., & Monroe, G. S. (2003). Exploring social desirability bias. *Journal of Business Ethics, 44*(4), 291-302. doi:10.1023/A:1023648703356
14. Dunlop, R. M., Sanders, B. J., Jones, J. E., Walker, L. A., & Caldwell, R. L. (2013). Pulp therapy in pediatric patients with congenital heart disease: Survey of American academy of pediatric dentistry members. *Journal of Dentistry for Children (Chicago, Ill.), 80*(3), 139. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/24351695

15. Duruk, G. & Erel, Z.B. (2020). Assessment of Turkish dentists' knowledge about managing avulsed teeth. *Dental Traumatology.* doi: 10.1111/edt.12543
16. Fanning, E. A (1962). Effect of extraction of deciduous molars on the formation and eruption of their successors. *Angle Orthod,* 32, 44–53
17. Fathian, M., Kennedy, D. B., Nouri, R. M., & Ped, D. (2007). Laboratory-made space maintainers: A 7-year retrospective study from private pediatric dental practice. *Pediatric Dentistry, 29*(6), 500-506. Retrieved from http://www.ingentaconnect.com/content/aapd/pd/2007/00000029/00000006/art00010
18. Fox, R. C. (1980). The evolution of medical uncertainty. *Milbank Memorial Fund Quarterly/Health and Society, 58*(1), 1-49.
19. Gable, T. O., Kummer, A. W., Lee, L., Creaghead, N. A., & Moore, L. J. (1995). Premature loss of the maxillary primary incisors: Effect on speech production. *ASDC Journal of Dentistry for Children, 62*(3), 173.
20. Galbreath, R. N. (5). Orthodontic treatment provided by general dentists who have achieved master's level in the academy of general dentistry. *American Journal of Orthodontics and Dentofacial Orthopedics, 129*(5), 678-686.
21. Garg, S., Rubin, T., Jasek, J., Weinstein, J., Helburn, L., & Kaye, K. (2013). How willing are dentists to treat young children? *The Journal of the American Dental Association (JADA), 144*(4), 416-425. doi:10.14219/jada.archive.2013.0135
22. Gianelly, A. A. (1995). Leeway space and the resolution of crowding in the mixed dentition. *Seminars in Orthodontics, 1*(3), 188-194. doi:10.1016/S1073-8746(95)80022-0
23. Gittelman, S., Lange, V., Cook, W. A., & Frede, S. M. (9). Accounting for social-desirability bias in survey sampling. *Journal of Advertising Research, 55*(3), 242-254.
24. Gumucio, S., Merica, M., Luhman, N., Fauvel, G., Zompi, S., Ronsse, A., Courcaud, A., Bouchon, M., Trehin, C., Schapman, S., & Ronsse. R. (2011). Data Collection Quantitative Methods, the KAP Survey Model (Knowledge, Attitude and Practices), IGC communigraphie: Saint Etienne, France, 2011; p. 5.
25. Han, P. K. J., Klein, W. M. P., & Arora, N. K. (2011). Varieties of uncertainty in health care. *Medical Decision Making, 31*(6), 828-838. doi:10.1177/0272989X10393976
26. Hilgers, K. K., Redford-Badwal, D., & Reisine, S. (2003). Orthodontic treatment provided by pediatric dentists. *American Journal of Orthodontics & Dentofacial Orthopedics, 124*(5), 551-560. doi:10.1016/S0889-5406(03)00622-X
27. Holan, G., & Needleman, H. L. (2014). Premature loss of primary anterior teeth due to trauma – potential short- and long-term sequelae. *Dental Traumatology, 30*(2), 100-106. doi:10.1111/edt.12081
28. Kaliyaperumal, K. (2004). I.E.C. Expert, & Diabetic Retinopathy Project.*Guideline for conducting a knowledge, attitude and practice (KAP) study*
29. Kaklamanos, E. G., Lazaridou, D., Tsiantou, D., Kotsanos, N., & Athanasiou, A. E. (2017). Dental arch spatial changes after premature loss of first primary molars: A systematic review of controlled studies. *Odontology, 105*(3), 364-374. doi:10.1007/s10266-016-0281-2
30. Kapoor, D., Bhatia, S., & Garg, D. (2018). Assessment of the attitude and knowledge of the principles and practices of orthodontic treatment among the non-orthodontic

specialists and general practitioner dentists. *JNMA; Journal of the Nepal Medical Association, 56*(212), 766-769. Retrieved from http://ezproxy.library.ubc.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=30387466&site=ehost-live&scope=site

31. Katz, J. (1984). Why doctors don't disclose uncertainty. *The Hastings Center Report, 14*(1), 35-44. doi:10.2307/3560848.

