EXTRACTION OF THE BROKEN DOWN FIRST PERMANENT MOLAR IN CHILDREN: PRACTICE AND KNOWLEDGE OF UNITED ARAB EMIRATES DENTISTS

By:

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ABSTRACT

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Introduction: Treatment of broken down first permanent molars (BDFPMs) varies from simple restorations to enforced extractions. In 2014, the guidelines for "Enforced Extractions of First Permanent Molars (EExFPMs)" were published in the United Kingdom.

Aim: To assess the knowledge and practice of dentists in the United Arab Emirates (UAE) regarding the extraction of BDFPMs in children in light of the 2014 guidelines.

Materials and methods: A cross-sectional sample of general dental practitioners (GDPs), paediatric dentists (PDs) and other practicing dentists dealing with children in the UAE completed a self-administered questionnaire between January 2016 and April 2016. Multiple-choice questions covered management of BDFPMs; experience of BDFPMs extraction; knowledge and practice of the principle of EExFPMs; views on preservation or extraction of BDFPMs; to whom a case of BDFPMs would be referred; knowledge of the ideal age for the EExFPMs and finally actual awareness of the 2014 UK guidelines. Chi-square tests were conducted and statistical significance was set at 5%.

Results: A total of 199 from 300 questionnaires were completed (66.33% return rate). Of those, 85% of the participants believed in saving BDFPMs rather than extraction and 89% preferred to refer/consult with other specialists. A majority (63%) believed that the decision to extract or keep BDFPMs was age related, and 61% knew the most appropriate age to extract lower FPMs (8.5-10.5 years). Despite 69% being aware of the concept of EExFPMs in general, 51% had not considered and 74% had not practiced it in children. In addition, 82% of UAE dentists were unaware of the UK 2014 EExFPMs guidelines. Training background, speciality were significant influencing factors ($p \leq 0.05$).

Conclusion: Dentists in UAE prefer to restore rather than extract BDFPMs in children, although they would consult other specialists in case of BDFPMs extraction. There was lack of awareness of the actual UK 2014 EExFPMs guidelines in the UAE.

DEDICATION

To my parents for their endless love and support.

To my brothers & my grandmother, without whom none of my success would be possible.

DECLARATION

I declare that all the content of the thesis is my own work. There is no conflict of interest with any other entity or organization.

Name: Maryam Dastouri

Signature:

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ABBREVIATIONS

AAPD- The American Academy of Paediatric Dentistry

AEEDC- The UAE International Dental Conference and Arab Dental Exibition

AFRO- African Region

AMRO- American Region

BDFPM- Broken Down First Permanent Molar

CPP-ACP- Casein Phosphopeptide-Amorphous Calcium Phosphate

DDE- Developmental Defects of Enamel

DHA- Dubai Health Authority

DHCA- Dubai Healthcare Authority

DMFT- Decayed Missing and Filled Permanent Teeth

DMH- Deciduous Molar Hypomineralisation

EExFPMs- Enforced Extraction of First Permanent Molars

EURO- Europe Region

FDI- The World Dental Federation

FDSRCS Eng- The Faculty of Dental Surgery at the Royal College of Surgeons of England

FPMs – First Permanent molars

FS- Fissure Sealants

GDP- General Dental Practitioner

GCP- Good Clinical Practice

HAAD- Health Authority of Abu Dhabi

KAU- King Abdulaziz University

MBRU- Mohammed Bin Rashid University of Medicine and Health Sciences

MBR-AMC- Mohammed Bin Rashed Academic Medical Centre

MIH- Molar Incisor Hypomineralisation

MOH- Ministry of Health

PAR- Population Attributable Risk

PEB- Post Eruptive Breakdown

PMCs- Preformed Metal Crowns

SBA- single-bottle adhesive

SEA- Self-etching adhesive

SSC- Stainless Steel Crowns

STROBE- Strengthening the Reporting of Observational Studies in Epidemiology

TAD- temporary anchorage device

TSL- Tooth Surface Loss

UK- United Kingdom

UAE- Unites Arab Emirates

WHO- World Health Organization

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Appendix I- Questionnaire

Appendix II- Ethical Approval Form

Appendix III- Poster publication (BSPD)

1.00 INTRODUCTION

First permanent molars (FPMs) are the first permanent multi cusped teeth to erupt in the oral cavity at around six years of age, thereby making these teeth more susceptible to dental caries[1,2]. In 2003, 43% of 12-year-old children in the United Kingdom (UK) had some caries experience[3]. A more recent literature review in 2014 showed that dental caries is a considerable public health problem in children aged 12 and younger residing in the United Arab Emirates (UAE) with the decayed missing and filled permanent teeth (DMFT) score ranged from 1.6 to 3.24[4]. These teeth represent the cornerstone of establishing the permanent occlusion, so their importance in the development of the dentition is never underestimated. Also, the occurrence of some chronological and non-chronological enamel defects lead first permanent molars to hypomineralization and hypoplasia such as Molar Incisor Hypomineralisation (MIH). According to previously published studies, the prevalence of MIH is context-dependant and differs between counties and years of birth, with the variation located between 2.4% to 40.2%[5]. Based on Hussain *et al*.'s study the prevalence of MIH in school children in Dubai, UAE was 27.2 percent[6].

The clinical management of caries and developmental defects of enamel of the FPMs is a challenge to dental professionals around the world. For example, the management of MIH is complicated[7]. The latter has immediate, short, medium and long-term management aspects that involve many dental disciplines. According to recently published UK guidelines, decision-making regarding poor prognosis FPMs should ideally involve both the paediatric dentist as well as the orthodontist; granted it is not always

possible to achieve this goal[8]. Other factors come into play in the decision-making process, besides the clinical features. These factors include the child's socioeconomic background, their ability to cooperate with restorative or orthodontic treatment and their oral hygiene practice.

The issue of removal of FPMs as an elective procedure, what is known as the "Enforced Extractions of First Permanent Molars," or EExFPMs. is a recently developed concept[8,9]. It does not represent all schools of thought in dentistry and therefore the procedure has its supporters as well as its opponents[10] - who are concerned about the general extraction of FPMs. In addition, if extractions take place, there is confusion among clinicians to whether a 'compensating extraction' (i.e. extraction of the opposing FPM to prevent it over erupting) or a 'balancing extraction' (i.e. extraction of the contralateral FPM to establish symmetry) is necessary although the guidelines recommend this in certain instances[11]. Therefore, in order to avoid inappropriate and unnecessary dental extractions, it is important to consider whether EExFPMs are in the best interest of the child, particularly when the children or parents refuse to accept the extractions required to achieve optimal long-term oral health.

Per the UK guidelines, EExFPMs is one modality of treatment for compromised FPMs and is a method that should be chosen carefully after appropriate planning. Other treatment options that are indexed for FPMs include: no treatment, fissure sealants, permanent restorations, temporary restorations, stainless steel crowns, fixed permanent crowns with or without root canal treatment[12]. Regardless of the method, a full developing dentition assessment should be performed prior to the extraction of FPMs. Aspects like dental pain, parental attitudes and views towards the treatment, and the

ability of the child to tolerate treatment under local anaesthesia should be taken into consideration in the decision-making process and may in turn affect the decision to restore or extract first permanent morals[11]. Moreover, the decision to extract some or more teeth affects management choices such as the decision to administer local anesthetic injections alone, to use inhalation sedation or to administer general anesthesia, all of which are needed to support the child patient with the extraction procedure[13].

The extraction of the BDFPM has not been addressed in the UAE before. Therefore, the purpose of this study was to assess UAE dentists' knowledge and practice of the extraction of the BDFPM in light of the EExFPMs 2014 guidelines.

2.00 LITERATURE REVIEW

2.10 Introduction

The first permanent molars (FPMs) are some of the earliest teeth to erupt in the permanent dentition in most cases (after lower central incisors). These molars undoubtedly have significant influence over the teeth erupting later, both behind and in front of them[14]. The FPMs have the greatest root surface area for anchorage, they support the primary masticatory duty, and they influence the vertical distance of upper and lower jaws, the occlusal height, and esthetic proportions[15]. Therefore, it is undeniable that the health of these teeth may serve as a sound basis to assess the oral health of children. It has been reported that FPMs are the most carious prone teeth in permanent dentition due to both their functional and morphological aspects (deep pits and fissures on the occlusal surface) alongside the surrounding conditions that the newly erupted permanent molars have to front[1].

Histologically, the first permanent molars are formed from dental lamina in week 17 of gestation in the human embryo and the enamel formation in the crowns of PFMs begins in utero around week 20. By birth, hard tissue formation has initiated in the first permanent molars, and by the age of three, coronal development is complete. Finally, around the age of six to seven years, eruption of the first permanent molars occurs, and by the age of 9-10 years, root formation is complete[16].

The complete crown formation of FPMs supposedly takes about three years. Therefore, research into the aetiology of defects such as hypomineralization and hypoplasia has concentrated on environmental insults occurring in the first three years after birth. Research conducted, however, has failed to show one specific aetiological factor associated with these defects[17]. Nevertheless, they show that FPMs are vulnerable to upsets and disturbances whether systemic in origin or acquired.

2.20 FPMs and developmental background: Embryology and histology in the mandible and maxilla

2.21 Initiation stage

Day 11 of gestation marks the earliest histological indication of tooth development. This step is marked by a thickening of the epithelium where tooth formation will occur on the oral surface of the first brachial arch[18]. A sheet of epithelial cells extends from the lining of the oral cavity into the underlying ectomesenchyme and forms the dental lamina[19].

2.22 Bud stage

In week six, the dental lamina resembles a U-shaped thickening or buds of the oral epithelium (surface ectoderm). Primarily, localized proliferation of cells in the dental lamina forms the round swellings and the tooth buds, which grow into the mesenchyme. The ten-week fetus formation sees the buds for all permanent teeth form and also initiates the development of the 20 deciduous predecessors, that have deeper continuations of

dental lamina[20]. Not including the second and third permanent molars that appear after birth, tooth buds for all the permanent teeth develop at various stages throughout the fetal period except. The permanent molars with no deciduous predecessors form as buds from late extensions of the dental lamina[16].

2.23 Cap stage

The deep surface of each ectodermal tooth becomes invaginated by mesenchymal tissue, referred to as the dental papilla, which in turn initiates the formation of dentin and dental pulp. Referred to as an enamel organ, the ectodermal, cap-shaped structure covering the papilla later creates the tooth enamel. This inner layer, the "cap", serves as the inner enamel epithelium and the outer layer of the ectodermal enamel serves as the outer enamel epithelium. What creates the core or the bulk of the inner "cap" is referred to as stellate or enamel reticulum. As the enamel organ forms alongside the dental papilla, the surrounding mesenchyme condenses into a dental sac that later develops the cementum and periodontal ligament[16].

2.24 Bell stage

It is due to the invagination of the enamel organ that the tooth assumes a bell shape. The mesenchymal cells in the dental papilla, next to the inner enamel epithelium, modify into odontoblasts, which create predentin, and deposit it adjacent to the inner enamel epithelium. The predentin later calcifies to form dentin. Alongside the thickening of the dentin, the odontoblasts regress to the core of the dental papilla. However, it important to

note that odontoblastic processes remain in the dentin and are called Tomes' dentinal fibers[21].

Ameloblasts are formed by cells of the inner enamel epithelium which are adjacent to the dentin. Ameloblasts are important in that they produce enamel rods over the dentin layer, thereby later assisting in the formation of the crown, the outer layer of the tooth. As enamel increases, the ameloblasts regress. Hence, both enamel and dentin contribute to creating the crown, which begins formation at the cusp or tip of the tooth and later progresses to the root. The formation of the root begins after the enamel and dentin are completely developed. Both the inner and outer enamel epithelium grow together in the neck area to later form an epithelial fold, the epithelial root sheath, whichever turns into the mesenchyme and causes the development of the root. The odontoblasts that are located next to the sheath form the dentin (continuous with that of the crown). As the dentin advances, the pulp cavity gets smaller and becomes a narrow canal allowing vessels and nerves to enter the root. The inner cells of the dental sac develop cementoblasts that produce cementum, which is deposited over the root dentin and engages the enamel at the neck of the tooth. As the teeth grow, the jaws ossify, and the outer cells of the dental sac further grow active in bone formation. The entire tooth is eventually enclosed by bone, and is locked in its bony socket or alveolus through the periodontal ligament[16].

2.25 Maturation and mineralisation

This step is marked by the completion of the calcification process. Hard tissues including

enamel and dentin develop during this stage. Both amelogensis and dentinogenesis, the formation of enamel and formation of dentin respectively, are the two first identifiable features of this stage[22]. The formation of enamel must always proceed the formation of dentin. Due to the different stages of dentin formation, various types dentin are formed: mantle dentin, primary dentin, secondary dentin and tertiary dentin[23].

2.26 Enamel and dentine development

Tooth enamel is a tissue of epithelial origin, unable to regenerate after its formation. Therefore, injuries that are sustained during the period of enamel formational are permanently recorded on the surface of the enamel, characterizing the Developmental Defects of Enamel (DDE) [23].

The process of enamel development, or amelogenesis, is divided into for defined phases of pre-secretion, secretion, transition and maturation[24].

During the first stage, pre-secretion, the epithelial cells of the inner enamel epithelium rest on a basement membrane which contains laminin. The second stage, secretion, is characterized by when these cells increase in length and differentiate into ameloblasts above the predentin matrix. Transition, the third stage, is marked by simultaneous pre-secretory ameloblasts sending processes through the degenerating basement membrane as they initiate the secretion of enamel proteins on the villous surface of mineralizing dentin. After establishing the dentin-enamel junction and mineralizing a thin layer of aprismatic enamel, secretory ameloblasts develop a secretory specialization or Tomes' process. Along the secretory face of the Tomes' process, in place of the absent basement

membrane, secretory ameloblasts secrete proteins at a mineralization front where the enamel crystals grow in length (Stage 4). Then each enamel rod follows a retreating Tomes' process from a single ameloblast.

The end of the secretory stage is marked by ameloblasts losing their Tomes' process and in turn producing a thin layer of aprismatic enamel (Stage 5). It is at this point that the enamel achieves its final thickness. During the transition stage, the ameloblasts undergo major restructuring processes that diminish their secretory activity and the types of proteins secreted changes to KLK4, which degrades the accumulated protein matrix (Stage 6).

Finally, during the maturation stage ameloblasts modulate between ruffled and smooth-ended phases and Their activities harden the enamel layer (Stage 7)[25].

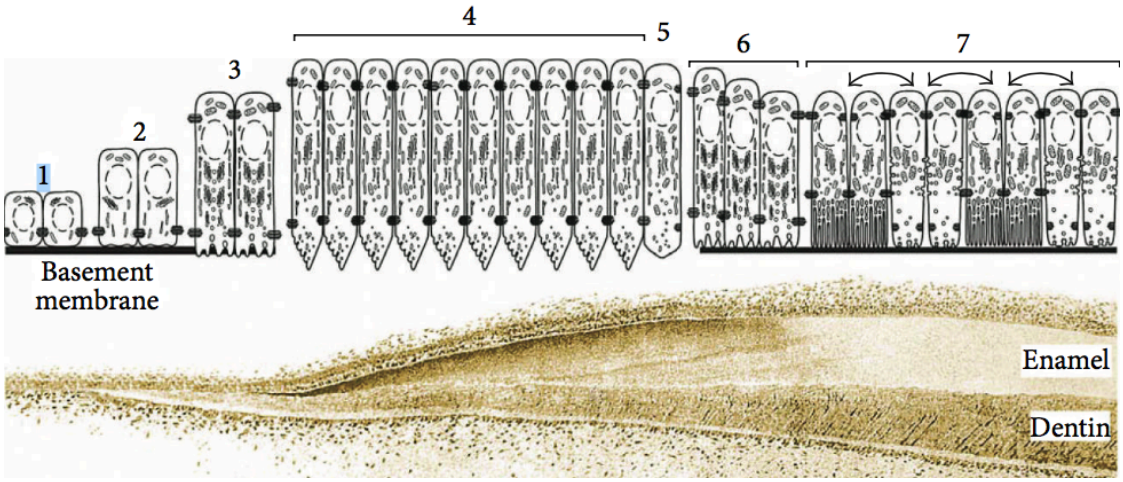

Figure 1: Enamel development process. (Bartlett, J. D. Dental Enamel Development : Proteinases and Their Enamel Matrix Substrates)[25].

The first distinguishable characteristic during the stage of crown formation is dentinogenesis, the term used for dentin formation. The formation of enamel must always precede the formation of dentin. Due to the different stages in dentin formation, various forms of dentin are resultant: mantle dentin, primary dentin, secondary dentin, and tertiary dentin[22].

Odontoblasts, the dentin-forming cells, differentiate from cells of the dental papilla. They begin secreting an organic matrix around the area directly adjacent to the inner enamel epithelium, closest to the area of the future cusp of a tooth. The organic matrix contains collagen fibers with large diameters (0.1-0.2 μm in diameter)[21]. The odontoblast process is formed when the odontoblasts begin to move toward the centre of the tooth. Therefore, it is the case that dentin formation continues inside of the tooth. The odontoblast process causes the secretion of hydroxyapatite crystals as well as the mineralization of the matrix. This area of mineralization is known as mantle dentin and is a layer usually about 150 μm thick[21].

Primary dentin forms through a different process contrary to the way in which mantle dentin is formed from the pre-existing ground substance of the dental papilla. Odontoblasts increase in size, eliminating the availability of any extracellular resources to contribute to an organic matrix for mineralization. Additionally, the larger odontoblasts lead to the secretion of collagen in smaller amounts, which results in more tightly arranged, heterogeneous nucleation that is used for mineralization. Other materials (such as lipids, phosphoproteins, and phospholipids) are also secreted during this process [21].

After the completion of the root formation process, secondary dentin is formed although

at a much slower rate. This being said, the secondary dentin forms faster along sections closer to the crown of a tooth and does not follow a uniform rate of growth along the tooth. This development continues throughout life and accounts for the smaller areas of pulp found in older individuals[26].

Tertiary dentin, also known as reparative dentin, forms in reaction to stimuli, such as attrition or dental caries[26].

2.30 FPM: Physiological considerations

2.31 Eruption theories

The mechanisms of tooth eruption have been a matter of long historical debate[23]. Recognizing basic parameters (i.e., that teeth move in three-dimensional space, erupt with varying speed, and arrive at a functional position that is inheritable) discard some previously held theories. Furthermore, it favours those that accommodate fundamental parameters, such as alveolar bone remodelling in association with root elongation, with possible correction elements in the form of cementum apposition and periodontal ligament formation[27].

According to the textbook *Oral Anatomy*, *Histology and Embryology*, Berkowitz et al. on page 363: “Having established that the connective tissues around the developing tooth are most likely to be the source of the eruptive mechanism, two major systems have been implicated in the generation of the eruptive force. One view holds that the force is produced by the activity of periodontal fibroblasts through their contractility and/or motility; the other vascular and/or tissue hydrostatic pressures in and around the tooth are

responsible for eruption" [28].

Additionally, in the textbook of *Pediatric Dentistry: a Clinical Approach,* Koch and Paulsen believe that the dental follicle surrounding the tooth crown is a factor decisive for the eruption process[29].

On the other hand, in the *Textbook Illustrated Dental Embryology, Histology, And Anatomy*, Bath-Balogh and Fehrenbach completely refuse theorizing tooth eruption, as they believe each theory for eruption is problematic in that it presents a problem in its conception. However, according to Bath-Balogh and Fehrenbach, a connection between pulpal and periodontal reactions can be a causal factor in eruption[30].

Additional proposed causes of eruption include cell proliferation, increased vascularity, and increased bone formation around the teeth. Additional important and possible causes for eruption include endocrinal influence, vascular changes, and enzymatic degradation. It has been found that all these factors have an influencing performance but are not significantly independent from each other[31].

2.32 FPM growth and development

2.32.1 Initial calcification

Histological and radiographic studies reveal that it is not possible to determine, by way of a radiograph, the precise time when cusp calcification begins due to the fact that the center is microscopically small. However, this center can be seen radiographically as an inverted cone by the time a visible mass of cusp tissue has calcified[32]. Most investigators

agree that both the maxillary and mandibular permanent first molars begin to calcify at, or soon after, birth[33]. Evidence in support of this statement is the occasional occurrence of neonatal lines of disturbed calcification in these teeth[32]. According to Kronfeld et al., the degree of calcification at birth may be related to the size and maturation of the entire newborn body[34].

2.32.2 Crown formation

According to Hess et al., the cusps of the permanent mandibular first molar fuse at about nine months[35]. Although, later it was found that this process is completed at seven months[32]. In a histologic examination of a child aged six months, Kronfeld found a fusion of the cusps by a very delicate layer of dentine and enamel, but he did not mention which cusps are so connected. And by the age of nine months, the occlusal surface of the tooth was completely closed[34]. In contrast, Churchill believes that complete coalescence may be expected at 12 months[8].