32. Kau, C. H., Durning, P., Richmond, S., Miotti, F. A., & Harzer, W. (2004). Extractions as a form of interception in the developing dentition: A randomized controlled trial. *Journal of Orthodontics, 31*(2), 107-114. doi:10.1179/146531204225020391
33. Kisling, E., & Høffding, J.. (1978a). Premature loss of primary teeth: Part I, its overall effect on occlusion and space in the permanent dentition. *ASDC Journal of Dentistry for Children, 45*(4), 279. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/279554
34. Kisling, E., & Høffding, J. (1978b). Premature loss of primary teeth: Part II, the specific effects on occlusion and space in the permanent dentition. *ASDC Journal of Dentistry for Children, 45*(4), 284. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/279555
35. Kisling, E., & Høffding, J. (1979c). Premature loss of primary teeth: Part III, drifting patterns for different types of teeth after loss of adjoining teeth. *ASDC Journal of Dentistry for Children, 46*(1), 34.
36. Kisling, E., & Høffding, J. (1979d). Premature loss of primary teeth: Part IV, a clinical control of sannerud's space maintainer, type I.*ASDC Journal of Dentistry for Children, 46*(2), 109.
37. Kisling, E., & Høffding, J. (1979e). Premature loss of primary teeth: Part V, treatment planning with due respect to the significance of drifting patterns. *ASDC Journal of Dentistry for Children, 46*(4), 300.
38. Koroluk, L. D., Jones, J. E., & Avery, D. R. (1988). Analysis of orthodontic treatment by pediatric dentists and general practitioners in indiana. *ASDC Journal of Dentistry for Children, 55*(2), 97.
39. Krumpal, I, (2013). Determinants of social desirability bias in sensitive surveys: A literature review. *Quality & Quantity, 47*(4), 2025-2047. doi:10.1007/s11135-011-9640-9
40. Kupietzky, A., & Tal, E. (2007). The transpalatal arch: An alternative to the nance appliance for space maintenance. *Pediatric Dentistry, 29*(3), 235-238. Retrieved from http://www.ingentaconnect.com/content/aapd/pd/2007/00000029/00000003/art00009
41. Laing, E., Ashley, P., Naini, F. B., & Gill, D. S. (2009). Space maintenance. *International Journal of Paediatric Dentistry / the British Paedodontic Society [and] the International Association of Dentistry for Children, 19*(3), 155-162. doi:10.1111/j.1365-263X.2008.00951.x

42. Launiala, Annika. (2009) How much can a KAP Survey tell us about people's Knowledge, Attitudes, and, Practices? Some observations from medical anthropology research on Malaria in pregnancy in Malawi, *Anthropology Matters, 11*.
43. Leader, D., Papas, A., & Finkelman, M. (2014). A survey of dentists' knowledge and attitudes with respect to the treatment of scleroderma patients. *JCR: Journal of Clinical Rheumatology, 20*(4), 189-194. doi:10.1097/RHU.0000000000000102

44. Letti, H. C. B., Rizzatto, S. M. D., de Menezes, L. M., Reale, C. S., de Lima, E. M., & Martinelli, F. L. (2013). Sagittal changes in lower incisors by the use of lingual arch. *Dental Press Journal of Orthodontics, 18*(3), 29-34. doi:10.1590/S2176-94512013000300006
45. Lin, H., Zhang, H., Yan, Y., Liu, D., Zhang, R., Liu, Y., & Xuan, D. (2014). Knowledge, awareness, and behaviors of endocrinologists and dentists for the relationship between diabetes and periodontitis. *Diabetes Research and Clinical Practice, 106*(3), 428-434. doi:10.1016/j.diabres.2014.09.008
46. Lin, Y. T., & Chang, L. C. (1998). Space changes after premature loss of the mandibular primary first molar: A longitudinal study. *The Journal of Clinical Pediatric Dentistry, 22*(4), 311. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/9796501
47. Lin, Y., Lin, W., & Lin, Y. J. (2007). *Immediate and six-month space changes after premature loss of a primary maxillary first molar*doi:https://doi-org.ezproxy.library.ubc.ca/10.14219/jada.archive.2007.0169
48. Lin, Y., Lin, W., & Lin, Y. J. (2011). Twelve-month space changes after premature loss of a primary maxillary first molar. *International Journal of Paediatric Dentistry, 21*(3), 161-166. doi:10.1111/j.1365-263X.2010.01105.x
49. Lingard, L., Garwood, K., Schryer, C. F., & Spafford, M. M. (2003). A certain art of uncertainty: Case presentation and the development of professional identity. *Social Science & Medicine, 56*(3), 603-616. doi:10.1016/S0277-9536(02)00057-6
50. Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational Behavior and Human Decision Processes, 69*(2), 149-163. doi:10.1006/obhd.1997.2679
51. Macena, M. C. B., Tornisiello Katz, C. R., Heimer, M. V., de Oliveira Silva, J. F., & Costa, L. B. (2011). Space changes after premature loss of deciduous molars among brazilian children. *American Journal of Orthodontics and Dentofacial Orthopedics, 140*(6), 771-778. doi:10.1016/j.ajodo.2011.04.023
52. Miyamoto, W., Chung, C. S., & Yee, P. K. (1976). Effect of premature loss of deciduous canines and molars on malocclusion of the permanent dentition. *Journal of Dental Research, 55*(4), 584-590. doi:10.1177/00220345760550040601
53. Moore, T. R., & Kennedy, D. B. (2006). Bilateral space maintainers: A 7-year retrospective study from private practice. *Pediatric Dentistry, 28*(6), 499-505. Retrieved from http://www.ingentaconnect.com/content/aapd/pd/2006/00000028/00000006/art00004
54. Nederhof, A. J. (1985). Methods of coping with social desirability bias: A review. *European Journal of Social Psychology, 15*(3), 263-280. doi:10.1002/ejsp.2420150303
55. Ngan, P., Alkire, R. G., & Fields, H., JR. (1999). Management of space problems in the primary and mixed dentitions. *The Journal of the American Dental Association, 130*(9), 1330-1339. doi:10.14219/jada.archive.1999.0403
56. Northway, W. M., Wainright, R. L., & Demirjian, A. (1984). Effects of premature loss of deciduous molars. *The Angle Orthodontist, 54*(4), 295. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6594960

57. Northway, W. M. (2000). The not-so-harmless maxillary: Primary first molar extraction. *The Journal of the American Dental Association, 131*(12), 1711. Retrieved from http://jada.ada.org/cgi/content/abstract/131/12/1711