It has been found that the baby's sex also plays a role in the FPMs stages of calcification. Based on a study conducted by Gleiser et al.'s study of babies aged 9 months, only one boy of the 18 participants showed a fusion of all centres. This was in contrast to the 5 out of 19 girls showed this degree of maturation. Even at 12 months, 6 out of 23 boys had yet to attain a complete fusion of cusps while all 20 girls had already arrived at this stage. The sequence of fusion of centers showed individual variations, but these differences may in part be artefacts produced by adverse angulations of the radiographs[32].

A reasonable estimate of the duration of rapid growth of the tooth can be based on the

assumption that calcification begins at one month and ends when the walls of the root canals become terminally convergent. This interval in boys on average is 105.6 months and in girls 101.5 months. The girls' interval is 96% of that found in boys[32].

As a result, the differences in sex in the mature measurement of the tooth and the related duration of its rapid growth are closely similar. These findings indicate that the absolute incremental velocities of calcification in the two sexes are alike and that the shorter span of rapid dental growth in the female is a simple function of the smaller ultimate size of her tooth[32].

2.32.3 Root formation

A study conducted by Saito el al. found that 96% of a group of children ranging from seven to eight years of age (86-96 months) had already had their permanent mandibular first molars erupted. Of the individuals with this tooth present in the oral cavity, 20% had two-thirds of the root completed. In another sample group aged eight to nine years (96-108 months), 89% had "completed" root formation, and all samples between nine and ten years (108- 120 months) had attained this stage[37].

2.32.4 Eruption times

Soon after the initial appearance of mesial and distal spicules of the newly forming roots does one witness the calcification of the cleft between the roots of the permanent mandibular first molar. At this time, the tooth is beginning its movements of eruption.

Indeed, the rapid development of the cleft might lead one to suspect that it acts as a wedge in propelling the tooth during eruption [32].

It is normally found that a child's first molar and lateral/central incisors erupt at the age of six to seven years, but eruption in these different tooth groups is not interrelated. A child's first molars can erupt at the age of six years and the incisors within the next one to two years[38]. Early root formation begins alongside the eruption process itself, or the moving of the tooth bud[39]. The 'eruption time' is referred to as the period from this early time and until the appearance of the teeth. There is great difference between the eruption times of different teeth and the time it takes for tooth to erupt is therefore different[31].

2.32.5 Time to eruption plane

The FPMs erupt at six years of age, which marks the beginning of the mixed dentition period; they reach the eruption plane when the last primary tooth is lost, usually at eleven or twelve years[31].

2.40 FPMs and orthodontic considerations

The FPMs are key to the permanent occlusion; they play an important role in the establishment and function of the occlusion of the permanent dentition. With the eruption of FPMs the dentition will be in mixed dentition period starting from 6 years of age[40].

The mixed dentition period can be classified into three phases

1. First transitional period

2. Inter-transitional period

3. Second transitional period

2.41 FPMs in the first transitional period

The transition from the primary dentition to the permanent dentition begins at six years of age with the eruption of first permanent molars and permanent incisors. The first permanent molar eruption at this stage is guided into the dental arch by the distal surface of a second deciduous molar [41].

2.42 FPMs in inter-transitional stage

After FPMs and incisors establish occlusion, there is an interim period of 1-2 years before the commencement of second transitional period in which little changes in the occlusion are seen. This phase of mixed dentition period is relatively stable and only minor changes occur, which is partially why it is referred to as inter-transitional period. By the end of this stage, all the teeth are in proper occlusion[40].

The occlusion of the FPMs depends on their position in the jaws, the relationship between the mandible and maxilla, and the mesiodistal crown dimensions of the teeth, particularly the mandibular second deciduous molar[42]. If the mandibular second deciduous molar has a mesiodistal crown dimension that is approximately the same as that of the corresponding maxillary tooth, the terminal plane of the deciduous dentition will have a mesial step. With such a mesial step, the FPMs can immediately achieve optimal interdigitation[42]. However, in most cases the mandibular second deciduous molar

is a few millimeters wider than the maxillary second deciduous molar. This results in a flush terminal plane[43]. A good mesiodistal occlusion and ideal intercuspation of the FPMs cannot happen until the deciduous molars are replaced by the narrower premolars, in the second transitional period. The mandibular first permanent molar then migrates more mesially than the maxillary first molar[43].

2.43 FPMs in the second transitional period

Shedding of the primary canines and molars followed by the eruption of the permanent canines, premolars, and permanent second molars characterizes the second transitional period. This period lasts 1 to 2 years and sometimes even longer. Leeway space and ugly duckling stage are the features of this period[44]. The primary molars are significantly larger than the premolars that replace them, and the "leeway space" provided by this difference offers an excellent opportunity for natural occlusal relationships at the end of dental transition[43].

2.44 FPMs in the permanent dentition

At the time the primary second molars are lost, both the maxillary and mandibular molars tend to shift mesially into the leeway space, but the mandibular molar normally moves mesially more than its maxillary counterpart. This differential movement contributes to the normal transition from a flush terminal plane relationship in the mixed dentition to a Class I relationship in the permanent dentition, in which the distal surface of the

distobuccal cusp of the upper FPM occludes with the mesial surface of the mesiobuccal cusp of lower second permanent molar [45].

2.45 The importance of FPMs in occlusion

The first permanent molar is the largest and strongest tooth in the dental arch. It plays a major role in mastication and the alignment of other permanent teeth. Moreover, it maintains the vertical dimension of the face. It has additionally plays a vital role in aesthetics by making the cheeks appear full and vibrant[46].

2.50 The susceptibility of FPMs to pathology

The relative timing of the development of FPMs and their eruption makes them more susceptible to dental caries, hypomineralization, and hypoplasia. Children may sometimes present a developing dentition affected by one or a combination of multiple conditions, which may necessitate their enforced extraction[47].

2.60 Pathological conditions affecting FPMs leading to the Broken Down First Permanent Molars (BDFPMs)

2.61 Dental caries

2.61.1 Definition and aetiology of dental caries

According to Selwitz et al. (2007), Keyes (1960) and Miller (1890, 1891), “dental caries is the localized destruction of susceptible dental hard tissues by the acidic by-product of

bacterial fermentation of dietary carbohydrates"[48–50]. Destruction should be interpreted as initial dissolution of mineral at the sub-clinical stage (where visual changes cannot be seen), followed by the incrementally progressive destruction that will be visible as firstly, an early lesion, and later as traditional cavitation. If not treated, the destruction will progress to include large parts of the tooth and sequelae to caries can occur as pulp infection and pulp necrosis[51].

The higher susceptibility of FPMs to caries could be due to various reasons such as the deep pits and fissures on the occlusal surface, the large-sized crown which leads to accumulation of acid produced by bacteria, the early eruption of these teeth as well as Streptococcus Mutans level in the mouth[52].

2.61.2 Prevalence of dental caries of FPMs (World, Regional, UAE)

A. Worldwide dental caries prevalence

Globally, dental caries remains the most widespread disease affecting the oral cavity. Dental caries is a global health problem and has a direct impact on the quality of life, and particularly on the health and development of those affected children[53].

The incidence of caries among teeth varies considerably. The morphology, time of eruption, and positioning of the tooth in the oral cavity confer inherited disadvantages or advantages to the various methods used in the control of plaque and hence tooth decay and losses[54].

The most common index to determine the oral health is the DMFT[52]. The World Health Organisation (WHO) Oral Health Program presented in its report regarding global oral health conditions a four-level scale for the classification of the DMFT index at 12 years-old. They are: very low (less than 1.2), low (1.2 to 2.6), moderate (2.7 to 4.4) and high (over 4.4)[55]. WHO has set goals including an average DMFT score of 3 or less in 2000 and an average DMFT score of 1 or less in 2010 at the age of 12[56].

With respect to the DMFT index, from the year 1973 until the year 2008, the average worldwide score was 2.11 (± 1.32). Half of the world's population had about 1.8 decayed teeth, missing or filled. Values ranged from 0.2 to 7.8. It is observed that the American Region (AMRO) and the Europe Region (EURO) present a risk of 1.14 and 1.10 times higher than the average in the world, representing an average increase in Population Attributable Risk (PAR) by 14% and 10%, respectively. The African Region (AFRO) was with a 19% lower risk compared to the average of all countries surveyed. Furthermore, the distribution of DMFT score at 12 years of age was high in most countries of South America, Northern Europe and South Asia. Interestingly, a significant proportion of African countries had low rates of caries[56].

The caries status of FPMs in some of the Asian countries was reported as follows:

In Taiwan 48% of children aged 6 years were caries free in their permanent first molars[57]. Among 13–16-year-old school children from Sri Lanka, it was found that, in 36% of cases all four molars were sound while 11% of children had all four FPMs affected by caries[58]. A Japanese study showed that the caries prevalence rate of FPMs reached approximately 50% five years after the molar's eruption[59]. In addition, the

existence of dental caries in FPMs in Pakistan among 8-12 year old children was reported to be 30.6%[60]. In the same age group but with regards to Chinese children, the prevalence of caries statues in FPMs was 26.5%[61].

The caries prevalence in a few European and African countries:

In England, Wales and Northern Ireland, the prevalence of dental caries and non-carious conditions in 2013 was found to be at 46% of 15-year-olds and 34% of 12-year-olds. The percentage of children who experienced decay in permanent teeth had reduced from 2003, when the respective figures were 56% and 43%[62].Furthermore, in Poland and with regard to permanent molars, caries was observed in 14.8% to 17.3% of the teeth in 7-8-year-old schoolchildren[63].

A study conducted in Nigeria showed that the FPMs accounted for 42% of all extractions due to caries, the highest percentage of prevalence when compared to other teeth[64].

B. Middle East dental caries prevalence

Based on WHO, the Eastern Mediterranean Region (EMRO) includes 21 countries. It is observed that only four countries (20%) had higher values than the target recommended by WHO in 2000 (DMFT = 3). They are: Saudi Arabia, Lebanon, Jordan and Yemen.

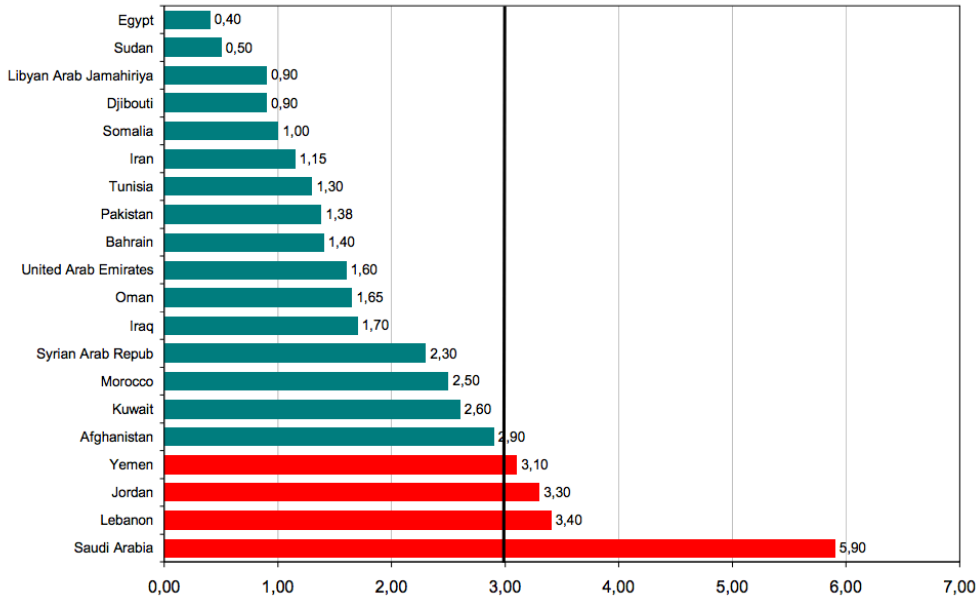

Figure 2: Distribution of DMFT according to the countries of the EMRO region. (World Health Organization: Oral Health Fact Sheet N°318. WHO (2012) [65].

Studies conducted by Alshammy and Miller reported that the prevalence in caries of first permanent molar teeth in Kingdom of Saudi Arabia was 68 to 70% among school going children[66].

C. UAE dental caries prevalence

A recent literature review done by Al-Bluwi in 2014 showed that dental caries is a considerable public health problem in young children (age 12 years and below) in the UAE. This review showed that for the 12-year-old group, the decayed missing and filled permanent teeth (DMFT) ranged from 1.6 to 3.24. The current data available also indicated that childhood dental caries continues to be common and as such a serious dental public health concern in the UAE, one that warrants immediate attention by the

healthcare authorities.

2.61.3 Management of dental caries of FPMs

The two most common locations where caries are prevalent on permanent molars are at the base of pits and fissures and on proximal surfaces, just below contact point[67]. The appropriate management of early carious lesions includes the use of a fissure sealant that may prevent the child from unnecessarily entering the restorative cycle[68]. Although, if a sealing-in approach is adopted when managing a suspicious fissure, then Careful long-term monitoring and repair of fissure sealants are essential particularly when the sealing-in approach is used.[69]. The identification of an early proximal lesion and the appropriate management that follows should serve the purpose of preventing the child from entering the restorative cycle unnecessarily[70]. Due to the fact that the alteration of the microenvironment of a lesion with the purpose of preventing it from progressing is not possible, cavitated proximal lesions should be managed with a restoration[71].

Children may present FPMs with advanced caries. Also, about 1 in 15 children will be affected by MIH to some degree. This condition, of unknown aetiology, can result in an extensive breakdown of FPMs[72]. . It may be in a child's long-term favourable prognosis to extract a molar should FPM be assessed as having a poor life-time prognosis and the second molar is yet to erupt[13].

Molars of poor prognosis include those that have:

- "An advanced occlusal lesion, or an approximal lesion

• Hypomineralisation that has caused breakdown and cavitation of enamel

• Lingual decalcification, with cavitation"[73]

When carrying out extractions of FPMs, the optimal occlusal result will be obtained when the bifurcation of the lower second permanent molar is seen to be forming on a full mouth panoramic radiograph, usually around the age of 8 ½ –10 years. The second premolars and the 3rd molars should all be present on a full mouth panoramic radiograph in addition to the presence of mild buccal segment crowding and finally a Class I incisor relationship is present. When deciding on extractions, each FPM should be considered on its own merit. It is not necessary to balance extractions (extraction of the contralateral tooth), and evidence supporting the benefit of compensating extractions (extraction of the same tooth in the opposing arch) is weak. The Royal College of Surgeons of England guidance provides more detailed advice on planned extraction of FPMs[74].

2.62 Molar Incisor Hypomineralisation (MIH)

2.62.1 Definition of MIH

Per Weerheijm, "MIH is a hypomineralisation of systemic origin of one to four permanent first molars frequently associated with affected incisors". In the recent literature MIH relate to "demarcated, qualitative defects of enamel of systemic origin, affecting one or more permanent molars (usually the FPMs) with or without involvement of the incisor teeth"[75].

Due to the both the fact that MIH is not chronological in expression and that it does not

affect the entire dentition, it is distinguishable from conditions like tetracycline staining or linear enamel hypoplasia. . It is for this reason that clinicians find it challenging to treat this condition w contemporary approaches such as restorative treatment as they find that these methods may be ineffective[76,77].

2.62.2 History of terminology of MIH

Enamel defects that appear in the literature have numerous other names that include: 'mottling'; 'internal enamel hypoplasia'; 'developmental opacities'; 'demarcated, diffuse, or confluent opacities'; aplasia'; 'internal and external hypoplasia'; 'pits'; 'grooves'; 'cheese molars'; 'non-fluoride enamel opacities'; 'idiopathic enamel opacities'; and 'opaque spots', making comparisons between studies difficult [76–78]. In face of the multitude of names, in 1982 The World Dental Federation (FDI) standardized the classification of these defects; this became known as the descriptive Developmental Defects of Enamel Index (DDE Index) [79].Unfortunatley, however, , the DDE Index is yet to be used universally and reported and implemented r in a standard fashion [80].

An under-estimation of the defect is possible as the defect in some cases may include demarcated opacities that can be seen on second primary molars, tips of canine cusps, and on second permanent molars as well as premolars. It is in this way that the term MIH may arguably be misleading; despite this, however, many prefer to keep the term MIH as it has been set by the EAPD criteria and is well known [17,81]. .

Furthermore, it is unclear whether the MIH is suitable in various unique cases including

instances of the hypomineralization of the FPMs only without affecting incisors, or lesions on the succedaneous tooth after trauma or pulpal infection in primary teeth. Also it should be noted that not all demarcated opacities are related to MIH [82].

While the periods of development of second primary molars and first permanent molars and permanent incisors overlap, the development of the former occurs somewhat earlier than the development of the latter [83] and the maturation of the permanent molar is slower [84]. If a risk factor occurs during this overlapping period, There is a threat of hypomineralisation occurring in the primary and permanent dentition should a risk factor occur during this overlapping period of development[85] A useful predictor for MIH may be deciduous molar hypomineralisation (DMH) as the second primary molars erupt 4 years earlier in life than the first permanent molars [86].

Yet, FPMs, which are affected by MIH, have been reported in the literature to be susceptible to post eruptive breakdown (PEB) or rapid caries breakdown soon after erupting into the oral cavity. It is for this reason that a few studies misreport MIH in FPMs or incorrectly classify them as PEB due to hypoplasia. Another important issue is under-reporting of MIH in studies due to the improper investigation of the reasons for early extraction of FPM in 10 year old children [80].

2.62.3 Prevalence of MIH (World, Regional and UAE)

According to many studies conducted globally, the prevalence of the MIH defect is very high[87]. Its prevalence ranges from 2.4 to 40.2% worldwide, with a variation depending on region of study and the study itself[88,89]. Since epidemiological surveys regarding caries

prevalence conducted on the national-levels do not include screening for MIH, studies which compare the prevalence of MIH in several birth cohorts are lacking. The most prominent and relevant studies of MIH were carried out in European countries with the prevalence of MIH ranging between 3.6% and 19.3 %[76,88,90,91]. Other studies have documented a 22% prevalence of MIH in Australia[92], a 14.8% prevalence in Turkey[93], 2.9% in Libya [94] and 13.70% in Kenya[95].

A study conducted in the South American country of Brazil revealed a very high prevalence of MIH, scoring at a 40.2 %[7]. While, a study conducted in East Asia, and Hong Kong reported a prevalence of 2.8%[88].

Even though a limited number of studies have been published in the literature regarding the prevalence of MIH in the Middle East, the prevalence of MIH reported is quite high in this region (8.6% to 20%)[72,96–98]. Specifically, two studies in Iraq and in Jordan which report the prevalence of MIH to be 21.5 %[96] and 17.6 %[99] , respectively.

A study in 2014 documented the prevalence of MIH in Dubai/UAE to be around 7.6%[98]. In 2016, it was reported that the prevalence of MIH in school children in Dubai was at 27.2%[6].

2.62.4 Aetiology of MIH

Dental enamel is a highly-mineralized tissue of ectodermal origin, which halts its metabolic activity as soon as it's fully formed. Therefore any disturbances during the developmental period can cause permanent defects in the erupted tooth[31]. These

disturbances have different effects in various stages of enamel formation. Hypomineralization is a structurally or qualitatively defect of enamel which causes disturbance to the calcification or maturation process of enamel[82].

Developmental defects of the enamel are frequent in the primary as well as in the permanent dentition[29]. The strength of the scientific evidence is mixed in the face of literature implicating a wide variety of factors in the etiology of enamel defects. The term 'hypoplasia' is often used to describe both qualitative and quantitative defects; this lack of consensus leads to even more confusion regarding the classification and definition of these defects[80]. As a matter of fact, enamel hypomineralization is a qualitative defect identified clinically as an abnormality in the translucency of the enamel and termed as the opacity of the enamel where enamel hypoplasia is a quantitative defect of the enamel. With regards to the opacity of the enamel, it can be of two main types: diffuse or demarcated. The diffuse opacities are white at eruption and spread over the enamel surface without a clearly defined margin with the adjacent normal enamel and the demarcated opacities have a clearly defined margin separating the abnormal enamel from the normal. Variations occur in their colour, ranging from white to cream, yellow or brown and in the degree of change in translucency[79].

Present scientific knowledge does not provide enough evidence to rank the importance of different postnatal etiological factors; however, it is agreed upon that the disturbance of tooth development occurs during the first two years of life [87]. A shortage of oxygen has been proposed to influence the mineralization of the enamel matrix[100]. Insult during this period could be the reason for only the occlusal part and never the cervical part of the enamel to be affected. Another possible explanation is that the thickness of the enamel

influenced the possibility for the ameloblasts to resist the insult[5]. Ameloblasts are extremely sensitive, and if disturbed during their secretory phase, you get a reduced thickness of normal enamel, which is hypoplasia. However, as it is opacities that occur in MIH, the ameloblasts must be affected in the later mineralization or maturation phase of Amelogenesis[102].

During pregnancy, medical problems are often an implicit indication for DMH; however, no specific determinants could yet be identified [96]. While it seems that pre- and perinatal factors do not have a large influence on MIH, their role in DMH is important[102].

Assessing the time and formation of the defective enamel is of great importance in finding possible etiological factors. Important factors to consider are then the phase of ameloblastic activity and the severity and duration of the insult[103]. There is however, considerable difficulty in deciding when or at what stage of ameloblast activity demarcated opacities are formed. Enamel hypomineralization has been considered to be a qualitative change of the matrix produced by disorders of the ameloblasts at the stage of maturation[104]. Suckling (1989) claimed that evidence from both sheep and humans following dysfunction during early maturation phase, exhibited yellow demarcated opacities. Suckling also claimed that yellow demarcated opacities often have a white opaque margin, which has a higher hardness value. These findings lead to the postulation that a number of maturation cells alongside secretory cells have the ability to recover[100].

For the crowns of the permanent first molars, it is an acknowledged fact that enamel formation commences at about week 20 *in utero*. With regards to the central incisors and lower laterals, enamel formation begins at about 3-4 months and for the upper lateral

incisors at about 10-12 months It is thought to take about 3 years for crown formation to complete[105]. Therefore, research into the etiology of MIH has concentrated on any environmental insults occurring in the first 4 years of life because of the pattern of molars and incisors affected[106].

Based on basic scientific literature, ameloblasts are remarkably susceptible to insignificant changes in their environment. Increases in temperature[107], hypocalcaemia[108], and pH levels[109] can all disrupt the normal process of amelogenesis, It is interesting to note that the sensitivity to environmental conditions may be controlled by genetics[110]. Furthermore, based on the available evidence in relation to MIH or similar enamel defects, the exposure to environmental contaminants such as polychlorinated biphenyls (PCBs) and polychlorinated dibenzodioxins/dibenzofurans (dioxins) does appear to be a risk factor for developing MIH-like defects. Furthermore, it has been found that the exposure to PCBs and dioxins serve as a potential cause of enamel defects, with breastmilk postulated as a source. The prevalence of MIH is not necessarily higher with increased duration of breast-feeding; interestingly, breastfeeding may indeed reduce enamel defects[77].

Research has shown that there is an increased risk of MIH occurring additively or even synergistically when harmful conditions are present and act together[87]. The role genetics plays is not clear as of yet; the susceptibility to MIH based on a genetic component is unknown [111]. Enamel developmental disorders such as amelogenesis imperfecta, or acquired with a known cause, like fluorosis or Turner's teeth are hereditary. This being said, the cause of some enamel disorders is still idiopathic[75]. The exact cause of the systemic insult is poorly defined and is unclear; however, although an increase in

childhood illness has been found to play a role[105] For the future, it is recommended to look more carefully into studies concerning twins. By comparing twins, that are monozygotic (identical) or dizygotic (non-identical), the relative importance of genetics may be identified[112]. Owing to, statistically, there is a relatively high frequency of twins are likely to have more problems in the neonatal period[112].

A variety of medical conditions such as coeliac disease, cystic fibrosis, and renal disease have been studied in relation to enamel defects[113]. Research has found that children have a higher prevalence of enamel defects whence they suffer chronic medical conditions, or those who are undergoing treatment. The evidence for these studies is weak, however, particularly with regard to MIH[114].

It is the case that in medically compromised populations, the existence of dental defects is higher. The frequency of pediatric care and greater number of episodes of urinary tract infection[115] were both associated with MIH. Children with MIH were ill more frequently[116]. Children who suffer from a variety of illnesses, including but not limited to otitis media, pneumonia, and high fever and who are treated with antibiotics were particularly at risk. [116,117].

The use of amoxicillin alters the immunological and inflammatory response of the host child in various illnesses[87]. The modified response lasts longer than the actual antibiotic course and the antibiotic has been shown, when tested on an animal model, to disturb enamel formation. Enamel formation may be compromised by a change in the levels of certain growth factors expressed also by ameloblasts[87]. In humans, however, it is unclear whether they are childhood illness/fever or the treatment itself that is the causative factor

or if both factors are involved[118].

It is also known that chickenpox affects ectodermal cells[21]. Fever also needs to be considered as it might have a synergistic effect with other conditions or aetiological factors[107]. Potential prescribers of antibiotics should be made aware that there there is a cause for concern: there is about a 2-fold increase in risk of MIH if amoxicillin is used in the first year of life. The use of amoxicillin in increasing the risk of MIH is relevant to only some cases, however, as archaelogical evidence has shown that MIH occurred long before amoxicillin was introduced. Effects on developing ameloblasts may be important[118]. A question arises as to whether ameloblasts never become mature cells when MIH occurs? There is also no clear answer to whether the enamel thickness of affected teeth is an important issue or not[87].

Therefore, it is safe to say that a disruption in the environment in which ameloblasts are operating may be caused by any maternal or childhood illness, exposure to medications, or by environmental contaminants. All of these factors may cause the development of defective enamel[77].

It is likely that many factors acting simultaneously (as in the preterm, low birth weight, respiratory compromise neonate) or sequentially (as in the child with otitis media with associated fever subsequently treated with antibiotics) contribute to the development of MIH. The putative multifactorial nature of the aetiology may go some way to explaining the variation in the distribution of the lesions seen clinically as the exact timing, nature, or particular combination of the insult/s may determine the clinical presentation[77].

By the age of three years, most of the tooth crown of a FPM is matured, with the

possibility of changes occurring after that. It is still unknown if there is a possibility for an etiological factor to have an impact up to 5 years of age or even age 6. Furthermore, mineralization may start before birth in some cases and after birth in other cases[17]. An outcome during the first year of life appears to be more significant; the early mineralization stage of tooth development could be the stage most susceptible to etiological factors causing MIH[17]. Also, the severity of MIH may correlate to the time of onset of the aetiological factor[119].

2.62.5 Presentation of MIH

The presence of a demarcated opacity in a primary molar that is yet to fully erupt and its presence in a permanent incisor is important as a critical moment for MIH early diagnosis. The dentist must pay particular attention to the incisors and other first molars and monitor the child constantly until the four permanent first molars have completely erupted. [120].

The following diagnostic criteria and clinical appearance of the defects have been agreed upon:

A. Permanent first molars and incisors affected

It is a cause for concern when one to all four permanent first molars (FPM) exhibit hypomineralisation of the enamel. The permanent incisors are also at risk of being affected. In order to adequately diagnose MIH, at least one FPM has to be affected. The

defects can additionally be seen in second primary molars, incisors and the tip of the canines. Where there are more molars and incisors affected the more severe is the defect[87].

B. Demarcated opacities

The demarcated opacities are clearly visible at the occlusal and buccal part of the crown. The defects vary in colour and size: they can be white in colour, can be creamy or yellow to brownish[87]. The opacities of MIH range differ from white to yellow-brown. This diversity in colour is related to the histological aspect of the lesion, as darker opacities present more intense porosity[5]. Moreover, there is also alternating relationship between the clinical appearance of the lesion and mineral density, as the darker opacities are less resistance and contain a lower mineral content in comparison with the lighter types[121]. Dark demarcated opacities also have less mechanical resistance[121] resulting in more extensive structural losses after the eruption of the affected tooth[7]. Whereas, the lighter opacities generally have a covering of well mineralized enamel[5], and present a lower incidence of post-eruptive structural loss[120,121].

The MIH lesions are mostly located on the middle and occlusal thirds of tooth crowns[5].The fact that it contributes to structural losses of enamel after tooth eruption is the reason for the localization of this lesion [121]. For example, the occlusal surface of molars is the highest incidence of masticatory forces when compared with the free surfaces of incisors[120,122]. The defect can be negligible or comprise the major part of the crown. It is recommended that defects less than 1 mm are not to be reported[87].

C. Enamel disintegration

The degree of porosity of the hypo-mineralized opaque areas varies. Severely affected enamel under masticatory forces breaks down instantly, leading to exposed dentine and rapid caries development [87]. Continuous post-eruptive structural losses result in extensive coronal destruction [76,121]. Hypomineralized enamel presents a reduction in its ratio of elasticity, regarding its resistance to abrasion. These structural losses may occur due to fracture of the hypomineralized enamel, because of its structural weakness or wear of the most affected tissue [120].

D. Atypical restorations

It is recommended that FPMs and incisors with restorations revealing similar extensions to are to be judge as affected[87].

E. Tooth sensitivity

The affected teeth may be frequently reported as sensitive, ranging from a mild response to external stimuli to spontaneous hypersensitivity; these teeth are usually difficult to anaesthetize[87].

F. Extracted teeth

Extracted teeth can be characterized as having MIH only in cases where there are notes in

the records or demarcated opacities on the other FPM. It is not possible to diagnose MIH is any other way [87].

G. Recording the severity of the defects

The severity of defects should be noted either as mild or as severe. In mild cases, there should be demarcated enamel opacities without enamel breakdown. In rare cases, sensitivity to external stimuli such as air or water – but not brushing – may be present as well as possible mild aesthetic concerns on the discolouration of the incisors. Furthermore, in severe cases there are demarcated enamel opacities with breakdown, caries, persistent or spontaneous hypersensitivity affecting daily functions such as, for example, teeth brushing. Severe cases may also present aesthetic concerns that may have a long-lasting socio-psychological impact[87].

Hypomineralized enamel experience greater dental abrasion due to teeth brushing. As such, structural micro losses may be present and the tissue may be superficially rough, even when not clinically visible[7,120].

2.63 Management of MIH

The possible treatment options for teeth with MIH are extensive, varying from prevention, restoration, to extraction. The choice of the treatment plan is complicated and may factors come into play when making the decision. Some of these factors include the severity of the condition, the patient's dental age and the child/parent's social background

and expectation[87].

Children who are diagnosed with MIH receive much more dental treatment than unaffected children. A retrospective Swedish study of 32 MIH children and 41 control children showed that by age 9, those with MIH had undergone treatment of their PFMs nearly 10 times more frequently than control children. On average, each defective molar had been treated twice due to restoration failure, PEB, or recurrent caries[89]. Consequently, it is not surprising that an MIH child who has had pain, difficulties with anaesthesia, and retreatment develops poor behaviour and dental anxiety[89]. The complex care involved in treating such a child must address their behaviour and anxiety, trying to provide a durable restoration under pain-free conditions[106].

Structural losses resultant from MIH may contribute to plaque accumulation and consequent development of dental caries and as such dealing with these losses may prove to be a clinical challenge[123]. Nevertheless, in addition to structural losses that may create niches for bacterial retention, the affected teeth are hypersensitive to mechanical manipulation, probably as a result of the constant state of pulp inflammation found in the teeth , which makes it difficult to clean them[81,123,124]. Another clinical concern with regards to MIH are the aesthetic problems generated when the permanent incisors present demarcated opacities, which may harm the self- esteem and social life of children with MIH[123].

In light of the fact that there is no specific criteria in classifying the level of severity of MIH cases, some researches have suggested that MIH lesions must be divided into slight or severe[87]. According to their clinical characteristics such as structural loss, in

conjunction with other subjective considerations, such as the patient's sensitivity to the management of the affected tooth[125]. According to the Guideline for the clinical treatment of MIH of the European Academy of Pediatric Dentistry, slight lesions that are only required to receive preventative treatment are those that present demarcated opacities only, free of sensitivity[87]. On the other hand, other lesions that display structural losses and sensitivity are cases that deserve special treatment. Treatment in these cases usually begins with prevention, restorative treatments and in more severe cases, going as far as extraction and orthodontic follow-up at an opportune time[120].

On the other end of the spectrum, severe cases require that the affected teeth be kept in the oral cavity with the minimum sensitivity and structural compromise possible. This should be the case until these teeth are definitively restored, or even until they can be extracted[126].

Parents play an important role in helping to ensure that these teeth remain in the oral cavity in such a way that they do not interfere with the child's quality of life. The cooperation of the parents is of manifold importance in these cases as it involves not only the patient's clinical needs but also his/ her psychological and social characteristics as well[120].

These characteristics alongside to masticatory forces contribute to post-eruptive structural losses being common in teeth affected by MIH. The difficulty in obtaining satisfactory results in the restoration of affected teeth appears to be a result of these factors [120]..

Restoring affected PFMs is complicated frequently by:

1. Difficulties in achieving anesthesia;

2. Managing the child's behavior;

3. Determining how much-affected enamel to remove;

4. Selecting a suitable restorative material[81].

Anaesthesia may be complicated by a porous and exposed subsurface enamel or dentin that subsequently causes chronic inflammation of the pulp[106]. The adjunctive use of nitrous oxide analgesia may alleviate anxiety and reduce dental pain, or general anesthesia may be required for restorative treatment[127]. In determining cavity margin placement, two approaches are described: "1. All defective enamel is removed 2. Only the very porous enamel is removed, until good resistance of the bur to enamel is felt" [127].

While it sacrifices tooth structure, the first approach – removing all defective enamel – may avoid premature restoration failure. The second approach – removing only porous enamel – while conservative, places restorations at risk of marginal breakdown. According to William et al. removal of all defective enamel is recommended when bonding resin composite restorations to hypomineralized PFMs due to the poor bond strength of resin adhesives to hypomineralized enamel[128].

2.63.1 Management of mild MIH

A. Prevention

Approaching the affected children alongside their parents with dietary advice is both

necessary and rational. Toothpaste with a fluoride level of at least 1,000 ppm F should be recommended[129]. Recently, it has been found that Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP), which provides a super saturated environment of calcium and phosphate on the enamel surface, intensifies re-mineralisation[130]. Albeit still debatable as to clinical effectiveness, the recommendation of toothpaste or sugar-free chewing gum may avail the patients who complain of mild pain to external stimuli[131,132]. For patients with spontaneous hypersensitivity, professional application of fluoride varnish (e.g. Duraphat 22,600ppm F) and probably 0.4% stannous fluoride gel may be helpful[87].

Involving the parents and making them aware of the problem is another very important aspect of successful dental treatment. The literature has detailed adequately enough that children with MIH are more at risk to develop caries, visit the dentist more frequently, and are exposed to hypersensitivity, even when the enamel is visually intact. [89,133]. All these characteristics must be made clear to the parents and must be supplemented with guidance. The growth of caries may be inhibited and tooth structures may be reinforced when parents are counselled on preventative measures including diet patterns and some attitudes, such as the parents' help during tooth brushing and the use of fluoridated toothpastes. Simple measures, such as the use of warm water during brushing, are important for the reduction of sensitivity, and also help to promote better control of plaque and consequently, of dental caries[126].

B. Fissure sealants and adhesive restorations

Fissure sealants (FS) are a clear choice that seek to protect the affected, without break-down of the permanent molar. Poor retention measures cast difficulty on its effectiveness when used for MIH molars[134]. Mathu-Muju and Wright recommended that a 60-second pre-treatment administration with 5% sodium hypochlorite may eliminate the surface enamel proteins to intensify etching pattern produced by 35% phosphoric acid; although, no clinical or laboratory studies support this claim yet[125]. A 2010 long-term clinical study has shown that higher retention rates could be obtained by a 5th generation bonding adhesive applied prior to FS application[135]. This may be due to deeper penetration of the adhesive into the porous MIH enamel because of its lower viscosity, and its ability to bind the residual enamel protein[87].

FS are important after the tooth fully erupts and before any breakdown, when there is enough moisture control. When the molars are partially erupted with inadequate moisture control, glass ionomer cement (GIC) can be considered as an interim treatment option. In late post-eruptive stage, FS may need to be re-applied due to wear. However, as the tooth would have matured, its efficacy is decreased[87].

C. Fluoride

The mineralization process may be further assisted by the use of other sources of fluoride, including but not limited to concentrated fluoride varnishes. These alternative methods serve to reinforce the tooth structure, particularly in recently erupted teeth, which are inherently more susceptible to caries and structural losses[133]. Another product

that has been tested for this purpose is calcium-phosphate casein, which has been shown to be effective in a number of ways: in increasing the phosphorous and calcium levels in MIH and also in the re-mineralization of the deeper layers of white spot caries[136]. These treatment modalities must be preferred instead of the use of more invasive measures, such as crown restorations or extractions[120].

2.63.2 Restorative treatment

When the case involves more severe structural loss including dentinal exposure or the development of carious lesions, restorative treatment is recommended. Nevertheless, it is necessary to consider two main questions: the patient's sensitivity to manipulation under the effect of anesthesia, as well as, the feasibility of maintaining the tooth in the oral cavity[120].

The dentist must be prepared for the difficulties encountered during the manipulation of affected teeth, such as hypersensitivity and the difficulty in providing the correct anesthesia. Extensive restorative interventions may be necessary , constant re-treatments due to failures in the restorations, or even endodontic treatment, and placement of prosthetic crowns, overloading the child emotionally and leading to behavioral problems during dental treatment[89].

Another factor that must be considered is the extent to which the opacities in the permanent incisors will have an impact on the social life of the affected children as these teeth may affect their quality of life. In these cases, interventions such as microabrasion and/or esthetic restoration with resin composite are recommended[120].

Amalgam should be a second option after adhesive materials when it comes to restorative materials used. Amalgam is known to perform poorly in the restoration of teeth with MIH [137].

The use of GIC is also recommended, particularly to serve as an intermediate restoration in a tooth still at the stage of eruption, and which may remain as a future base for adhesive restorations[120].

In comparison to other restorative materials, the performance of adhesive restorations seems to be the most reliable method in repairs as of yet[137,138]. Nevertheless, one must consider that in cases where the restoration margins are in hypomineralized enamel, there is greater possibility of future structural losses and marginal leakage; this is due to the low mechanical resistance of the tissue, and the low bond strength to this tissue[128]. As such, it is still important and necessary to conduct longitudinal studies with reference to the durability of these restorations with regard to cavity preparation, in order to choose between whether or not to remove all the hypomineralized enamel[17,87,138].

Otherwise, metal crowns must be applied to teeth in which there is not sufficient dental structure to support a conventional restoration[87].

2.63.3 Microabrasion, bleaching and sealants for anterior teeth

Any child with MIH incisors is likely to have to deal with aesthetic concerns resultant from MIH. Yellow or brownish-yellow defects are of full thickness while those that are creamy-yellow or whitish-creamy are less porous and variable in depth[139].

Consequently, the previous defects may hardly respond to bleaching with carbamide peroxide[127] and microabrasion with 18% hydrochloric acid or 37.5% phosphoric acid and abrasive paste[140,141]. Uniting the two methods might be an effective management tool for more pronounced enamel defects[142]. It is important to note that hypersensitivity, mucosal irritation, and enamel surface alterations may all be a consequence of bleaching for young children [143], while microabrasion may result in loss of enamel[144]. A new etch-bleach-seal method with satisfactory clinical results have been suggested by Wright involving: a) 60 seconds etch with 37% phosphoric acid; b) bleach with 5% sodium hypochlorite for 5-10 min, c) re-etch and application of FS over the surface to occlude the porosities[145]. The infiltration of the clear FS may be enough to change the reflective index of the detective enamel to create an acceptable appearance[87].

These modalities are important about the time of the late mixed dentition when patients usually start to express their interest on mild discolorations. The first treatment option should be the conventional approach and it should be utilized before any other more invasive treatment methods – such as resin restorations, veneers, crowns – are sought. These alternative more invasive methods may create obstacles due to the large pulp size of young incisors and immature gingival contours of them[87].

2.63.4 Management of moderate MIH

The prevention and adhesive sealant restoration approaches follow the same approached used for mild MIH.

A. Glass ionomer restorations (GIC)

This category includes conventional GICs, Resin Modified GICs and polyacid modified composite resins. These materials have an adhesive ability to both enamel and dentine. The main advantage is their long-term fluoride release and their hydrophilicity for usage in conditions with poor moisture control. These can be used as immediate restorations; however, it is advised that they are not to be used in stress bearing areas in MIH molars due to their weak mechanical features. For large cavities of dentine, GIC has been proposed to be used as a sub-layer under the composite restoration [125,145]. This treatment as an intermediate treatment is important in early post-eruptive stages because it can be used in less-than-ideal conditions of moisture control. In late post-eruptive stage, it might be used as a sub-layer beneath composite restorations[87].

B. Composite resin restorations

Compared to other restorative materials, composite resin material was shown to have longer stability. Composite resin materials have a median survival rate of 5.2 years[137] and with a success rate of 74%-100% in MIH teeth[134,138] during a 4-year follow up period. Self-etching adhesive (SEA) have a greater bond strength to MIH affected enamel than all-etch single-bottle adhesive (SBA) according to an *in-vitro* study [106]. This was associated with the elimination of rinsing, thus omission of any interference of residual water on the bond strength and to the presence of both micromechanical and chemical bonds between hydroxyapatite and SBA. Alternatively, the hydrophilic properties of acetone included in some other SBA systems may play the same role for eliminating the

residual water from the etched enamel surface[135]. For incisors, composites can be used with opaque resin for direct veneers in deep lesions to achieve a more satisfactory aesthetic result[127,146].