58. Owen, D. G. (1971). The incidence and nature of space closure following the premature extraction of deciduous teeth: a literature study. *Am J Orthod.*, 59, 37–49.
59. Padma Kumari, B., & Retnakumari, N. (2006). Loss of space and changes in the dental arch after premature loss of the lower primary molar: A longitudinal study. *Journal of the Indian Society of Pedodontics and Preventive Dentistry, 24*(2), 90. doi:10.4103/0970-4388.26023
60. Park, K., Jung, D., & Kim, J. (2009). Three-dimensional space changes after premature loss of a maxillary primary first molar. *International Journal of Paediatric Dentistry, 19*(6), 383-389. doi:10.1111/j.1365-263X.2009.00990.x
61. Patel, A. M., Blanchard, S. B., Christen, A. G., Bandy, R. W., & Romito, L. M. (2011). A survey of united states periodontists' knowledge, attitudes, and behaviors related to Tobacco-Cessation interventions. *Journal of Periodontology, 82*(3), 367-376. doi:10.1902/jop.2010.100405
62. Pit, S. W., Vo, T., & Pyakurel, S. (2014). The effectiveness of recruitment strategies on general practitioner's survey response rates - a systematic review. *BMC Medical Research Methodology, 14*, 76. doi:10.1186/1471-2288-14-76
63. Posen, A. L. (1965). The effect of premature loss of deciduous molars on premolar eruption. *The Angle Orthodontist, 35*, 249. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14331026
64. Proffit, W. R., Fields, H. W.,Jr, Larson, B. E., & Sarver, D. M. (2018). *Contemporary orthodontics* (Sixth ed.). Philadelphia, PA: Elsevier. Retrieved from http://ubc.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwhV2xjsIwDLWgSAcbFE60B6g_UNTGDm1mOMRy2-1Vm6Qj_z9il6LjUCXGRIqVRJYt-9nPAKj2WfpiE9BZRS2xNnOMa7XBtimcaklrS43N_NtSnddWu0F0xqAuWEHHMMaiDP6muolVVrkwwZsOsFWoCTlS6Al4Hmv813ov_uU8h0B6DhYw8tcQpiep4JEhbCF8_PTY9xKiZyKpROAWjiivwrK8gvj8_Xu8pCy26vMxVX9L9QkBR_h-DUntrGNHntncIhuuvHSNK4lqgxnVGn0E4YCACDbPu4__qMxBON8pHjz0BTN2-eU9ibCBSctK7rfdu3fdh90Am_J26A
65. Qudeimat, M. A., & Fayle, S. A. (1998). The longevity of space maintainers: A retrospective study. *Pediatric Dentistry, 20*(4), 267. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9783298
66. Rajah, L. D. (2002). Clinical performance and survival of space maintainers: Evaluation over a period of 5 years. *Journal of Dentistry for Children, 69*(2), 156-160. Retrieved from http://www.ingentaconnect.com/content/aapd/jodc/2002/00000069/00000002/art00011?crawler=true
67. Razavi, S., Zolfaghari, B., Foroohandeh, M., Doost, M., & Tahani, B. (2013). Dentists' knowledge, attitude, and practice regarding oral cancer in iran. *Journal of Cancer Education, 28*(2), 335-341. doi:10.1007/s13187-013-0460-6
68. Rebellato, J., Lindauer, S. J., Rubenstein, L. K., Isaacson, R. J., Davidovitch, M., & Vroom, K. (1997a). Lower arch perimeter preservation using the lingual arch. *American*

Journal of Orthodontics & Dentofacial Orthopedics, 112(4), 449-456. doi:10.1016/S0889-5406(97)70054-4

69. Rich, J.P., Straffon, L., & Inglehart, M. R. (2006). General dentists and pediatric dental patients: The role of dental education.*Journal of Dental Education, 70*(12), 1308.
70. Rönnerman, A. (1977). The effect of early loss of primary molars on tooth eruption and space conditions A longitudinal study. *Acta Odontologica, 35*(5), 229-239. doi:10.3109/00016357709019797
71. Sanbonmatsu, D. M., Prince, K. C., Vanous, S., & Posavac, S. The Multiple Roles of Attitudes in Decision Making. Psychology Press, 2004, pp. 131-146. doi:10.4324/9781410611826.
72. Sayin, M. O., & Türkkahraman, H. (2006). Effects of lower primary canine extraction on the mandibular dentition. *The Angle Orthodontist, 76*(1), 31. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16448266
73. Sonis, A., & Ackerman, M. (2011). E-space preservation. *The Angle Orthodontist, 81*(6), 1045-1049. doi:10.2319/030711-165.1
74. Sjögren, A., Arnrup, K., Lennartsson, B., Huggare, J., Institutionen för odontologi, Institute of Odontology, . . . Sahlgrenska Academy. (2012). Mandibular incisor alignment and dental arch changes 1 year after extraction of deciduous canines. *European Journal of Orthodontics, 34*(5), 587-594. doi:10.1093/ejo/cjr028
75. Terlaje, R. D., & Donly, K. J. (2001). Treatment planning for space maintenance in the primary and mixed dentition. *ASDC Journal of Dentistry for Children, 68*(2), 109. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11475685
76. Tulunoglu, O., Ulusu, T., & Genç, Y. (2005). An evaluation of survival of space maintainers: A six-year follow-up study. *The Journal of Contemporary Dental Practice, 6*(1), 74. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15719079
77. Tunc, E. S., Bayrak, S., Tuloglu, N., Egilmez, T., & Isci, D. (2012). Evaluation of survival of 3 different fixed space maintainers. *Pediatric Dentistry, 34*(4), e97. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23014081
78. Tunison, W., Flores-Mir, C., ElBadrawy, H., Nassar, U., & El-Bialy, T. (2008). Dental arch space changes following premature loss of primary first molars: A systematic review. *Pediatric Dentistry, 30*(4), 297-302. Retrieved from http://www.ingentaconnect.com/content/aapd/pd/2008/00000030/00000004/art00004
79. Viglianisi, A. (2010). Effects of lingual arch used as space maintainer on mandibular arch dimension: A systematic review. *American Journal of Orthodontics and Dentofacial Orthopedics, 138*(4), 382.e1-382.e4. doi:10.1016/j.ajodo.2010.02.026
80. Villalobos, F. J., Sinha, P. K., & Nanda, R. S. (2000). Longitudinal assessment of vertical and sagittal control in the mandibular arch by the mandibular fixed lingual arch. *American Journal of Orthodontics & Dentofacial Orthopedics, 118*(4), 366-370. doi:10.1067/mod.2000.109626
81. Watt, E., Ahmad, A., Adamji, R., Katsimbali, A., Ashley, P., & Noar, J. (2018). Space maintainers in the primary and mixed dentition - a clinical guide. *British Dental Journal, 225*(4), 293-298. doi:10.1038/sj.bdj.2018.650