This modality of treatment becomes more important as a child grows because of this material's proven survival rate. However, studies with longer follow-up are needed especially on comparison of marginal placement in cavity design[87].

C. Preformed metal crowns (PMCs) or Stainless Steel Crowns (SSCs)

PMCs have been recommended as a treatment option to provide full coverage of defective molars[12]. PMCs have the following advantages: "inhibit further tooth surface loss, control sensitivity, establish correct interproximal and proper occlusal contacts, are not expensive and need a short time to prepare and insert"[128]. High success rates were recorded[134,147] when this material was used and with a follow-up period of 2 and 5 years respectively. The conventional preparation of the tooth for a permanent molar PMC start with an occlusal reduction of about 1.5 to 2 mm[148] . Followed by the preparation of proximal slices but no preparation of buccal or lingual tooth walls[149].

Furthermore, the modified 'Hall' technique with PMCs could be used[150] . In this technique, there is no need for tooth reduction. The hall technique is utilized as an intermediate restorative method targeting severely affected FPMs, until they are later extracted. FPMs are restored with preformed metal crowns using a technique that is similar to the Hall Technique[151] for restoring carious primary molars. In the Hall technique, orthodontic separators are used to create space mesially and distally and the

tooth is not anaesthetised or prepared. The PMC is sized and cemented with glass ionomer cement. There is a transient increase in the occlusal vertical dimension. For FPMs, unlike primary molars, care must be taken not to traumatise the periodontal ligament; therefore, crowns must be sized and cut[150]. There are no reports on the long-term effectiveness of this method and greater occlusal problems might be expected[87] . Furthermore, based on Innes et al. 'Hall' crowns are not indicated for permanent teeth[152].

PMCs can be used from early to late post-eruptive stages for MIH molars exhibiting breakdown, and can be particularly used on those that do not have enough tooth structure to support composite restorations. Long-term studies regarding the effectiveness and efficacy of PMCs must be conducted as current clinical studies are only limited to short-term results [87].

D. Cast restorations and porcelain veneers

Adhesive metal copings, full coverage metal or crowns for molars and porcelain veneers or crowns for incisors are options for this approach. Generally, full coverage crowns are not recommended for young children because of their large pulp size, short crown height, and difficulties in obtaining a good impression for subgingival crown margins[153]. Adhesive metal copings, usually made of nickel chrome alloy, are less destructive and have a good short-term success rate over 2 years follow-up[147]. Porcelain veneers for incisors could give good aesthetic results but it cannot be used in immature teeth. They are not recommended for teeth in early post-eruptive stage because of the continuous eruption exposing the crown margins, apart from the difficulties mentioned earlier[87].

This type of treatment is not suitable for teeth in the early post-eruptive stage because composite or PMC could give similar outcomes. In the late post- eruptive stage, the cast restorations are possibly more durable but there is no long-term study to prove it[87].

E. Extraction and orthodontic management

Only after orthodontic complications are considered can FPMs be extracted. If the orthodontic conditions were desirable, the best dental age for extracting the FPM with poor prognosis would be 8.5-9 years of age[154]; this is to allow the second permanent molars to move into the FPM position, thereby establishing an acceptable occlusion[155]. A later extraction at the age of 10.5 years could additionally give satisfying outcomes[137]. When a lower FPM is extracted, consider compensating extraction of the upper FPM to provide mesial drifting of the second permanent molar. Furthermore, a balancing extraction of the contralateral molar/premolar to prevent a middle line shift should be considered, particularly in crowded cases[154].

The ideal time to commence this treatment plan is in the late mixed dentition when radiographically the second premolar is in the crypt of the second primary molar and the second permanent molar's bifurcation starts to form[87].

2.64 FPM and other pathology

There are usually three reasons for non-carious tooth surface loss (TSL) in addition to abfractions and bruxism as causes for non-carious TSL.

Erosion is a "chemical process during which the tooth surface is removed in the absence of plaque; erosive factors may either be intrinsic or extrinsic" [156]. Extrinsic factors include drinks such as fresh fruit juices, carbonated drinks, cordials, alcoholic beverages, and some foods and industrial processes. Intrinsic factors include gastro oesophageal reflux and eating disorders, amongst others[157].

Toothbrush bristles and dietary factors have an abrasive effect on the teeth and may therefore elicit abrasion[158]. The removal of tooth tissue due to opposing tooth surfaces contacting in either the process of function or parafunction is referred to as "attrition".
This direct contact happens at proximal areas, on supporting cusps and on guiding surfaces during empty grinding movements[158].
Abfractions (stress lesions) is a result of eccentric forces on the tooth structure[159,160]. The theory propounds tooth fatigue, flexure, and deformation via biomechanical loading of the dentition, mostly at the cervical regions. Cusp flexure creates stress at the cervical fulcrum in which loss of the overlying tooth structure occurs. The lesion is typically wedge shaped with sharp line angles, but occlusal abfractions may present as the round invaginations. The size, duration, direction, frequency and location of the forces are all factors at play when it comes to the degree of tooth tissue Loss. It should be noted that abfractive lesions are caused by flexure and fatigue of susceptible teeth at sites that are usually distant from the point of loading. Other factors, like erosion and abrasion, may cause tooth tissue loss, but the initial force is the biomechanical loading [158].
Bruxism is a significant factor related to tooth surface loss. It is defined as "the grinding of teeth during non-functional movements of the masticatory system." Furthermore, it is a mandibular parafunction and wear is normally uniform when opposing teeth are affected.

If bruxism is severe, either marked wear of occlusal surfaces will occur or, in cases of compromised periodontal support, tooth mobility may result. Bruxism can also be associated with muscle spasm, fractured teeth, and restorations[161].

2.70 Planned long term restorative management of teeth and the FPM

2.71 The tooth restorative cycle concept

The *restorative cycle* consists of three main events: first loss of tooth structure due to trauma or the original disease process. Secondly, the loss of tooth structure because of the process of preparing a tooth for a restorative treatment. Third is the failure of the restoration and subsequent replacement, at which time the restorative cycle is repeated. The tooth may end up being extracted in the long term. How long a restoration will last is dependent on the environment (patient), the physical properties of the restorative material and the dentist's skill level combined. All restorative options are subject to a restorative cycle[162].

2.72 Loss of FPM: Consequences of unplanned early loss

If the extraction of FPM was done too early, the second premolar might drift distally and would inhibit eruption of the second permanent molar into the FPM's space. Nonetheless, if the extraction was done late, there is less chance for spontaneous closure by mesial movement of the second permanent molar. As a result, the residual space between the second premolar and second permanent molar will increase, especially in the lower jaw[87].

Another relevant long-term consequence of first permanent molar extraction is the short

dental arch (SDA). The SDA is defined as "a specific type of dentition with an intact anterior region and a reduction in the occluding pairs of posterior teeth" [163]. However, it is only experienced by people 40 years of age and older.

2.80 Elective loss of FPMs or the enforced extraction of first Permanent molars (EExFPMs)

The issue of loss of FPMs as an elective procedure, or what is known as *Enforced Extractions of First Permanent Molars* (or EExFPMs), is a recently developed concept that has specific guidelines[8]. It does not represent all schools of thought in dentistry and therefore, of course, has its opponents and supporters[10]. A study conducted by Jalevic et al. in 2007 evaluated spontaneous space closure and development of permanent dentition after extraction of FPMs due to severe MIH. Their results showed that favorable spontaneous space reduction and development of the permanent dentition positioning can be expected without any intervention in the majority of cases extracted prior to the eruption of the second molar[155]. On the other hand, a similar study by Teo et al. on 2013 concluded that FPM extraction at the "ideal time" did not necessarily result in successful positioning of the upper or lower second permanent molars[10].

2.81 Summary of 2014 EExFPMs guidelines

In attempt to assist dentists in treatment planning, this guideline offers advice on the extraction of first permanent molars in the child [8]. Ideally, all cases that are expected to involve the loss of a FPM should be co-managed with an orthodontist. In order to

examine the presence, position, and normal formation and the time of extractions, it is recommended to start by checking the radiographs. Based on the published guidelines, while enforced extraction of FPMs is rarely ideal, with appropriate timing and case selection, it can result in an acceptable occlusion for the child. It is accepted that the timing of FPM extraction in the lower arch is more important for successful eruption of the second permanent molar than upper arch. The most favorable chronological age range is 8-10 years, after lateral incisors have erupted and when the second permanent molars are still within bone and in the lower jaw demonstrating radiographic evidence of calcification in the root bifurcation to produce the best occlusal position[164,165]. These guidelines recommend that in Class I and Class II cases, the extraction of a mandibular FPM should be compensated by the extraction of the opposing maxillary FPM. The rationale for compensating the extraction of a lower FPM is that an unopposed maxillary FPM may over-erupt and prevent mesial migration of the erupting lower second permanent molar. However, it has been suggested that there is little evidence to support this being a significant risk[137]. Furthermore, in the upper arch, an un-erupted second permanent molar will eventually achieve a good occlusal outcome following extraction of FPM[8]. The balancing extraction of sound FPM is also recommended to preserve arch symmetry[154,166].

A. Class I with minimal crowding

Balancing is not recommended in case of unilateral EEXFPM in either upper or jaws with healthy FPMs. Although, compensating extractions could be considered, if upper FPMs

were likely to be unopposed for a significant length of time, after forced extraction of the lower FPMs. This rule does not apply to the lower FPM when upper FPMs must be lost[74].

B. Class I with moderate crowding

In dealing with moderate crowding that is present in the buccal segment, extraction at the optimal time would allow eruption of second permanent molar into a good position and would further relieve crowding. In the case of bilateral buccal and premolar crowding, it is recommended to consider balancing extraction of contralateral FPM with poor prognosis to provide relief. On the other hand, FPM extraction provides little relief when crowding is present in the labial section and may require fixed appliances for alignment for the buccal crowding[74].

C. Class II with minimal crowding

Because of the need for space to correct incisor relationships, the extraction of FPMs can be challenging with regard to upper FPM extractions. If the upper FPMs have a poor prognosis and require immediate extraction, orthodontic treatment may be instituted to correct the incisor relationship with a functional or removable appliance, headgear or temporary anchorage device (TAD). These orthodontic treatments provide an additional source of anchorage to correct buccal segment relationship. The extraction of upper FPMs should ideally be carried out when it is radiographically shown that the third molars have erupted. In cases of missing third molars or if the upper FPMs can be temporized or restored, then an elective FPM extraction can be delayed until the eruption

of second permanent molars. After this, the dentist handling the case may pursue functional and fixed orthodontic appliances to correct the occlusion[74].

D. Class II with crowding

In this case because the space requirement in the upper arch will be greater, it is recommended to temporize or restore upper FPMs and refer the child to a specialist orthodontist. Nevertheless, it is mentioned if the upper FPM is unopposed and third permanent molar is present, extraction of upper FPMs may be indicated to prevent over eruption. Furthermore, to relieve crowding in the lower jaw if the third molars are present radiographically, lower FPMs can be extracted at the optimum time to allow second molar eruption. The extraction of premolars following by fix appliance treatment needed in later stages. Although balancing and compensating extraction of lower FPMS are not required[74].

E. Class III cases

It is often difficult to manage and ideally require the opinion of a specialist. As a general rule, balancing and compensating are not recommended in class III cases[74].

2.82 Importance of guidelines

The guidelines are intended to educate healthcare providers, parents, and ancillary organizations about the management of oral health care needs[167]. As per the UK General

Dental Council the guidance is there to help dentists to meet the standards[168]. Dentists are expected to "follow current evidence and authoritative guidance, to use their professional judgment, demonstrate insight all the time and [should be able to]justify any decision that is not in line with the guidance to provide good quality care[169].

The American Dental Association defines evidence based dentistry as: "An approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences"[170]. It is recommended that dentists follow the hierarchy of evidence to manage clinical questions related to therapy, prevention, etiology or harm[171].

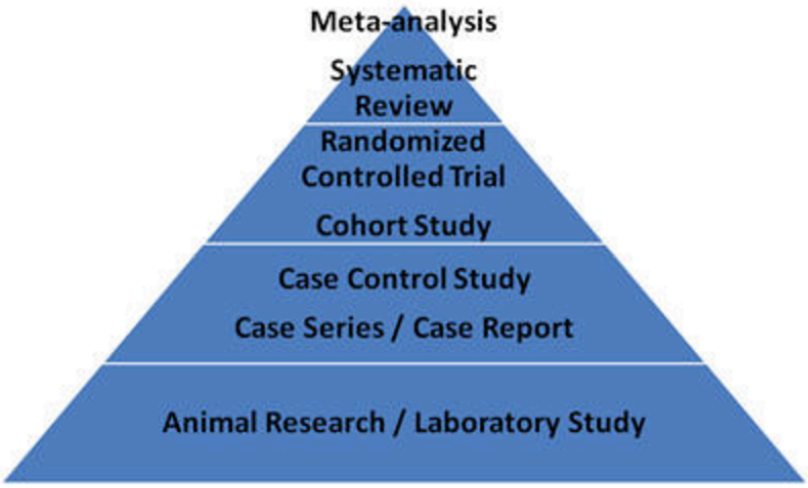

Figure 3: The hierarchy of evidence pyramid. (Evidence Based Dentistry: Evidence Levels. UNC health science library. 2009)[172]

Guidelines propose advice on the extraction of FPMs in children with developing dentition affected by one or more FPMs poor prognosis. The right time for extraction is crucial as FPM extractions can and should be followed by successful eruption of the

second permanent molar to provide a suitable replacement, and eventually third molar eruption to complete the molar dentition, although this is not guaranteed. Thus, the FPMs with an ambiguous long-term prognosis should also be considered for enforced extraction when treatment planning these teeth. Ideally, consultation with the pediatric dentist and the orthodontist for treatment planning should be done, admitting this may not always be achievable. Although, aside from clinical features, additional factors may affect decision making including the "child's social background, the necessity for general anesthesia to allow extraction of these teeth, the possibility of the child cooperating with restorative or orthodontic treatment, prevention and oral hygiene practice within the family". Additional consideration is given for people who live in the UK and have local difficulties in accessing NHS restorative or orthodontic treatment[74].

2.83 Development of FPMs guidelines

It is important for practicing dental surgeons to access and use appropriate clinical guidelines. The Faculty of Dental Surgery at the Royal College of Surgeons of England (FDSRCS Eng) develops and maintains a wide range of clinical guidelines through its Clinical Standards Committee. These either represents work of the committee itself or the endorsement of work by other bodies, such as professional societies. Updated guidance produced in 2014 by the Clinical Governance Directorate of the British Orthodontic Society through the FDSRCS Eng on the extraction FPMs in children[74].

2.84 Opinions regarding loss of FPMs

The generally accepted orthodontic practice about the management of FPMs with poor prognosis has been formed by several authoritative bodies and different theories. Regrettably, there is a very limited strong indication or evidence for the explanation of the timing and extraction patterns for the FPM[154]. Angle, in the beginning of the 19th century, supported a non-extraction policy. He in particular resisted extraction of FPMs, because he considered them the "keystones of the dentition"[173]. On the other hand, Wilkinson, in the 1940-50's, believed in the extraction FPMs[174]. However, at that time of Wilkinson's writings many patients had experienced rampant caries in the mixed dentition and restorative procedures were not as advanced as now. Today dental caries is still an issue as more than 50% of children over the age of 11 years have experienced some dental decay[175]. Although, with the arrival of improved operative techniques and materials the long-term prognosis of FPMs has improved considerably[154]. Mills in the 1960's, took a more moderate opinion of the extraction or non-extraction debate with regarding to the extraction of a first permanent molar with a poor prognosis[176]. On the contrary, he also acknowledged the orthodontic complexities resulting from the loss FPMs. He stated that when you extracted the FPMs you "double the treatment time and halve the prognosis"[176]. This generalization has established the fact that the FPM are particularly important to the orthodontist as a source of anchorage because of their large root surface area. Additionally, the space after the extraction of a FPM is distant from the anterior teeth so that treatment duration is normally extended. For these multitude of differing reasons, the FPMs are rarely an orthodontist's teeth of choice for extraction[154].

Associated with the extraction of FPMs, most orthodontists today hold the following

opinions:

1) Functional appliances do not make patients grow significantly in a favorable way;

2) Extractions do not predispose to TMJ pathology;

3) First permanent molars are not the "keystones of the dentition"[154].

Besides some brief tribute in the literature, there is no available specific guideline from European, American or international associations on this matter. The American Academy of Pediatric Dentistry, AAPD, primarily focused on saving the FPMs based on their guideline on pulp therapy for primary and immature permanent teeth[177]. Importantly, a leading American text in pediatric dentistry, *Macdonald And Avery's Dentistry For Child And Adolescent*, briefly described the EExFPMs as a treatment approach for FPMs with poor prognosis[177]. Regarding European literature, journals of orthodontics and pediatric dentistry did publish some of the leading articles on EExFPMs of FPMs but mostly in the context of MIH. In addition, on the same context a study in the UK and two studies in Saudi Arabia explore dentist's knowledge regarding different treatment approaches[178–180].

2.85 Ideal timing of FPMs loss

As mentioned above, the ideal timing for the loss of an FPM is when radiographically the second premolar is in the crypt of the second primary molar and the calcification of the bifurcation of the second permanent molars start, which happens frequently at the age of 8-10 years. As a result, it would facilitate mesial movement of the second permanent

molar into the FPM area when a good contact expected to establish with the second premolars[74]. Later extraction at the age of 10.5 years could additionally give satisfying outcomes[137]. When a lower FPM is extracted, dentists should consider compensating extraction of the upper FPM to provide mesial drifting of the second permanent molar. Furthermore, a balancing extraction of the contralateral molar/premolar to prevent a middle line shift should be reviewed, particularly in crowed cases [154].

2.86 The aborted SIXES study

Despite the fact that guidelines were released regarding this very question, there is still confusion among clinicians as to whether or not a 'compensating extraction' (e.g. extraction of the upper FPM to prevent it over erupting) is [13]. This confusion and debate led to a clinical trial investigation conducted by the University of Dundee in 2014 to determine whether compensating extraction of upper FPMs following loss of lower FPMs in children is of benefit or not. The benefits being investigated are related to the resulting occlusion, patient experience and oral health related quality of life. Unfortunately this study has been terminated due to poor recruitment[13]. The reason why this is reported here in this present paper is to highlight the fact that there is a paucity of investigative randomised control trials with regards to EExFPMs.

2.87 Knowledge and awareness of dentists of EExFPMs guidelines (World, Regional, UAE)

Currently, there are no available studies regarding the dentists' knowledge about enforced

extraction of broken down first permanent molars. Some studies, however, investigated the knowledge of dentists regarding the management of MIH molars in the region and the world at large. A study by Albadri et al. investigated the reasons for and patterns of extraction of first permanent molars (FPMs) in three UK dental hospitals. The main reason for extraction was caries with poor prognosis (70%); molar incisor hypomineralisation was the reason for extraction in 11% of cases. The children who attended dental hospitals for extraction of FPMs tended to be older than the optimal age for achieving space closure. Based on this study more than half of the children received an orthodontic assessment. However, no significant relationship was found between orthodontic assessment and the number of FPMs extracted. They found that primary care dentists do not have enough knowledge of optimum time to extract sixes in children. Therefore, in conclusion it was found out that primary care dentists may benefit from a set of guidelines advising when to refer children for extraction of FPMs[11].

A similar study was done in Saudi Arabia to report the decision making in management of badly decayed FPMs in children and adolescents among clinical consultants (specialists) and pediatric dentists at King Abdulaziz University (KAU). Based on this study there was little known regarding the way dentists are adopting treatment decisions developed for management of badly decayed FPM. Moreover, there were noticeable controversies among dentists when it came to decision-making in management of badly decayed FPMs for 6 to 9 years old patients in that particular study. Most of the respondents recommended a more conservative treatment such as a protective liner, and indirect pulp capping, for badly decayed FPMs for 6 to 9 years old patients than enforced extraction. In the Saudi study, The American Academy of Paediatric Dentistry (AAPD)

guidelines were recommended to help dentists to make appropriate decision for the management of badly decayed FPMs in children[178]. This study is one of a few studies that had investigated the knowledge and experience of EExFPM among specialists in paediatric dentistry and general dental practitioners in the world. In the UAE or the greater Middle East, the knowledge of the concept EExFPM has not been addressed.