82. Yellowitz, J.A., Horowitz, A.M., Drury, T.F., & Goodman, H.S. (2000a). Survey of u.s. dentists' knowledge and opinions about oral pharyngeal cancer. *The Journal of the American Dental Association, 131*(5), 653-661. doi:10.14219/jada.archive.2000.0239

Appendices

Appendix 1: General dentists' survey

Survey Completion

Dear Colleague:

Because you are a practicing dentist in British Columbia, you are invited to participate in the study "Space Maintenance Treatment for Pediatric Patients". The Principal Investigator for this study and the supervisor is Dr. Jolanta Aleksejuniene, Associate Professor, Faculty of Dentistry, UBC.

Dr. Jassica Sarai is a graduate dental student for the combined MSc pediatric specialty program at the University of British Columbia. Her MSc will research about your experience with space management for pediatric dental patients.

This is an important study, because the combination of knowledge, attitudes and practices governs the decision-making process of health care professionals. Thus, the aim of the anonymous survey is to understand the knowledge, attitudes and practices of dentists with respect to diagnosing and treatment planning for space maintenance for their pediatric patients.

Your honest answers are important and all data in this survey is collected anonymously!
Your participation is completely voluntary, and you may decide not to answer some questions in the survey. Please note that the online UBC survey platform is provided by Qualtrics, that is the Canadian-hosted tool that meets both the BC privacy legislation and the UBC requirements. The cloud-based software stores the data on secure servers in Toronto, Canada and it is backed up in Montreal, Quebec. The survey will be open for a year starting from January 15, 2019.

Your decision to complete this survey will indicate your agreement to participate in the study.

Regardless of whether or not you choose to complete the survey, you will be automatically entered into a random draw where one in ten dentists will win a Starbucks gift card.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

If you require additional information or have any questions, please contact us.

Sincerely,

Survey Completion

Do you treat children in your practice?

- ◯ Yes
- ◯ No

How old are you?

- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ 65+

What is your gender?

- ◯ Male
- ◯ Female

How many years have you been practicing?

- ◯ <5
- ◯ 5-10
- ◯ 10-20
- ◯ 20+

What is your practice type?

- ◯ Solo
- ◯ Partnership
- ◯ Associate
- ◯ Other

Where did you attend dental school?

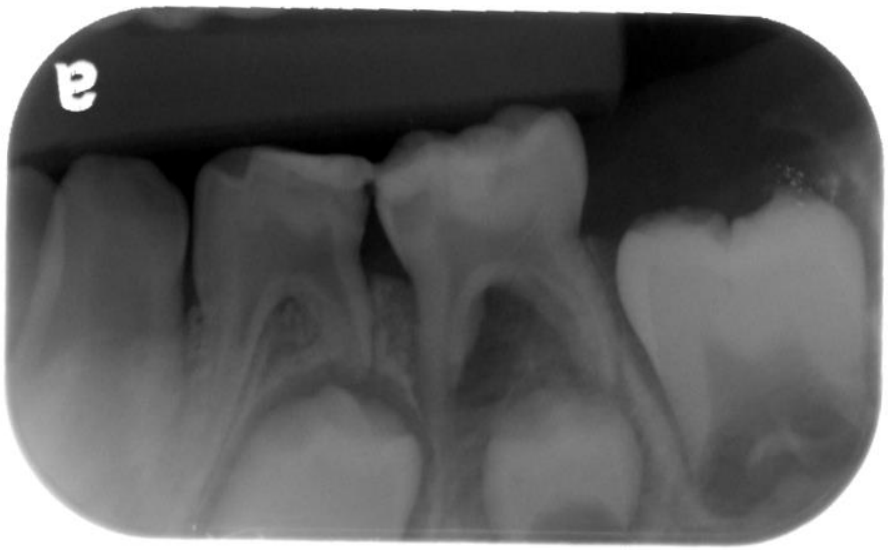
- ◯ Canada
- ◯ US
- ◯ Other

Are you part of any orthodontic or pediatric related study clubs? If so, please specify.

→

A 4-year 8- month old healthy male presents to your office with deep decay on the **left mandibular second primary molar (tooth #75)**. His mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below.

You have decided to restore the #74 and extract tooth #75



Space loss from extraction of a primary second molar in primary dentition is mostly the result of:

- ○ a. Mesial movement of the erupting permanent first molar
- ○ b. Distal movement of the primary first molar
- ○ c. Space loss is insignificant after loss of a primary first molar in primary dentition

Majority of the space closure, if any, happens within how many months after extraction of a primary molar?

- ○ a. 3 months
- ○ b. 6 months
- ○ c. 9 months
- ○ d. 12 months

Which is/are purposes of the primary second molar?

- ○ a. Maintain space for the permanent second premolar
- ○ b. Guide the eruption of the permanent first molar into place
- ○ c. Both A and B

How would you manage the space after the extraction?

- ◯ a. I would not manage this space at this time
- ◯ b. Immediately place a distal shoe space maintainer with a band on tooth #74
- ◯ c. Wait for tooth #36 to erupt and place a band and loop with a band on tooth #36
- ◯ d. Wait for tooth #36 to erupt and place a band and loop with a band on tooth #74
- ◯ e. Wait for tooth #36 and #46 to erupt and place a LLHA
- ◯ f. Refer to a pediatric dentist for space management
- ◯ g. Consider an orthodontist for a consultation

What clinical factors did you consider when planning for this patient's space management?

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage the #75 space with a fixed appliance	○	○	○	○	○
The space loss from the extraction of tooth #75 is insignificant	○	○	○	○	○
This patient will most likely need orthodontic treatment in the future, so space management with a fixed appliance is unnecessary at this time	○	○	○	○	○
I am comfortable with placing a distal shoe fixed appliance if necessary	○	○	○	○	○
The patient will feel discomfort with the space maintenance procedure	○	○	○	○	○
I received adequate training in dental school about managing space for this case	○	○	○	○	○
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would lose the confidence of the guardian and patient if I was to refer this patient to a pediatric dentist for space management	○	○	○	○	○
Space management for this case is the responsibility of the practitioner extracting the tooth	○	○	○	○	○
I believe space maintenance in this case is an important part of their pediatric dental care	○	○	○	○	○
The patient's dental coverage would strongly influence my decision to place a fixed appliance	○	○	○	○	○
I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth	○	○	○	○	○
I am concerned about losing this patient to follow up if a fixed appliance was placed	○	○	○	○	○

→

Survey Completion

A cooperative 10 year old healthy male presents to your office for a new patient exam. He is in late mixed dentition, has class I malocclusion, 2 mm overjet, and 40% overbite. With respect to the mandibular anterior sextant, you notice the presence of all the lower permanent incisors, and the right permanent canine (tooth#43). You decide to a take a panoramic radiograph, which appears below.

What is Leeway Space?

- ◯ a. Physiologic space between the primary lateral incisors and primary canine
- ◯ b. Physiologic space between the primary canine and primary first molar
- ◯ c. Difference between the D/E and succedaneous premolars
- ◯ d. Difference between the C/D/E and the succedaneous permanent canine, and premolars

What is the normal Leeway space available for the maxilla?

- ◯ a. 0.9 mm in total
- ◯ b. 1.8 mm in total
- ◯ c. 3.6 mm in total

What is the normal Leeway space available for the mandible?

- ◯ a. 0.9 mm in total
- ◯ b. 1.8 mm in total
- ◯ c. 3.6 mm in total

What is the earliest time a LLHA should be considered?

- ◯ a. Permanent molars are fully erupted, and lower permanent central incisors have not erupted
- ◯ b. Permanent molars and centrals are fully erupted, lower permanent laterals have not erupted
- ◯ c. Permanent molars, lower centrals and lower laterals have erupted

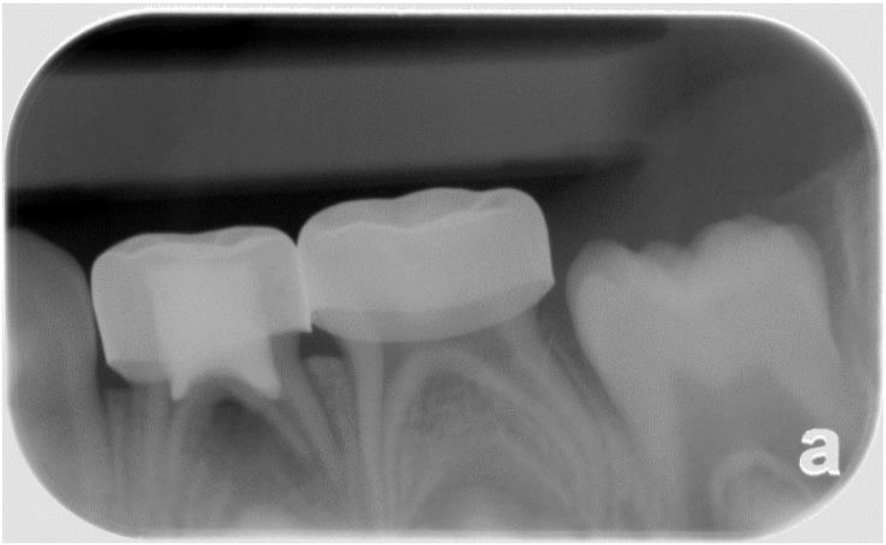
How would you proceed?

- ◯ a. Never paid attention for a potential spacing concern
- ◯ b. Place a Lower Lingual Holding Arch
- ◯ d. Refer to a pediatric dentist for space management
- ◯ e. Consider an orthodontist for a consultation

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage this case with a fixed appliance	◯	◯	◯	◯	◯
Diagnosing space management for this case is within the scope of care that a general dentist is responsible for providing	◯	◯	◯	◯	◯
Immediate space management intervention will improve the ease of future orthodontic treatment for this case	◯	◯	◯	◯	◯
I am comfortable with placing a lower lingual holding arch fixed appliance for a patient of this age and behaviour	◯	◯	◯	◯	◯
The patient will feel discomfort with the space maintenance procedure	◯	◯	◯	◯	◯
I received adequate training in dental school about diagnosing whether space management is needed for this case	◯	◯	◯	◯	◯
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would lose the confidence of the guardian and patient if I was to refer this patient to a pediatric dentist for space management	◯	◯	◯	◯	◯
I believe space maintenance is an important part of pediatric dental care	◯	◯	◯	◯	◯
The patient's dental coverage would strongly influence my decision to place a fixed appliance	◯	◯	◯	◯	◯
Intervention with a fixed appliance to manage space is time consuming	◯	◯	◯	◯	◯
I lack a personal interest in space management	◯	◯	◯	◯	◯

A 4-year 5- month old healthy female presents to your office with deep decay on the **left mandibular first primary molar (tooth #74).** Her mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below. You have decided to extract the tooth.