2.90 Aim of the study

The aim of this study was to assess the knowledge and practice of UAE dentists regarding the extraction of the BDFPM (Broken Down First Permanent Molar) in light of the UK's 2014 EExFPMs guidelines.

3.00 MATERIALS AND METHODS

In this chapter, the study logistics are presented, including the study design, criteria and statistical analysis.

3.10 Study characteristics

3.11 Study design

This study is a cross-sectional survey with a quantitative, descriptive and comparative design. Data were collected by means of a paper and online questionnaire, by the principle investigator (MD), by surveying dentists in the UAE who treated children, in the period between (January 2016-April 2016). The design of this study followed the guidelines published by "Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement", 2007[181].

3.12 Study population and location

The paper questionnaires were distributed to a convenience sample of dentists who treated children, working in the UAE and present in Dubai, for various reasons. They were conveniently sampled by qualified dentists working and studying at the Hamdan Bin Mohammed College of Dental Medicine (HBMCDM- Dubai), dentists attending the General Dental Practitioner (GDP) lectures series hosted by Mohammed Bin Rashid University of Medicine and Health Sciences (MBRU), dentists who were on the database

of the Mohammed Bin Rashed Academic Medical Centre (MBR-AMC) computers, and finally dentists working in the UAE and attending the UAE International Dental Conference and Arab Dental Exibition (AEEDC- held in Dubai in February 2016) and other popular dental conferences held in UAE from January to march 2016. Assurances were made that no individual completed the questionnaire twice, by asking them if they had completed this survey before. Those who expressed willingness to participate in the paper survey but did not have time to complete the form, and those who were on the MBR-AMC database were contacted by electronic mail in the form of an identical *Survey Monkey*^{TM} styled survey. Therefore, assurances were made that no crossover between online and paper groups occurred. The questionnaire was identical to the paper one and was uploaded in Survey Monkey website.

3.20 Sample size and dependent variables

The sample size was calculated based on the probality of having knowledge about EExFPM equal to 10% equal and using the formula of Cochran's sample size calculation for cross-sectional design:

$$N = \frac{Z^2_{\frac{\alpha}{2}}\, pq}{B^2} D$$

Where

$$B = z_{\alpha/2}\sqrt{\frac{pq}{n}}$$

Where

P is a prevalence of erosion from the reference study.

q is (1-p)

$z_{\alpha/2}$ is the quartile of 95%, and

B is the width of the confidence interval of 95% (error)

Using the above formula with error 0.05, the calculation yielded a sample size of 138 and adding 20% of nonresponse the size was determined to be 166 participants.

A total of 200 paper questionnaires were distributed at the aforementioned events and 100 email survey requests were sent out.

3.30 Eligibility criteria

3.31 Inclusion criteria

The participant inclusion criteria were as follows:

1. Fully qualified dentists from any specialty who treated children;
2. Working in the UAE
3. Licensed by one of the UAE regulatory authorities, namely
    a. Ministry of Health (MOH)
    b. Dubai Health Authority (DHA),
    c. Health Authority Abu Dhabi (HAAD)

d. Dubai Health Care City Regulations (DHCR)

3.32 Exclusion criteria

The participant exclusion criteria were as follows:

1. Dental professionals working outside the UAE.
2. Dental students
3. Any dentist who did not wish to take part in the study.
4. Participants who completed the questionnaire but left blank fields

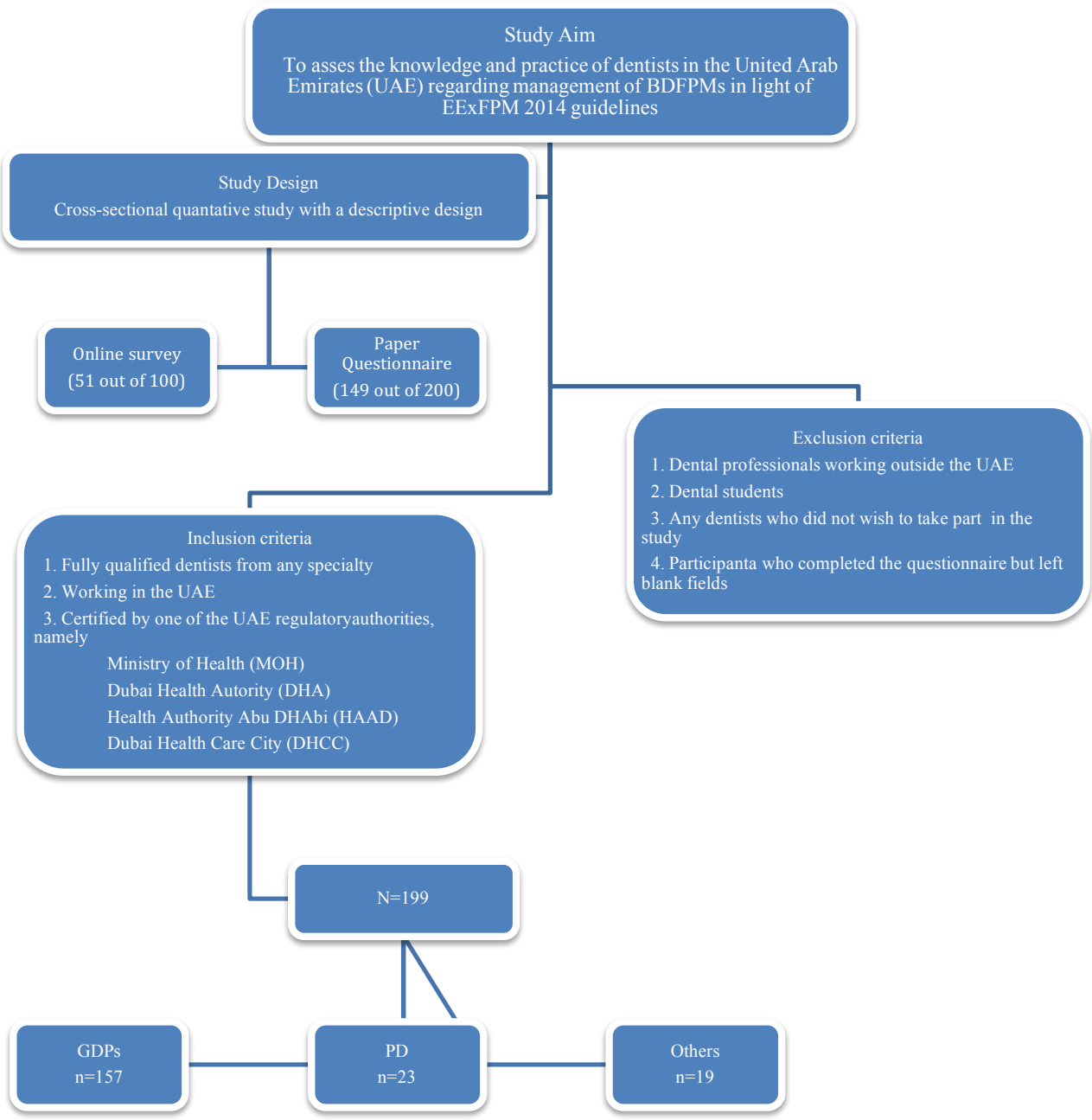

Figure 4: Study Flow Chart

3.40 Questionnaire setting

This study carried out in the form of a survey, with data been collected by a questionnaire. The questions were collated by a team of paediatric dentistry specialists with extensive experience in managing children with BDFPMs. The questionnaire was piloted amongst five residents for feasibility and readability and feedback was sought by a statistician to ensure that questions were valid and easy to understand and equally could be completed within a reasonable time. Modifications were made accordingly for language and proofing purposes. The pilot surveys were not included in the final results.

The participants were informed about the objectives of the study by informing them that we were surveying dentists about BDFPMs and would appreciate their opinion. No information sheet was distributed as it would have affected the results. Each participant was ensured anonymity and informed that the data would be used for statistical purposes only. Once the participant was confirmed to be a dentist working in the UAE, the form was handed out, with the request to complete the survey or leave a contact email to do later. The completed surveys were left in a collection box. The survey was anonymous, and no personal details were collected. Those who did not complete the surveyed but left their email addresses, were contacted anonymously to complete the online survey. The anonymous, web-based survey was distributed through an email sent by a third party (the executive officer of HBMCDM). The email contained information and a web link for direct access to the questionnaire. The online information was analysed anonymously in return. The online survey remained open for eight weeks.

The questionnaire (see Appendix I) consisted of

1. Demographic data fields (age, gender, specialty, country of practice, country of qualification, years of practice, treated children yes/no).
2. The survey contained nine questions related to the knowledge and practice of BDFPMs and EExFPMs. The variables included in the questionnaire were as follows:

    Question 1 – BDFPM treatment options scenario.

    Question 2 – Consideration for EExFPMs

    Question 3 – Dentist awareness of concept of EExFPMs

    Question 4 – Dentist own practice of EExFPMs

    Question 5 – Preference to preserve or extract BDFPMs

    Question 6 –Knowledge of relationship between child age and BDFPMs

    Question 7 – BDFPMs and practice of referral outcome

    Question 8 – Knowledge of ideal age to extract BDFPM

    Question 9 – Awareness of the actual 2014 UK guidelines for EExFPMs

3.50 Statistical analysis

The collected data from the questionnaires were transferred to computer-spread sheets and analysed using computerized Statistical Package for Social Sciences (SPSS, version

20, Chicago, SPSS Inc). Descriptive statistics were performed for the general description of the data. Chi-square and Exact Fisher's test were performed to examine differences between categorical data and t-test was performed to compare continuous variable. The level of statistical significance was set at 5%. A p-value of < 0.05 was considered significant in all statistical analysis.

3.60 Ethical considerations

This study conducted in full conformance with principles of the "Declaration of Helsinki", Good Clinical Practice (GCP), and within the laws and regulations of the UAE/Dubai Healthcare Authority (DHCA). The ethical approval obtained from the Research Ethics Review Committee in Hamdan bin Mohammed College of Dental Medicine (HBMCDM) (Ethical approval number: HBMCDM/EC/2032) (Appendix II).

4.00 RESULTS

4.10 Demographical characteristics of participants

Three hundred dentists from different educational backgrounds who work in the UAE were targeted via a direct paper survey and online with assurance of no crossover or duplication. Both surveys were identical in content. The paper arm of the study included a total of 148 of 200 completed questionnaires (74% return rate), whilst the online arm of the study included a total of 51 out of 100 answered questionnaires (51% return rate). Out of the total 300 surveys distributed and emailed, there were 199 completed responses returned (total return rate was 66.33%). None of the completed surveys were excluded. Among participants 157 were general dental practitioners, 23 were paediatric dentists and 19 were other dental specialties. The participants were dentists representative of different educational levels (general practitoner and specialists) as seen in Figure 5.

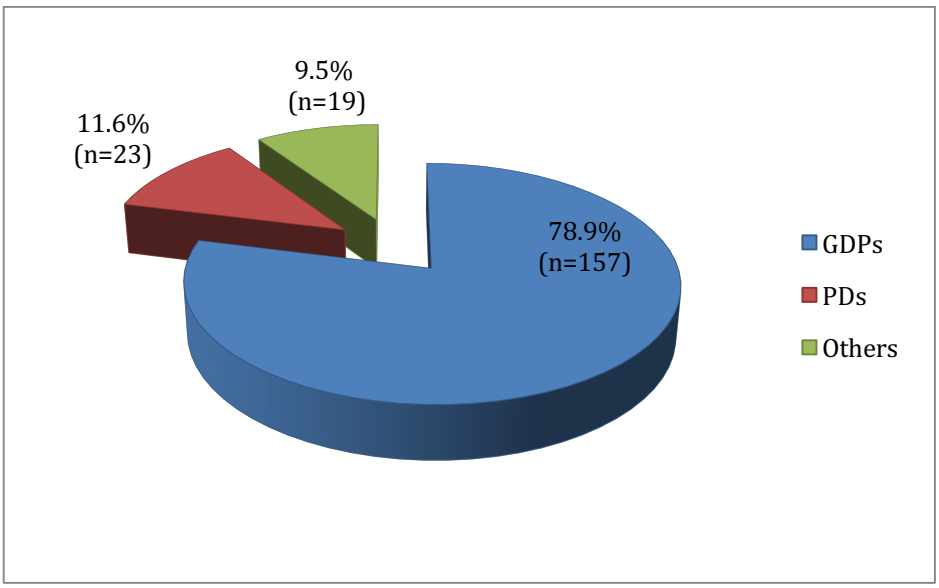

Figure 5: Distrubution of background of participating dentists (N=199). (percentages and numbers).

Demograhics of participants (age, gender, speciality, place of qualification and years in practice) are demonstrated in table 1. All the dentists (100%) treated or had treated children in the past.

Table 1: Demographics of participants

Variables		% (N=199) Nr (%)
Gender	Female	123 (62.1)
	Male	75 (37.9)
Educational status	General dental pratitioner	157 (78.9)
	Paediatric dentist	23 (11.6)
	Other specialities	19 (9.5)
Place of qualification	Arab countries	159 (82)
	Asian countries	11 (5.7)
	Western : America + Europe	24 (12.4)
Years in practice: Mean		7.1
Age: Mean (SD)		30.96 (±7.736)

More than half of the participants were female 62.1% (n=123) and 37.9% (n=75) were male. Of 199 participants, 78.9% (n= 157) were general dental practitioners (GDPs). Specialist were totally 21.1% (n=32). Paediatric dentists (PDs) were 11.6% (n=23) and other specialities were 9.5% (n=19). Background training was divided into three groups: Arab, Western and Asian; 82% (n=159) of dentists were qualified in *Arab* countries including the Egypt, Iraq, Jordan, lebanon, Syria. The rest of dentists qualifications were

gained in the *West* (12.4%, n=24) including the Belgium, Germany, Hondoras, Hungary, Ireland, Romania , Spain, Sweden, UK, USA ; and *Asia* including Pakistan and India (5.7%, n=11). The mean age of participants was 30.96 years and their mean years of experience was 7.1 years. The questions were grouped into two groups:

a) Broken down first permenent molars (BDFPMs) management options responses; and

b) Enforced extraction of first permanent molars (EExFPMs) awareness responses

4.20 BDFPMs management options related questions and responses

Tables 2, 3 and 4 summarises the questions and responses of those surveyed about preferred management of BDFPMs.

Table 2: BDFPMs management options: responses breakdown questions: according to specialty

Questions	Options	GP Nr (%)	PD Nr (%)	Other Specialists Nr (%)	P-value
Q1. If a 7-year-old boy visited your dental clinic with very sensitive teeth and no significant medical history, the examination revealed lower FPMs (first permanent molars) to be severely hypo mineralized with post eruption breakdown as well as a class I malocclusion. What would your first line of treatment be?	Do nothing	13 (8.3)	0 (0)	0 (0)	0.021*
	Build up the crowns with composite	34 (21.7)	2 (8.7)	7 (36.8)	
	RCT and crown the teeth	21 (13.4)	1 (4.3)	2 (10.5)	
	Place SSC over these teeth and wait till the child gets older and extract these teeth	39 (24.8)	14(60.9)	5 (26.3)	
	Place GIC temporary dressing only	50 (31.8)	6 (26.1)	5 (26.3)	
Q2. Do you believe in preserving the FPM as much as you can instead of extracting it in children?	No	20 (12.7)	7 (30.4)	3 (15.8)	0.086
	Yes	137 (87.3)	16(69.6)	16 (84.2)	
Q3. Does the age of child affect your decision regarding keeping the FPM tooth or extracting it?	No, all my intention is to save the tooth no matter what age	61 (38.9)	5 (21.7)	8 (42.1)	0.255
	Yes, I know the best time to extract FPMs in children	96 (61.1)	18(78.3)	11 (57.9)	
Q4. If I have a case like above	I will refer the patient to paediatric dental specialist	42 (26.8)	4(17.4)	5 (25.6)	0.003*
	I will consult with a paediatric specialist	62 (39.5)	4(17.4)	2 (10.5)	
	I will consult with an orthodontic specialist	42 (26.8)	9(39.1)	7 (36.8)	
	I am confident enough to diagnose and treat this patient	11(7.0)	6(26.1)	5 (26.3)	

Table 3: BDFPMs management option: responses breakdown questions: according to education background

Questions	Options	Arab Nr (%)	Western Nr(%)	Asia Nr (%)	**P-value**
Q1. If a 7-year-old boy visited your dental clinic with very sensitive teeth and no significant medical history, the examination revealed lower FPMs (first permanent molars) to be severely hypo mineralized with post eruption breakdown as well as a class I malocclusion. What would your first line of treatment be?	Do nothing	12 (7.5)	0 (0)	0 (0)	0.22
	Build up the crowns with composite	32 (20.1)	4 (16.7)	4 (36.4)	
	RCT and crown the teeth	23 (14.5)	0 (0)	1 (9.1)	
	Place SSC over these teeth and wait till the child gets older and extract these teeth	45 (28.3)	10 (41.7)	2 (18.2)	
	Place GIC temporary dressing only	47 (26.9)	10 (41.7)	4(36.4)	
Q2. Do you believe in preserving the FPM as much as you can instead of extracting it in children?	No	22 (13.8)	7 (29.2)	0 (0)	0.052
	Yes	137 (86.2)	17 (70.8)	11 (100)	
Q3. Does the age of child affect your decision regarding keeping the FPM tooth or extracting it?	No, all my intention is to save the tooth no matter what age	60 (37.7)	5 (20.8)	8 (72.7)	0.013
	Yes, I know the best time to extract FPMs in children	99 (62.3)	19 (79.2)	3(27.3)	
Q4. If I have a case like above	I will refer the patient to paediatric dental specialist	40 (25.2)	6 (25)	3 (27.3)	0.006*
	I will consult with a paediatric specialist	61 (38.4)	2 (8.3)	2 (18.2)	
	I will consult with an orthodontic specialist	44 (27.7)	12 (50)	2 (18.2)	
	I am confident enough to diagnose and treat this patient	14 (8.8)	4 (16.7)	4 (36.4)	

Table 4: BDFPMs management option: responses breakdown questions: according to the gender

Questions	Options	Male Nr (%)	Female Nr (%)	P-value
Q1. If a 7-year-old boy visited your dental clinic with very sensitive teeth and no significant medical history, the examination revealed lower FPMs (first permanent molars) to be severely hypo mineralized with post eruption breakdown as well as a class I malocclusion. What would your first line of treatment be?	Do nothing	2 (2.7)	11 (8.9)	0.022*
	Build up the crowns with composite	15 (20)	27 (22)	
	RCT and crown the teeth	15 (20)	9 (7.3)	
	Place SSC over these teeth and wait till the child gets older and extract these teeth	17 (22.7)	41 (33.3)	
	Place GIC temporary dressing only	26 (34.7)	35(28.5)	
Q2. Do you believe in preserving the FPM as much as you can instead of extracting it in children?	No	8 (10.7)	22 (17.9)	0.169
	Yes	67 (89.3)	101 (82.1)	
Q3. Does the age of child affect your decision regarding keeping the FPM tooth or extracting it?	No, all my intention is to save the tooth no matter what age	33 (44)	40 (32.5)	0.10
	Yes, I know the best time to extract FPMs in children	42 (56)	83 (67.5)	
Q4. If I have a case like above	I will refer the patient to paediatric dental specialist	20 (26.7)	31 (25.2)	0.74
	I will consult with a paediatric specialist	26 (34.7)	41 (33.3)	
	I will consult with an orthodontic specialist	19 (25.3)	39 (31.7)	
	I am confident enough to diagnose and treat this patient	10 (13.3)	12 (9.8)	

The first question described a case of a 7-year-old with BFDPMs and a Class I malocclusion and suggested management options were given. Overall (see Figure 6), when assessing the responses as a whole, there was no agreement amongst those surveyed. 30.7% (n=61) of the responders chose to place a temporary dressing rather than any a definite treatment, 29.1% (n= 58) would prefer to place SSCs over BDFPMs and wait till the child gets older and extract these teeth, 21.6% (n=43) would build up the crowns with composite restorations, 12.1% (n=24) would perform root canal treatments followed by a crown and 6.5% (n=13) dentists would chose to do nothing. It is worthy of mentioning that there was a statistically significant difference in the pattern of referral of such cases between GDPs, pediatric dentists and other specialists (Q4) with a P value of 0.003.