At what age is it expected for a lower first premolar to erupt?

- ◯ a. 8-10 years old
- ◯ b. 9-11 years old
- ◯ c. 10-12 years old
- ◯ d. 11-13 years old

Will extracting a non-restorable first primary molar in the primary dentition affect the eruption of the successor permanent tooth?

- ◯ a. Yes, it will accelerate its eruption
- ◯ b. Yes, it will delay its eruption
- ◯ c. No, it will not affect the eruption of the succedaneous tooth

Space loss from the extraction of a mandibular primary first molar in primary dentition is mostly the result of:

- ◯ a. Mesial movement of the primary second molar
- ◯ b. Distal movement of the primary canine
- ◯ c. Space loss is insignificant for loss of a primary first molar in primary dentition

How would you manage the space after the extraction?

- ◯ a. The space does not need to be managed at this time
- ◯ b. Plan for a band-and-loop space maintainer
- ◯ c. Refer to a pediatric dentist for space management
- ◯ d. Consider an orthodontist for a consultation

→

Survey Completion

If you decided to place a band-and loop space maintainer, how would you proceed?

- ◯ a. Fit a band on the 75, and then send an impression for a lab fabricated space maintainer
- ◯ b. Send an impression for a lab fabricated space maintainer without band fitting the 75
- ◯ c. Place an in-office band and loop on the 75

What clinical factors did you consider when planning for this patient's space management?

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage the #74 space with a fixed appliance	○	○	○	○	○
The space loss from the extraction of tooth #74 is insignificant	○	○	○	○	○
This patient will most likely need orthodontic treatment in the future, so space management is unnecessary at this time	○	○	○	○	○
I am comfortable with placing a band and loop fixed appliance for a patient of this dental age	○	○	○	○	○
The patient will feel discomfort with the space maintenance procedure	○	○	○	○	○
I received adequate training in dental school about managing space for this case	○	○	○	○	○
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I would lose the confidence of the guardian and patient if I was to refer this patient to a pediatric dentist for space management	○	○	○	○	○
Space management for this case is the responsibility of the practitioner extracting the tooth	○	○	○	○	○
I believe space maintenance in this case is an important part of their pediatric dental care	○	○	○	○	○
The patient's dental coverage would strongly influence my decision to place a fixed appliance	○	○	○	○	○
I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth	○	○	○	○	○
I am concerned about losing this patient to regular follow up if a fixed appliance was placed	○	○	○	○	○

Survey Completion

Please answer the following questions related to your practice:

	Frequencies			
	Frequently	Occasionally	Seldom	Never
How often in an average month do you see patients in primary dentition?	○	○	○	○
How often in an average month do you see patients in early mixed dentition?	○	○	○	○
How often in an average month do you see patients in late mixed dentition?	○	○	○	○
How often do your pediatric patients have ministry coverage?	○	○	○	○
How often do your pediatric patients have private dental coverage?	○	○	○	○
	Frequently	Occasionally	Seldom	Never
How often do you mention space loss to parents of pediatric patients when there is an extraction of a primary molar?	○	○	○	○
How often do you place band and loop space maintainers for cases where the 6 has erupted?	○	○	○	○
How often do you place distal shoe space maintainers for cases where the 6 has not yet erupted?	○	○	○	○
How often do you place a Lower Lingual Holding Arch?	○	○	○	○
How often do you or your staff band fit for fixed appliances?	○	○	○	○

→

Survey Completion

Thank you for your participation! Please provide us with any of your comments or questions below.

→

Appendix 2: Pediatric dentists' survey

Survey Completion

Dear Colleague:

Because you are a practicing dentist in British Columbia, you are invited to participate in the study "Space Maintenance Treatment for Pediatric Patients". The Principal Investigator for this study and the supervisor is Dr. Jolanta Aleksejuniene, Associate Professor, Faculty of Dentistry, UBC.

Dr. Jassica Sarai is a graduate dental student for the combined MSc pediatric specialty program at the University of British Columbia. Her MSc will research about your experience with space management for pediatric dental patients.

This is an important study, because the combination of knowledge, attitudes and practices governs the decision-making process of health care professionals. Thus, the aim of the anonymous survey is to understand the knowledge, attitudes and practices of dentists with respect to diagnosing and treatment planning space maintenance for their pediatric patients.

Your honest answers are important and all data in this survey is collected anonymously! Your participation is completely voluntary, and you may decide not to answer some questions in the survey. Please note that the online UBC survey platform is provided by Qualtrics, that is the Canadian-hosted tool that meets both the BC privacy legislation and the UBC requirements. The cloud-based software stores the data on secure servers in Toronto, Canada and it is backed up in Montreal, Quebec. The survey will be open for a year starting from January 15, 2019.

Your decision to complete this survey will indicate your agreement to participate in the study.

Regardless of whether or not you choose to complete the survey, you will be automatically entered into a random draw where one in 10 dentists will win a Starbucks gift card.

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

If you require additional information or have any questions, please contact us.

Sincerely,

Survey Completion

How old are you?

- ◯ 25-35
- ◯ 36-45
- ◯ 46-55
- ◯ 56-65
- ◯ 65+

What is your gender?

- ◯ Male
- ◯ Female

How many years have you been practicing?

- ◯ <5
- ◯ 5-10
- ◯ 10-20
- ◯ 20+

What is your practice type?

- ◯ Solo
- ◯ Partnership
- ◯ Associate
- ◯ Other

Where did you complete your residency ?

- ◯ Canada
- ◯ US
- ◯ Other

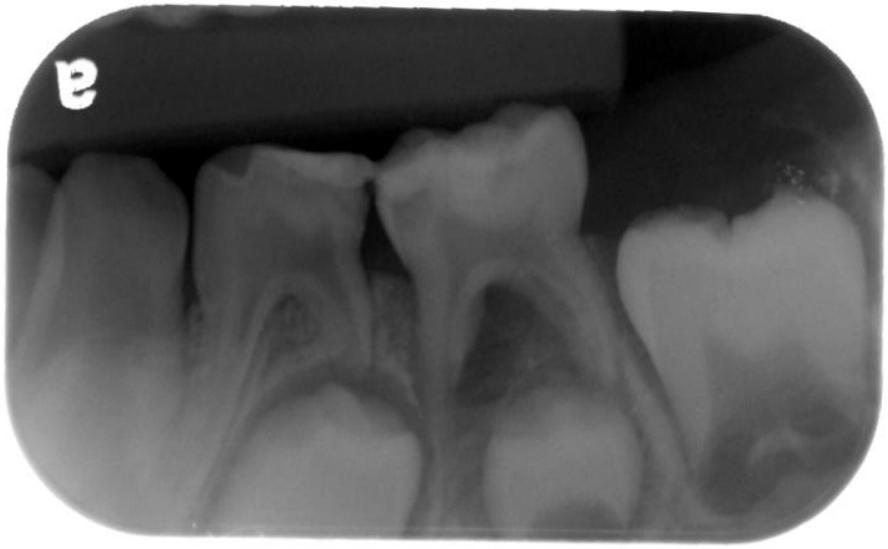
Are you part of any orthodontic or pediatric related study clubs? If so, please specify.

→

Survey Completion

A 4-year 8- month old healthy male presents to your office with deep decay on the **left mandibular second primary molar (tooth #75)**. His mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below.

You have decided to restore the #74 and extract tooth #75



Space loss from extraction of a primary second molar in primary dentition is mostly the result of:

- ◯ a. Mesial movement of the erupting permanent first molar
- ◯ b. Distal movement of the primary first molar
- ◯ c. Space loss is insignificant after loss of a primary first molar in primary dentition

Majority of the space closure, if any, happens within how many months after extraction of a primary molar?

- ◯ a. 3 months
- ◯ b. 6 months
- ◯ c. 9 months
- ◯ d. 12 months

Which is/are purposes of the primary second molar?

- ◯ a. Maintain space for the permanent second premolar
- ◯ b. Guide the eruption of the permanent first molar into place
- ◯ c. Both A and B

How would you manage the space after the extraction?

- ◯ a. I would not manage this space at this time
- ◯ b. Immediately place a distal shoe space maintainer with a band on tooth #74
- ◯ c. Wait for tooth #36 to erupt and place a band and loop with a band on tooth #36
- ◯ d. Wait for tooth #36 to erupt and place a band and loop with a band on tooth #74
- ◯ e. Wait for tooth #36 and #46 to erupt and place a LLHA
- ◯ f. Consider an orthodontist for a consultation

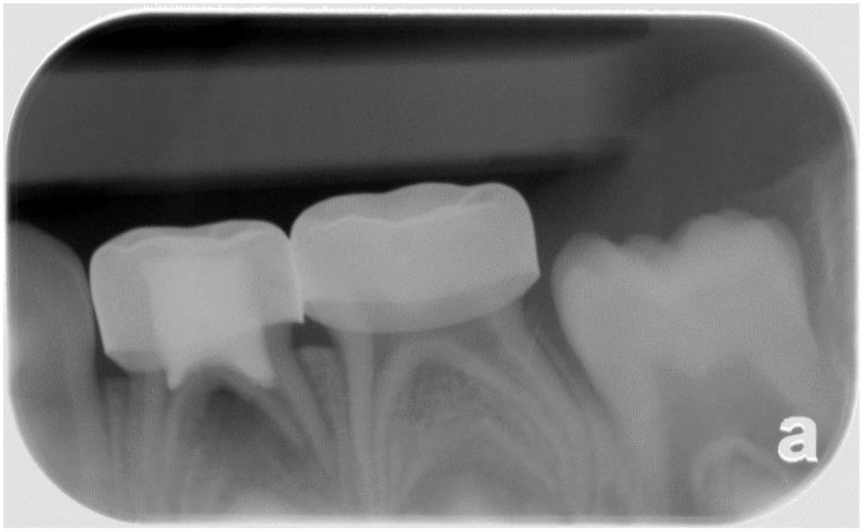
What clinical factors did you consider when planning for this patient's space management?

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage the #75 space with a fixed appliance	○	○	○	○	○
The space loss from the extraction of tooth #75 is insignificant	○	○	○	○	○
This patient will most likely need orthodontic treatment in the future, so space management with a fixed appliance is unnecessary at this time	○	○	○	○	○
I am comfortable with placing a distal shoe fixed appliance if necessary	○	○	○	○	○
The patient will feel discomfort with the space maintenance procedure	○	○	○	○	○
I received adequate training in my residency about managing space for this case	○	○	○	○	○
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Space management for this case is the responsibility of the practitioner extracting the tooth	○	○	○	○	○
I believe space maintenance in this case is an important part of their pediatric dental care	○	○	○	○	○
The patient's dental coverage would strongly influence my decision to place a fixed appliance	○	○	○	○	○
I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth	○	○	○	○	○
I am concerned about losing this patient to follow up if a fixed appliance was placed	○	○	○	○	○

→

A 4-year 5- month old healthy female presents to your office with deep decay on the **left mandibular first primary molar (tooth #74).** Her mother reports a history of spontaneous pain on the tooth. The periapical radiograph appears below. You have decided to extract the tooth.



At what age is it expected for a lower first premolar to erupt?