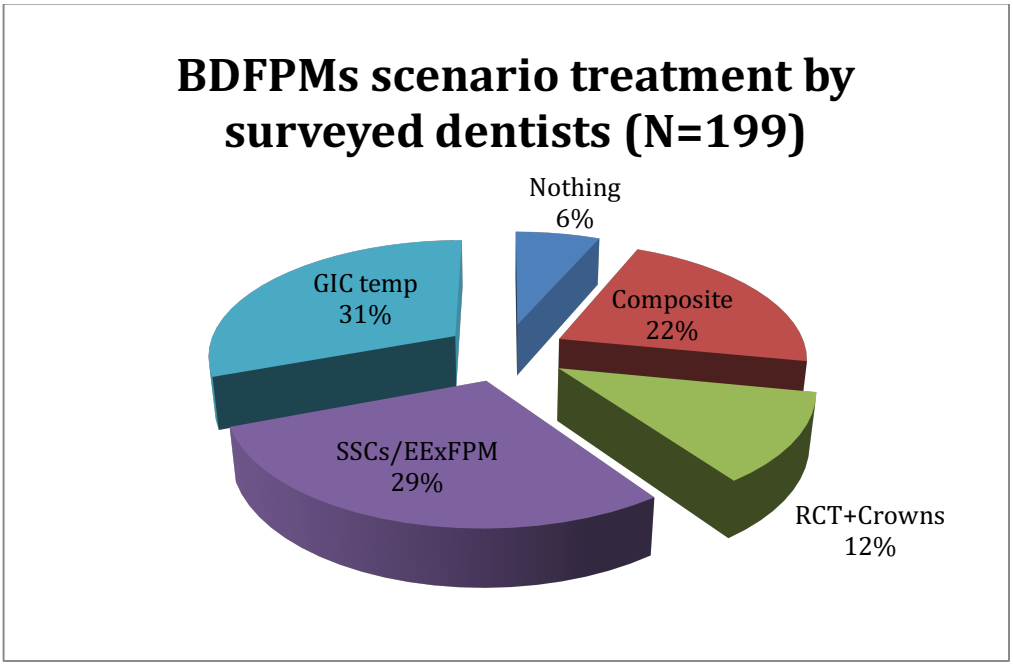

Figure 6 : BDFPMs scenario treatment. Overall results.

The responses in this question were cross-tabulated against; a) training background, b) gender of dentist and c) specialty. The following was found:

4.21.1 BDFPM scenario treatment and training background

When tabulating the responses to this question against training background (Arab, Western, Asian) no statistically significant difference was found (p=0.224). Although there was a tendency for Western trained dentists to consider GIC temporary restorations, at the same level of choosing SSCs then EExFPMs.

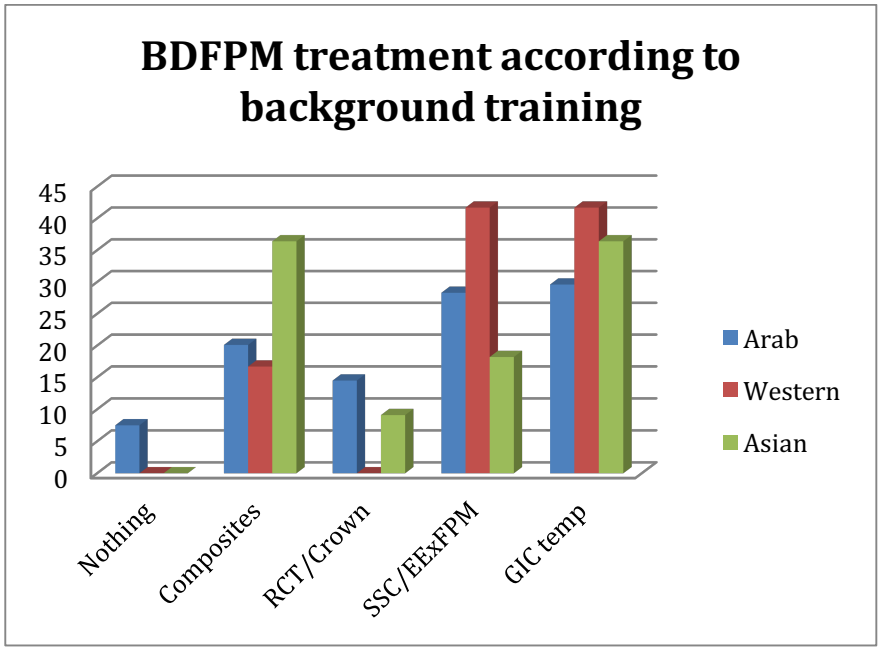

Figure 7: BDFPM treatment scenario and training background.
SSC: stainless steel crown, EExFMP: enforced extraction of first permanent molars, RCT: Root canal treatment, GIC: Glass ionomer.

4.21.2 BDFPM scenario treatment and dentist gender

When tabulating the response to this question against gender of the dentist (see Figure 4.4) we found differences that were statistically significant (p=0.022). 33.3% of female dentists' (n=41) first choice was the placement of SSC then ExFPM, as opposed to 22.7% (n=17), male dentists. while 34.7 % (n=26) male dentists first choice was the placement of GIC as opposed to 28.5% of female dentists (n=35).

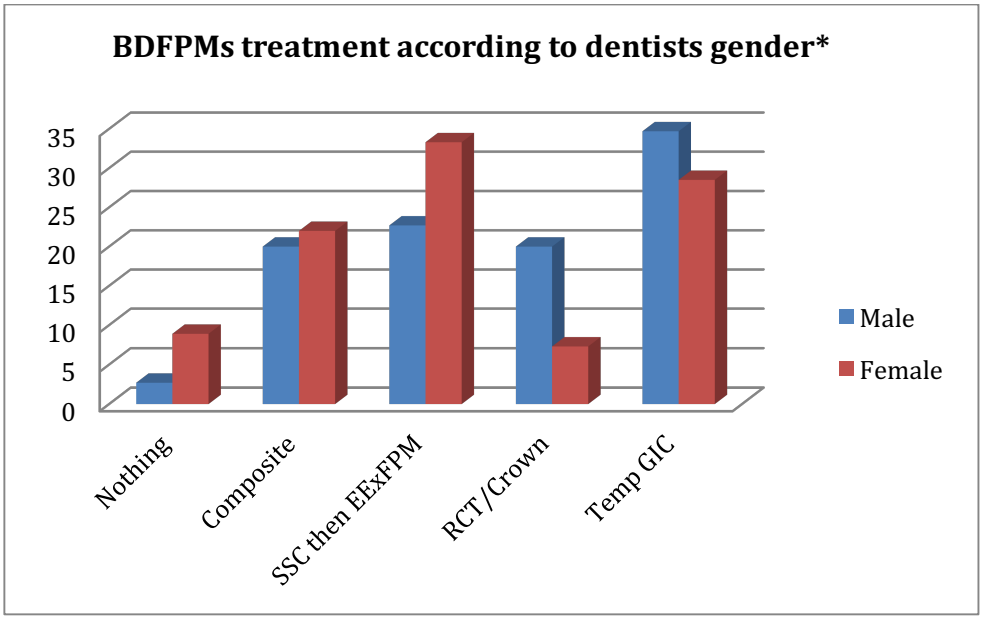

Figure 8: Treatment options for BDFPMs (broken down first permanent molars) according to dentists gender (p=0.022).*

4.21.3 BDFPM scenario treatment and dental specialty

When tabulating the responses against specialty (GDPs, PDs and others) statistically significant differences were found (p=0.021). More paediatric dentists would treat the scenario case with SSCs and then EExFPM compared to GDPs and others. While more GDPs would treat BDFPMS with GICs, compared to other specialities who would use composite.

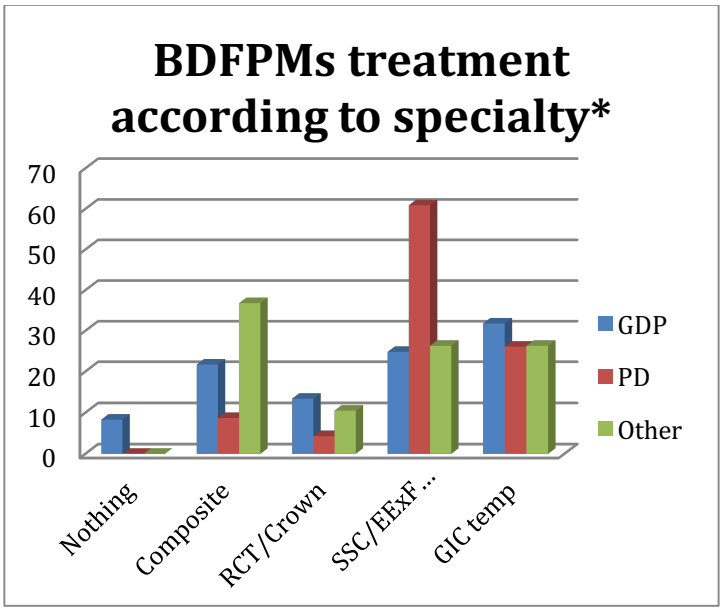

*Figure 9: BDFPMs treatment according to specialty. *p=0.021.*

A. BDFPMs scenario treatment options of GDPs

GDPs chose their first line of treatment as follows: 31.8% (n=50) would place GIC temporary dressing, 24.8% (n=39) would put SSC over these teeth and wait till the child gets older and extracts these teeth, 21.7% (n=32) would build up the crowns with composite, 13.4% (n=21) would do the root canal treatment and crown the tooth and 8.3% (n=13) would not do any treatment.

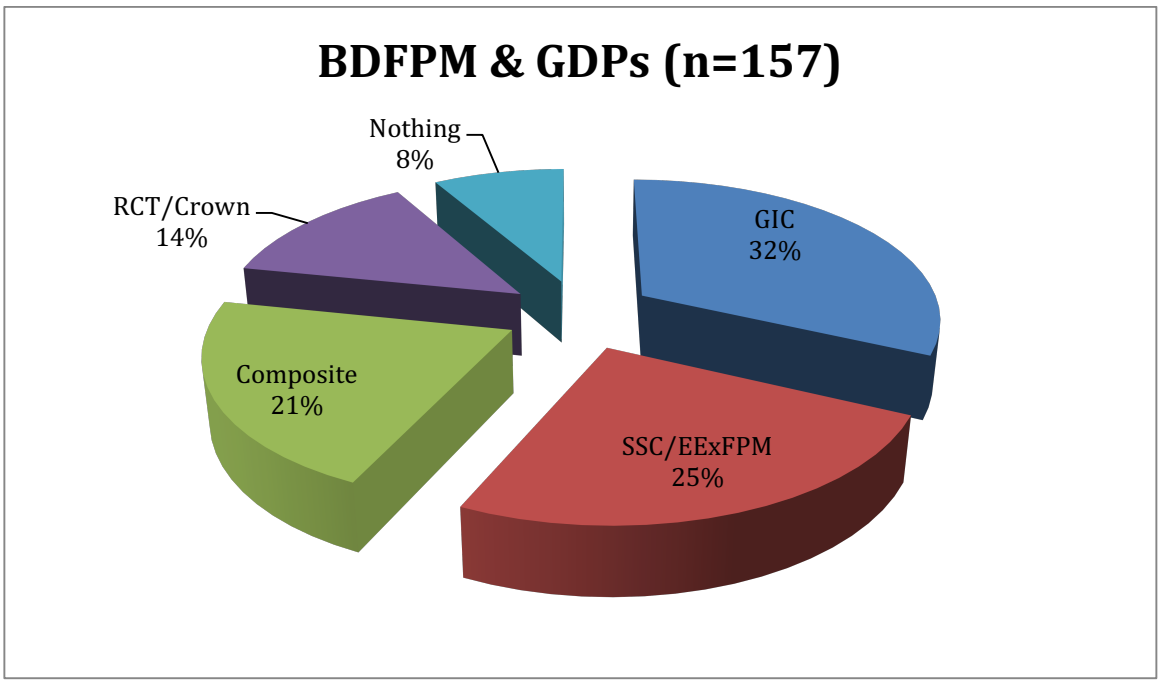

Figure 10: BDFPMs treatment options of GDPs

B. BDFPMs scenario treatment options of PDs

Most of the PDs (60.9%, n=14) would place SSCs over these teeth and wait till the child gets older and extract these teeth, while 26.1% of PDs (n=6) would place GIC temporary dressing, 8.7% (n=2) would build up the crowns with composite and 4.3% (n=1) would do the root canal and crown the teeth.

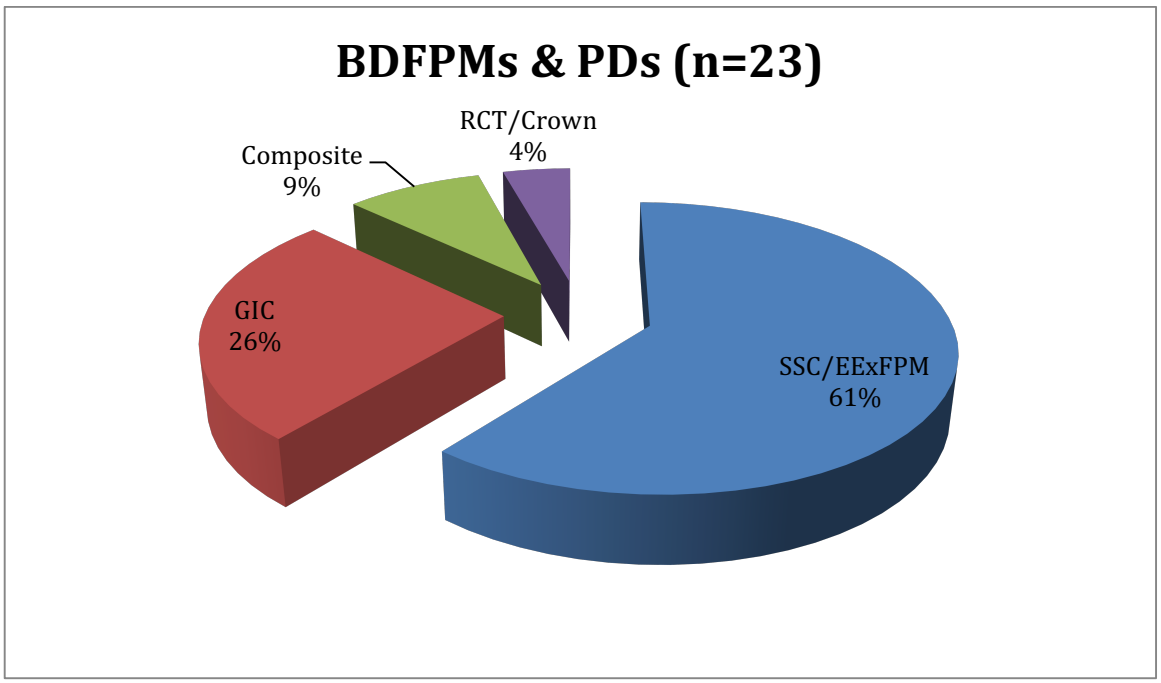

Figure 11: BDFPMs treatment options of PDs

C. BDFPMs scenario treatment options of other specialties

In the group (other specialties) a majority (36.8%, n=7) prefer to build up the crowns with composite, 26.3% (n=5) would either place SSCs over these teeth and wait till the child gets older and extract these teeth or would only place GIC temporary dressings, and only 10.5% (n=2) would do the root canal treat and crown the teeth. Neither of the paediatric dentists or other specialities participants chose to do nothing as an option.

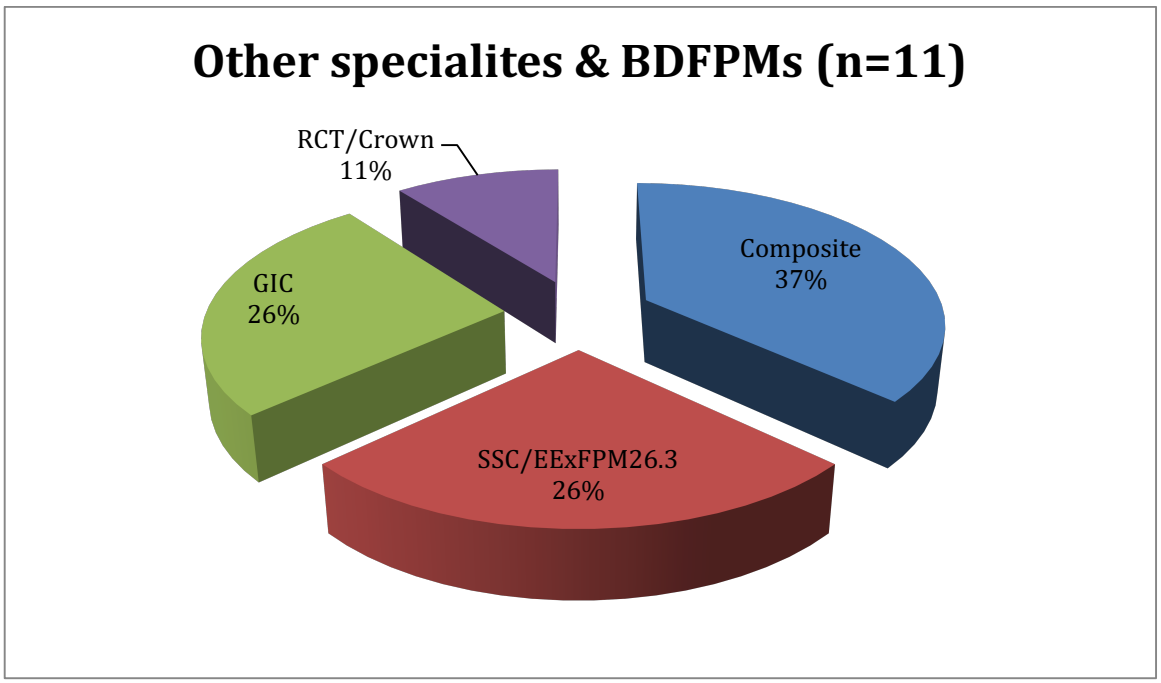

Figure 12: BDFPMs treatment options of other specialties

4.22 The second question: preserve or extract BDFPMs

The second question asked participants if they believe in preserving BDFPMs as much as they can instead of extracting them in children. Overall, most of all the participants (84.9%, n=169) believed in preserving BDFPMs (see Figure 13) as much as they can instead of extracting them in children.

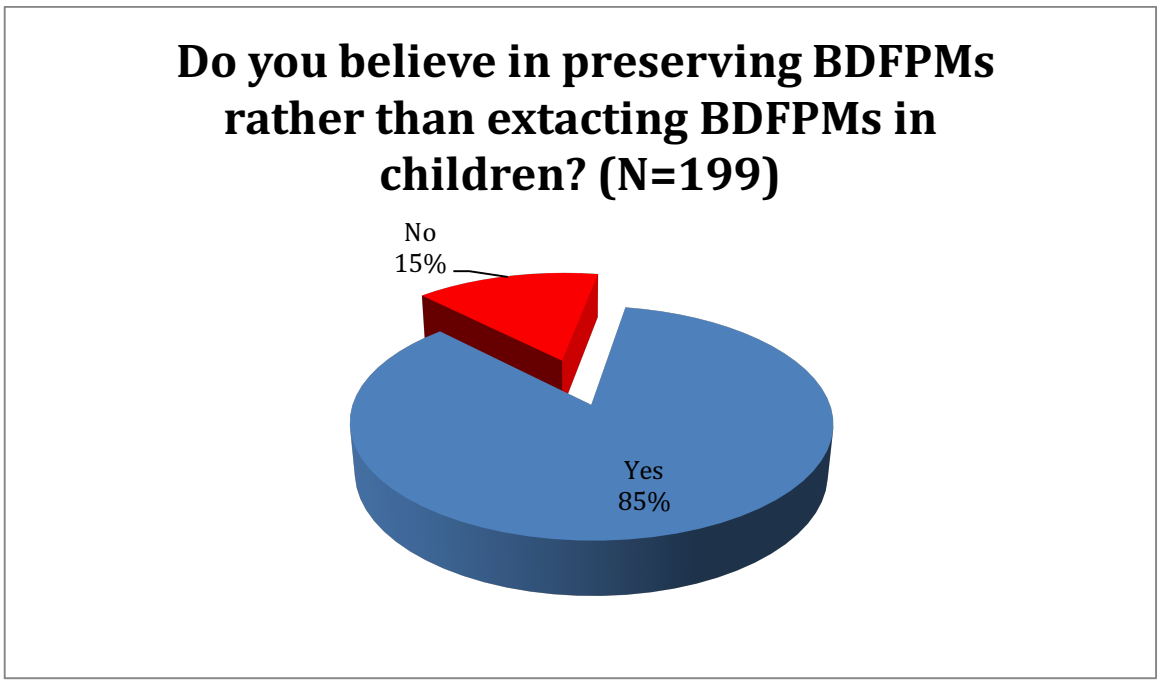

Figure 13: Preserve or extract BDFPMs

The responses to this question were cross tabulated against a) training background b) dentists gender and c) specialty. No statistically significant difference was found in all three categories (p=0.052, p=0169 and p=0.086 respectively) see Figure 14.