- ◯ a. 8-10 years old
- ◯ b. 9-11 years old
- ◯ c. 10-12 years old
- ◯ d. 11-13 years old

Will extracting a non-restorable first primary molar in the primary dentition affect the eruption of the successor permanent tooth?

- ◯ a. Yes, it will accelerate its eruption
- ◯ b. Yes, it will delay its eruption
- ◯ c. No, it will not affect the eruption of the succedaneous tooth

Space loss from the extraction of a mandibular primary first molar in primary dentition is mostly the result of:

- ◯ a. Mesial movement of the primary second molar
- ◯ b. Distal movement of the primary canine
- ◯ c. Space loss is insignificant for loss of a primary first molar in primary dentition

How would you manage the space after the extraction?

- ◯ a. The space does not need to be managed at this time
- ◯ b. Plan for a band-and-loop space maintainer
- ◯ c. Consider an orthodontist for a consultation

→

Survey Completion

If you decided to place a band-and loop space maintainer, how would you proceed?

- ◯ a. Fit a band on the 75, and then send an impression for a lab fabricated space maintainer
- ◯ b. Send an impression for a lab fabricated space maintainer without band fitting the 75
- ◯ c. Place an in-office band and loop on the 75

What clinical factors did you consider when planning for this patient's space management?

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage the #74 space with a fixed appliance	○	○	○	○	○
The space loss from the extraction of tooth #74 is insignificant	○	○	○	○	○
This patient will most likely need orthodontic treatment in the future, so space management is unnecessary at this time	○	○	○	○	○
I am comfortable with placing a band and loop fixed appliance for a patient of this dental age	○	○	○	○	○
The patient will feel discomfort with the space maintenance procedure	○	○	○	○	○
I received adequate training in my residency about managing space for this case	○	○	○	○	○
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Space management for this case is the responsibility of the practitioner extracting the tooth	○	○	○	○	○
I believe space maintenance in this case is an important part of their pediatric dental care	○	○	○	○	○
The patient's dental coverage would strongly influence my decision to place a fixed appliance	○	○	○	○	○
I am concerned about the patient's oral hygiene status, and risk of caries around a banded tooth	○	○	○	○	○
I am concerned about losing this patient to regular follow up if a fixed appliance was placed	○	○	○	○	○

→

Survey Completion

A cooperative 10 year old healthy male presents to your office for a new patient exam. He is in late mixed dentition, has class I malocclusion, 2 mm overjet, and 40% overbite. With respect to the mandibular anterior sextant, you notice the presence of all the lower permanent incisors, and the right permanent canine (tooth#43). You decide to a take a panoramic radiograph, which appears below.

What is Leeway Space?

- ◯ a. Physiologic space between the primary lateral incisors and primary canine
- ◯ b. Physiologic space between the primary canine and primary first molar
- ◯ c. Difference between the D/E and succedaneous premolars
- ◯ d. Difference between the C/D/E and the succedaneous permanent canine, and premolars

What is the normal Leeway space available for the maxilla?

- ◯ a. 0.9 mm in total
- ◯ b. 1.8 mm in total
- ◯ c. 3.6 mm in total

What is the normal Leeway space available for the mandible?

- ◯ a. 0.9 mm in total
- ◯ b. 1.8 mm in total
- ◯ c. 3.6 mm in total

What is the earliest time a LLHA should be considered?

- ◯ a. Permanent molars are fully erupted, and lower permanent central incisors have not erupted
- ◯ b. Permanent molars and centrals are fully erupted, lower permanent laterals have not erupted
- ◯ c. Permanent molars, lower centrals and lower laterals have erupted

How would you proceed?

- ○ a. Never paid attention for a potential spacing concern
- ○ b. Place a Lower Lingual Holding Arch
- ○ d. Refer to a pediatric dentist for space management
- ○ e. Consider an orthodontist for a consultation

Please indicate your level of agreement/disagreement with the following statements regarding your treatment decisions for this case.

	Level of Agreement				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am confident with diagnosing if it is necessary to manage this case with a fixed appliance	○	○	○	○	○
Immediate space management intervention will improve the ease of future orthodontic treatment for this case	○	○	○	○	○
I am comfortable with placing a lower lingual holding arch fixed appliance for a patient of this age and behaviour	○	○	○	○	○
The patient will feel discomfort with the space maintenance procedure	○	○	○	○	○
I received adequate training in my residency about diagnosing whether space management is needed for this case	○	○	○	○	○
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I believe space maintenance is an important part of pediatric dental care	○	○	○	○	○
The patient's dental coverage would strongly influence my decision to place a fixed appliance	○	○	○	○	○
Intervention with a fixed appliance to manage space is time consuming	○	○	○	○	○
I lack a personal interest in space management	○	○	○	○	○

→

Survey Completion

Please answer the following questions related to your practice:

	Frequencies			
	Frequently	Occasionally	Seldom	Never
How often in an average month do you see patients in primary dentition?	○	○	○	○
How often in an average month do you see patients in early mixed dentition?	○	○	○	○
How often in an average month do you see patients in late mixed dentition?	○	○	○	○
How often do your pediatric patients have ministry coverage?	○	○	○	○
How often do your pediatric patients have private dental insurance?	○	○	○	○
	Frequently	Occasionally	Seldom	Never
How often do you mention space loss to parents of your pediatric patients when there is an extraction of a primary molar?	○	○	○	○
How often do you place band and loop space maintainers for cases where the 6 has erupted?	○	○	○	○
How often do you place distal shoe space maintainers for cases where the 6 has not yet erupted?	○	○	○	○
How often do you place a Lower Lingual Holding Arch?	○	○	○	○
How often do you or your staff band fit for fixed appliances?	○	○	○	○

→

Survey Completion

Thank you for your participation! Please provide us with any of your comments or questions below.

→