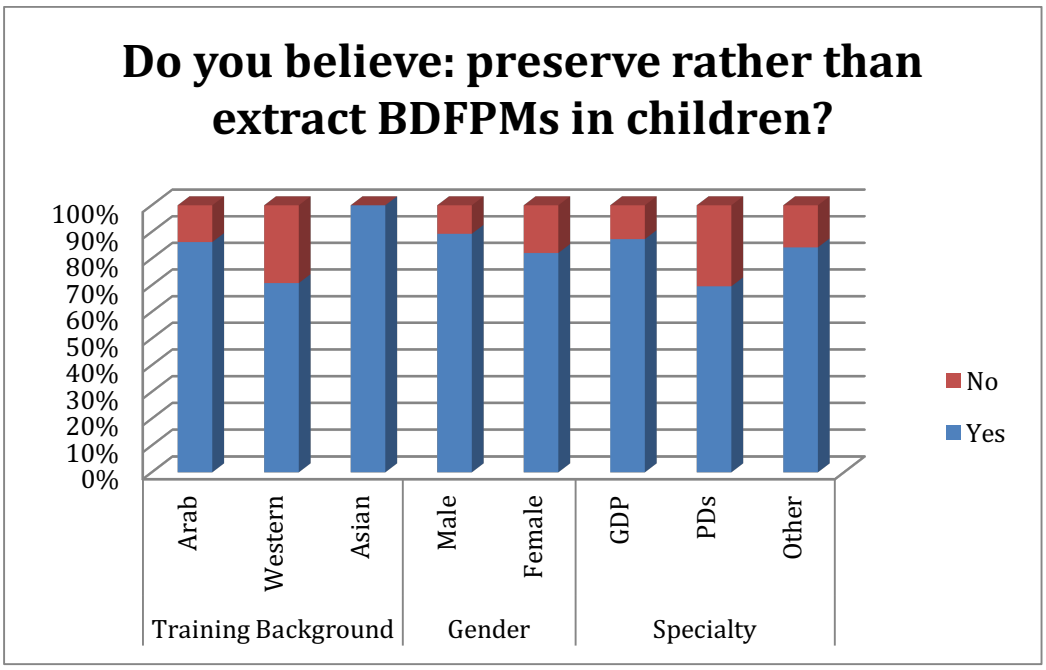

Figure 14: Preserve rather than extract BDFPMs against variables. No statistical significance found.

4.22.1 Training background and to preserve or extract BDFPMs

When tabulating the responses agains training background (Arab, Western and Asian), the majority of dentists were in favour of preserving the BDFPM (86.2%, 70.8% and 100 % respectively) rather than extractions.

4.22.2 Dentists gender and preserve or extract BDFPMs

When tabulating the responses against dentists gender, the majority of both male and female dentists were in favour of preserving the BDFPM (89.3% and 82.1% respectively) rather than extractions.

4.22.3 Dental specialty and preserve or extract BDFPMs

When tabulating the responses against specialty (GDPs, PDs, and others) the majority opted for preserving the BDFPM (87.3%, 69.6%, and 84.2% respectively). Although among these groups about 30.4% of PDs, 15.8% of other specialities and 12.7% of general dental practitioners did not believe so.

4.23 The third question: The child's age and BDFPMs

The third question asked about the importance of child's age when dealing with FPMs. The question was "Does the age of the child affect your decision regarding keeping the FPM tooth or extracting it?". Overall, the greater number of responses (62.8%, n=125) was "Yes, I know the best time to extract first permanent molars in children" . The percentage of answers to the option "no, as my intention is to save the tooth no matter what age" was 37.2% (n=74).

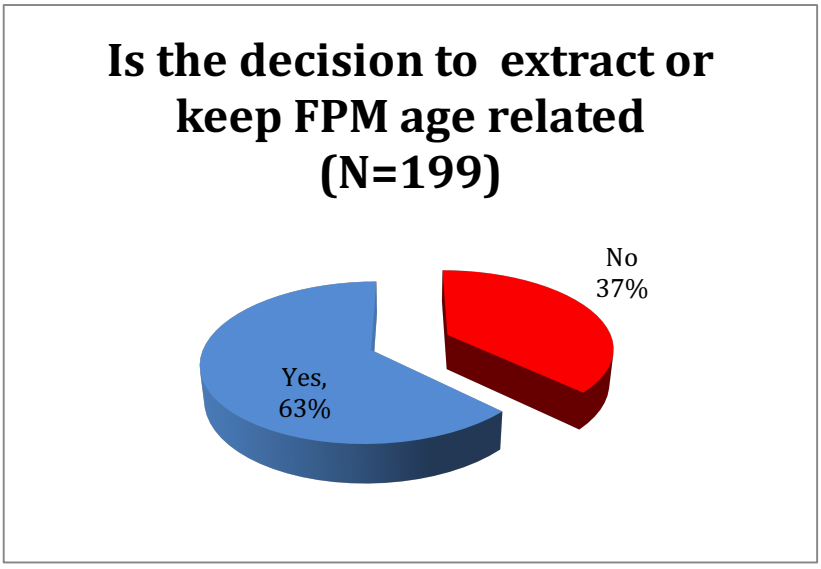

Figure 15: The child's age and participant's decisions to extract or keep BDFPMs

When the responses were cross tabulated against a) training background, b) dentist gender and c) specialty; no statistically significant differences were found (p=0.13, p=0.071 and p=0.255 respectively). The results are represented in the following figure. The majority in all groups regarded age of the child important when deciding to keep or extract FPM except those of Asian training; there was a tendency for them to have an opposite view (but this was not statistically significant).

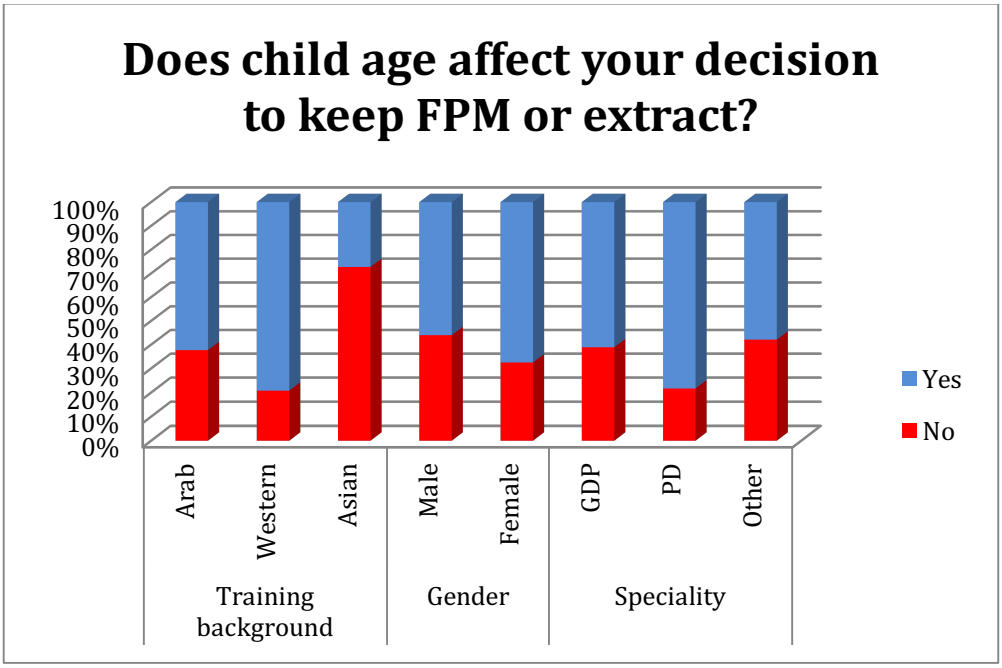

Figure 16: The child's age and BDFPMs. No statistical significance

4.23.1 Training background and child's age and BDFPMs

When tabulating the responses against training background (Arab, Western and Asian), the majority of dentists from Arab (62.3%, n=99) and Western (79.2%, n=19) countries believed that the age of the child was important when deciding to keep or extract FPM.

Although, most of the Asian trained dentists (72.2%, n=8) were in favour of saving the tooth regardless of the child's age.

4.23.2 Dentists gender and child's age and BDFPMs

When tabulating the responses against dentists' gender, the majority of both male (56%, n=42) and female (67.5%, n=83) dentists believed in the importance of the age of the child when deciding to keep or extract FPMs.

4.23.3 Dental specialty and child's age and BDFPMs

When tabulating the responses against specialty (GDPs, PDs and others), the majority opted for knowing the best time to extract the FPM in children (61.1% (n=96), 78.3% (n=18), and 57.9% (n=11) respectively). Although among these groups about 21.7% (n=5) of PDs, 42.1% (n=8) of other specialities and 38.9% (n=61) of general dental practitioners did not believe so and all their intention was to save the tooth regardless the age of the child.

4.24 The fourth question: BDFPMs and referral outcomes

The question of this part asked the participants about what was the referral outcome once a dentist was faced with a case of BDFPMs (like the scenario presented in the questionnairre and presented in the table 4.2): Options given were a) refer to a PD, b) consult (discuss) with a PD, c) consult (discuss) with an orthodontist or d) self treat and diagnose with no referral or consultation. The overall results (see Figure 17) showed

that a large majority would refer or consult with a PD or orthodontist (89.9%, n=177) while only 11.1% (n=22) would self diagnose and treat.

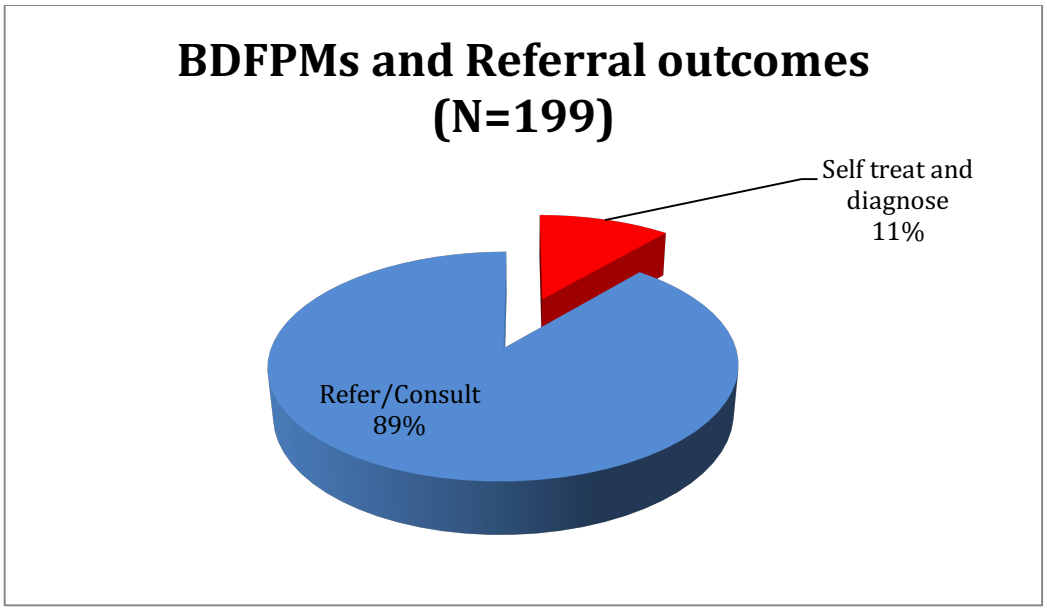

Figure 17: BDFPMs and referral outcomes.

When breaking down the results further, the following was found

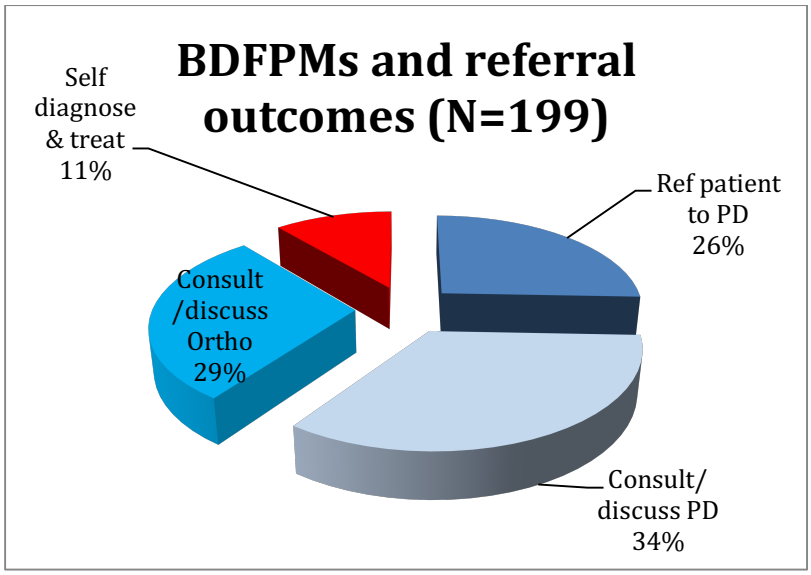

Figure 18: BDFPMs and referral outcome details.

When cross-tabulating the responses to the above question against a) training background and b) specialty there was a statistically significant difference (p=0.006 and p=0.003 respectively). There was no statistical significance when cross-tabulating against the dentist's gender.

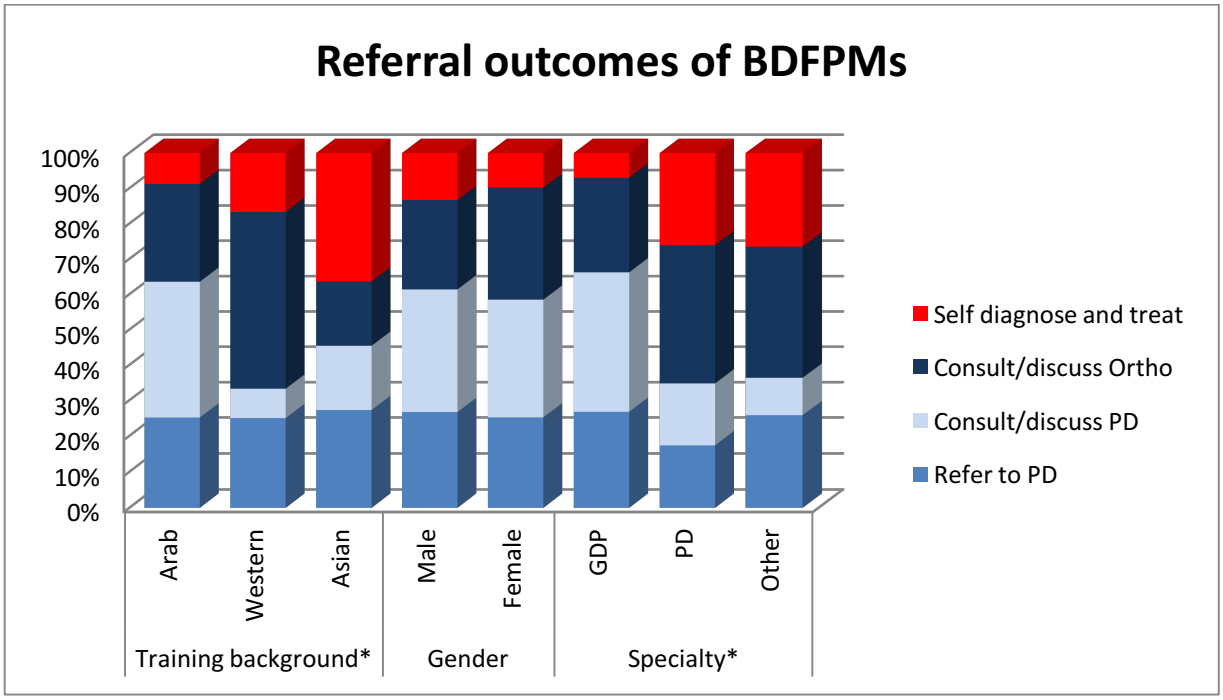

Figure 19: BDFPMs and referral outcome- cross tabulated against training background, specialty and gender. statistically significant.*

4.24.1 Training background and BDFPMs referral outcomes

With a significant P-value (p=0.006), the results are detailed below (Figure 20):

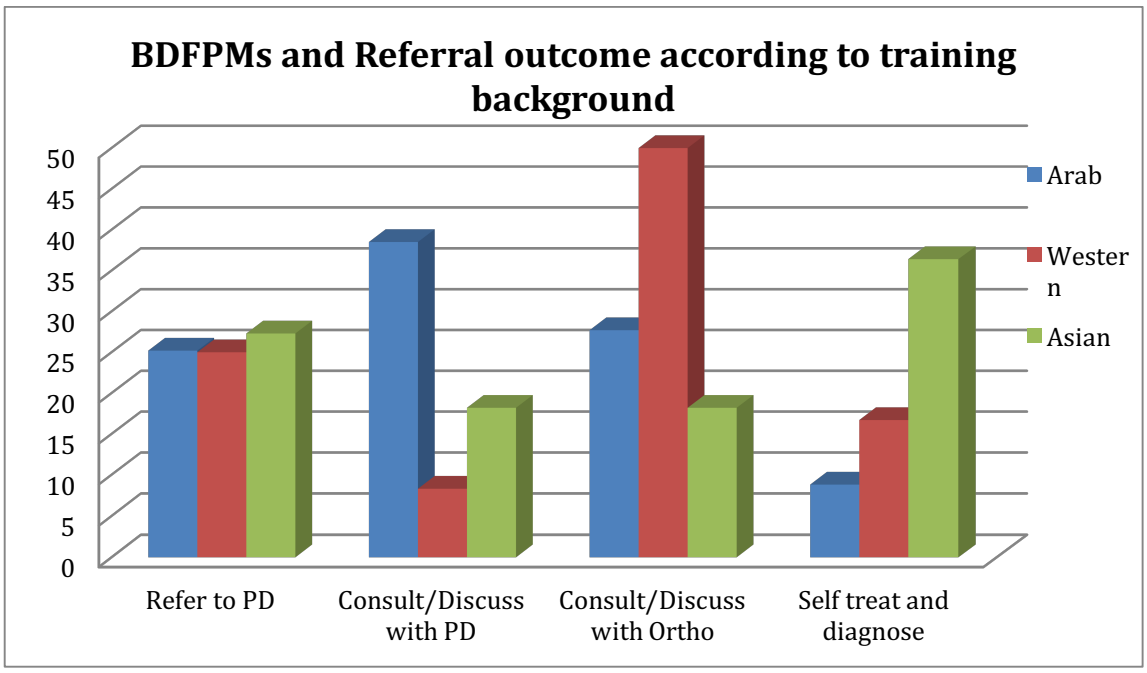

Figure 20: BDFPMs referral outcome according to training brackground.

A. Arab trained dentists and BDFPMs referral outcomes

38.4% dentists (n=61) would consult (discuss) the case with a PD specialist, 25.2% (n=40) would send the patient to a PD specialist. 27.7% (n=44) would consult (discuss) the case with an orthodontist, and only 8.8% (n=14) would be confident to treat the case themselves.

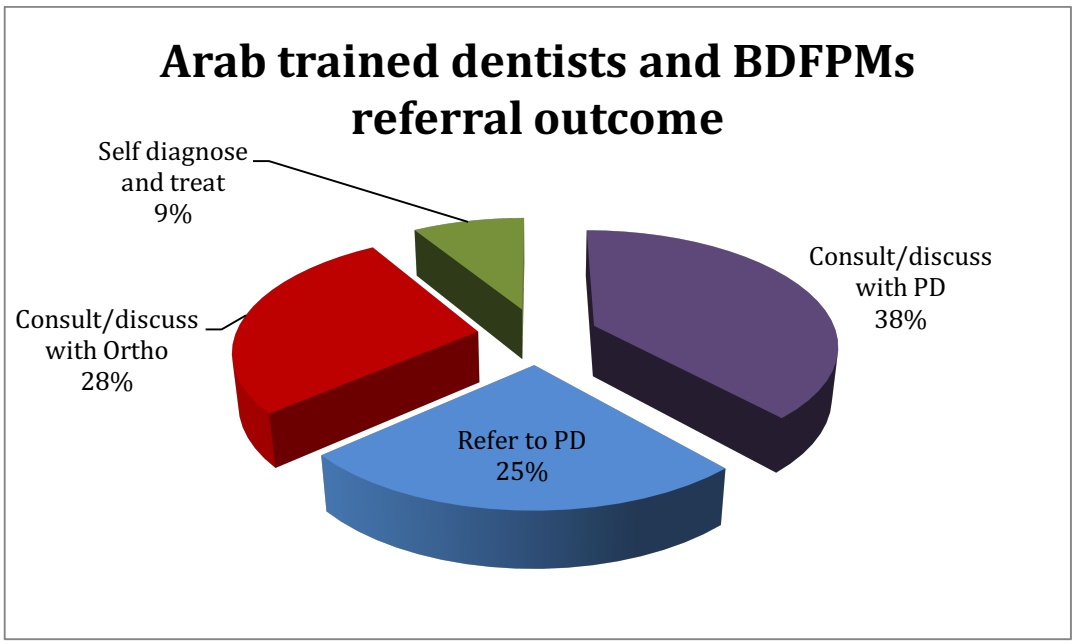

Figure 21: BDFPMs referral outcome and Arab dentists.

B. Western trained dentists and BDFPMs referral outcomes

Half of western trained dentists (50%, n=12) would consult an orthodontist, 16.7% (n=4) would self diagnose and treat, 25% (n=6) would refer the patient to a PD, and 8.3% (n=2) would consult (discuss) with a PD.

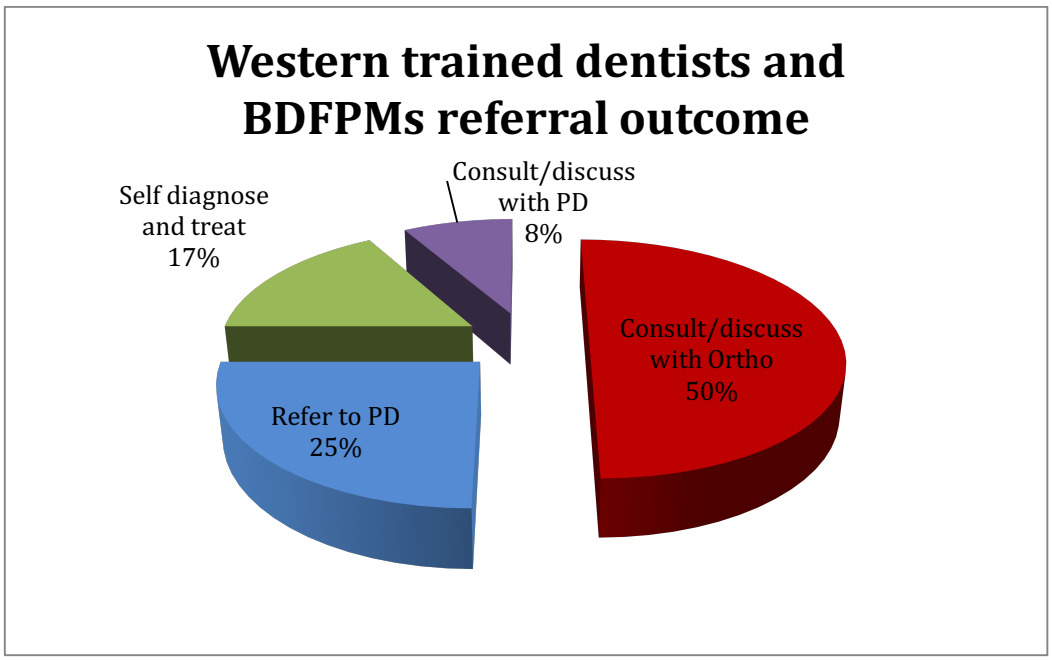

Figure 22:BDFPMs referral outcome and Western trained dentists.

C. Asian trained dentists and referral outcomes

More than one third, 36.4% (n=4) would self diagnose and treat, 27.3% (n=3) would refer the patient to a PD, 18.2% (n=2) would consult an orthodontist or a PD.

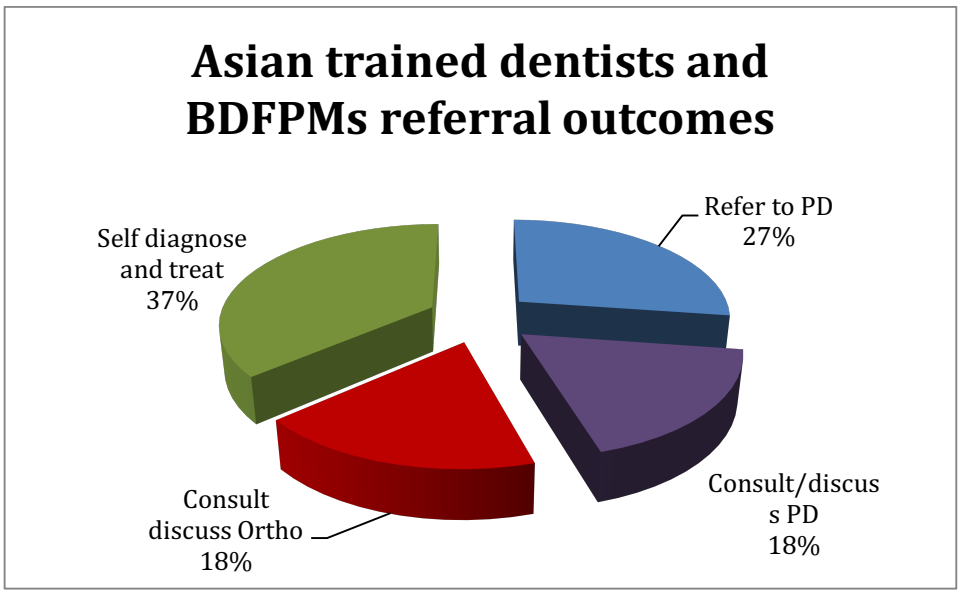

Figure 23: BDFPMS referral outcomes and Asian trained dentists.

4.24.2 BDFPMs referral outcomes and dentist's gender

When tabulating the responses against dentists gender, 26.7% (n=20) of male dentists and 25.2% (n=31) of female dentists would refer the patient to a PD, 34.7% (n=26) of male dentists and 33.3% (n=41) of female dentists would consult (discuss) the case with a PD specialist, 25.3% (n=19) of male dentists and 31.7% (n=39) of female dentists would consult an orthodontist , 13.3% (n=10%) of male dentists and 9.8% (n=12) of female dentists would self diagnose and treat. The above was not statistically significant (p=0.742).

4.24.3 BDFPMs referral outcomes and dental specialty

With a significant P-value (p=0.003), the results are detailed below (figure 24):

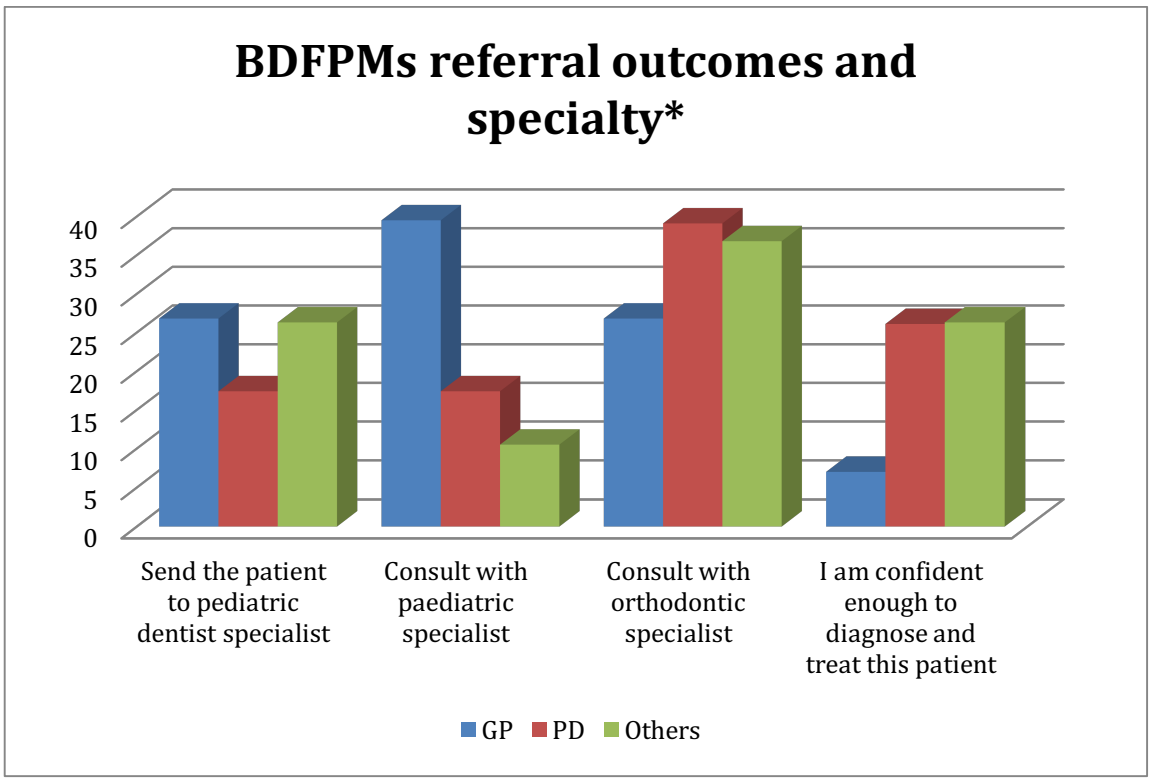

*Figure 24: Overall BDFPMs referal outcomes and speciality. * statistically significant*

A. BDFPMs referral outcomes and GDP group

With a significant P-value (p=0.003) 39.5% of GDPs (n=62) would consult (discuss) the case with a PD specialist, 26.8% (n=42) would send the patient to a PD specialist. 26.8% (n=42) would consult (discuss) the case with an orthodontist, and only 7% (n=11) would be confident to treat the case themselves.

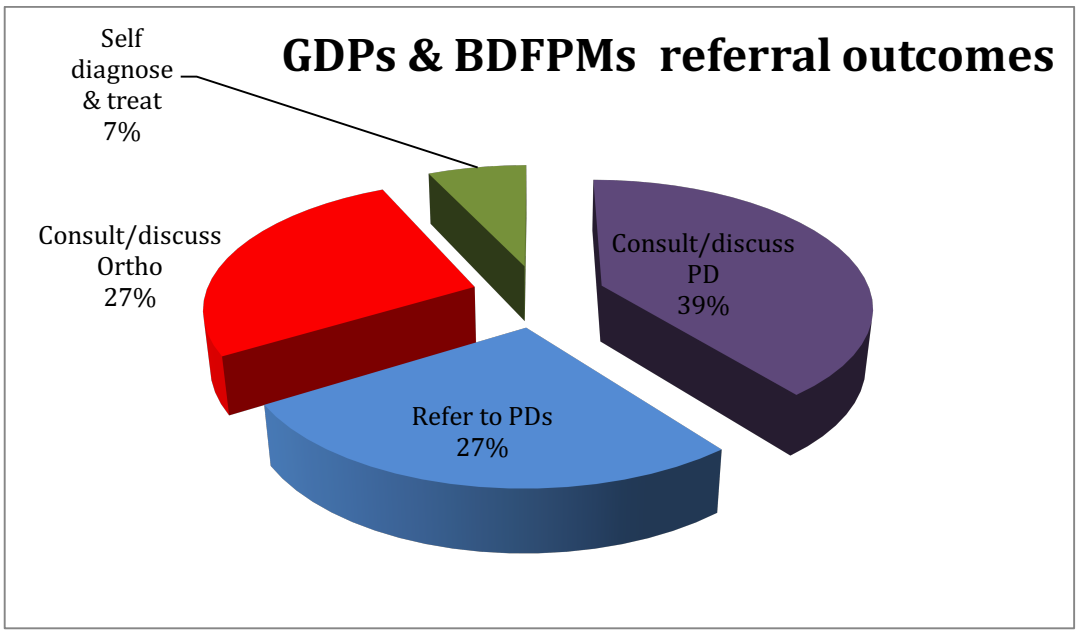

Figure 25: GDPs and BDFPMs referral outcome.

B. BDFPMs referral outcomes and PD group

When looking at PDs surveyed, 39.1% (n=9) would consult an orthodontist, 26.1% (n=6) would self-diagnose and treat, while 17.4% (n=4) would refer or consult with another PDs.

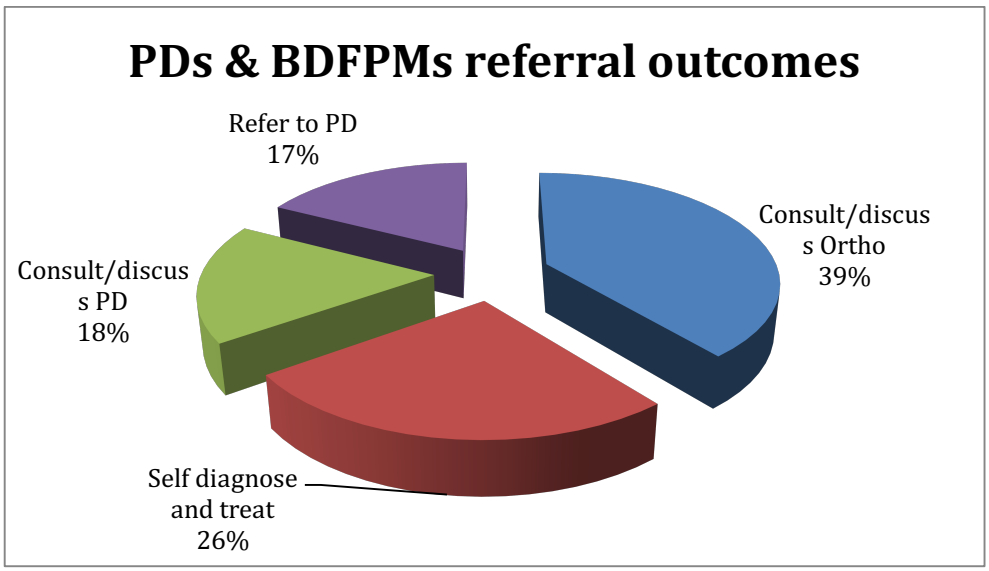

Figure 26: PD and BDFPMs referral outcome.

C. BDFPMs referral outcomes and other groups

Seven (36.8%) would consult an orthodontist, 26.3% (n=5) would self diagnose and treat, 25.6% (n=5) would refer the patient to a PD, and 10.5% (n=2) would consult (discuss) with a PD. See Figure 27.

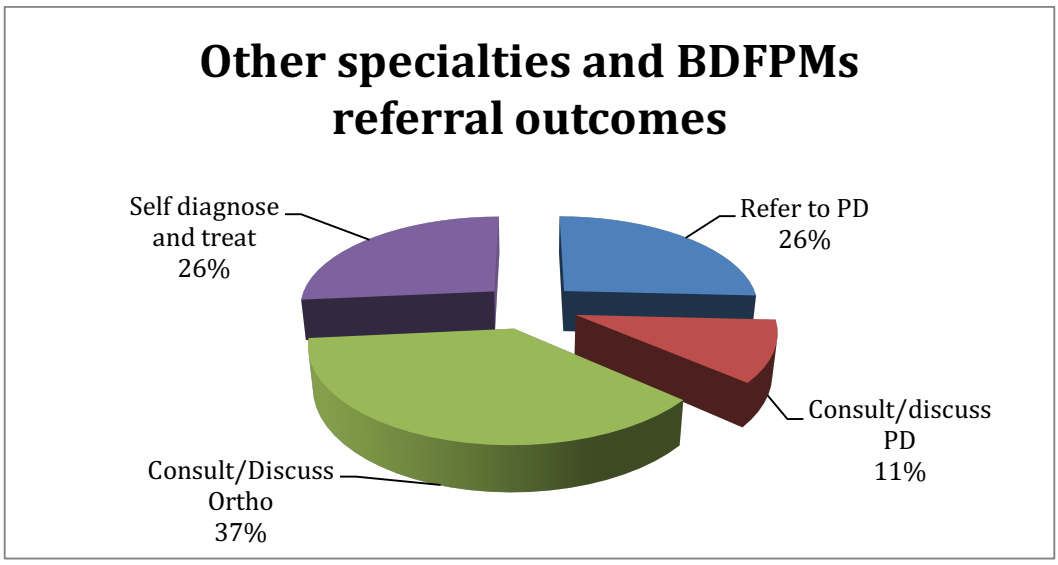

Figure 27: Other specialties and BDFPMs referral outcomes.

4.30 Enforced extraction of first permanent molars (EExFPMs) related questions and responses:

Response to the questions about enforced extraction of broken down first permanent molars due to MIH or caries are shown in tables 5, 6 and 7.

Table 5: Response of participants to the questions about enforced extraction of broken down first permanent molars due to MIH or caries: according to speciality

Questions	Options	GP Nr(%)	PD Nr(%)	Other Specialists Nr(%)	P-value
Q1. Have you ever considered enforced extraction of broken down FPMs?	No, I should preserve the tooth as much as I can	91 (58.3)	4 (17.4)	6 (31.6)	*0.000
	Yes, but first I should consult with orthodontics	65 (41.7)	19 (82.6)	13 (68.4)	
Q2.Have you ever heard about the concept of enforced extraction of FPMs?	Yes but I am not practicing it	51 (32.5)	5 (21.7)	6 (31.6)	*0.002
	Yes and I am familiar with all its related guidelines and practicing it	26 (16.6)	11 (47.8)	1 (5.3)	
	Yes, but I do not agree with enforced extraction of any teeth (Unless for orthodontic purposes)	28 (17.8)	6 (26.1)	3 (15.8)	
	No, I have no idea about it	52 (33.1)	1 (4.3)	9 (47.4)	
Q3.Have you ever done any enforced extraction of broken down FPMs for a child?	No	121 (77.1)	12 (54.5)	14 (73.7)	0.077
	Yes	36 (22.9)	10 (45.5)	5 (26.3)	
Q4. "The Enforced Extraction Of First Permanent Molar In Children" UK guideline 2014	I never knew there was a guideline for EExFPM	101 (64.3)	10 (43.5)	9 (47.4)	*0.007
	I know the UK supports and practices EExFPM but I never knew there was a guideline	33 (21.0)	3 (13.0)	7 (36.8)	
	I am fully aware of this guideline	23 (14.6)	10 (43.5)	3 (15.85)	

Table 6: Response of participants to the questions about enforced extraction of broken down first permanent molars due to MIH or caries: according to education background

Questions	Options	Arab Nr(%)	Western Nr(%)	Asian Nr(%)	P-value
Q1. Have you ever considered enforced extraction of broken down FPMs?	No, I should preserve the tooth as much as I can	88(55.7)	2 (8.3)	9 (81.8)	0.00*
	Yes, but first I should consult with orthodontics	70 (44.3)	22 (91.7)	2 (18.2)	
Q2.Have you ever heard about the concept of enforced extraction of FPMs?	Yes but I am not practicing it	49 (30.8)	7 (29.2)	6 (54.5)	0.132
	Yes and I am familiar with all its related guidelines and practicing it	29 (18.2)	7 (29.2)	0(0)	
	Yes, but I do not agree with enforced extraction of any teeth (Unless for orthodontic purposes)	28 (17.6)	3 (12.5)	4 (36.4)	
	No, I have no idea about it	53 (33.3)	7 (29.2)	1 (9.1)	
Q3.Have you ever done any enforced extraction of broken down FPMs for a child?	No	119 (75.3)	15 (62.5)	9 (81.8)	0.34
	Yes	39 (24.7)	9 (37.5)	2 (18.2)	
Q4. "The Enforced Extraction Of First Permanent Molar In Children" UK guideline 2014	I never knew there was a guideline for EExFPM	65.4 (104)	9 (37.5)	5 (45.5)	0.09
	I know the UK supports and practices EExFPM but I never knew there was a guideline	30 (18.9)	8 (33.3)	3 (27.3)	
	I am fully aware of this guideline	25 (15.7)	7 (29.2)	3 (27.3)	

Table 7: Response of participants to the questions about enforced extraction of broken down first permanent molars due to MIH or caries: according to gender

Questions	Options	**Male Nr(%)**	**Female Nr(%)**	**P-value**
Q1. Have you ever considered enforced extraction of broken down FPMs?	No, I should preserve the tooth as much as I can	38 (50.7)	62(50.8)	0.55
	Yes, but first I should consult with orthodontics	37 (49.3)	60 (49.2)	
Q2.Have you ever heard about the concept of enforced extraction of FPMs?	Yes but I am not practicing it	24 (32.0)	38 (30.9)	0.052
	Yes and I am familiar with all its related guidelines and practicing it	11 (14.7)	27 (22)	
	Yes, but I do not agree with enforced extraction of any teeth (Unless for orthodontic purposes)	9 (12)	27 (22)	
	No, I have no idea about it	31 (41.3)	31 (25.2)	
Q3.Have you ever done any enforced extraction of broken down FPMs for a child?	No	58 (78.8)	88 (71.5)	0.28
	Yes	16 (21.6)	35 (28.5)	
Q4. "The Enforced Extraction Of First Permanent Molar In Children" UK guideline 2014	I never knew there was a guideline for EExFPM	46 (61.3)	73 (59.3)	0.95
	I know the UK supports and practices EExFPM but I never knew there was a guideline	16 (21.3)	27 (22)	
	I am fully aware of this guideline	13 (17.3)	23 (18.7)	

4.31 The first question: personal consideration for EExFPMs

In response to the question "Have you considered EExFPM for BDFPMs"?" the overall responses were: "No"51% (n=101) and "Yes" 49% (n=97).

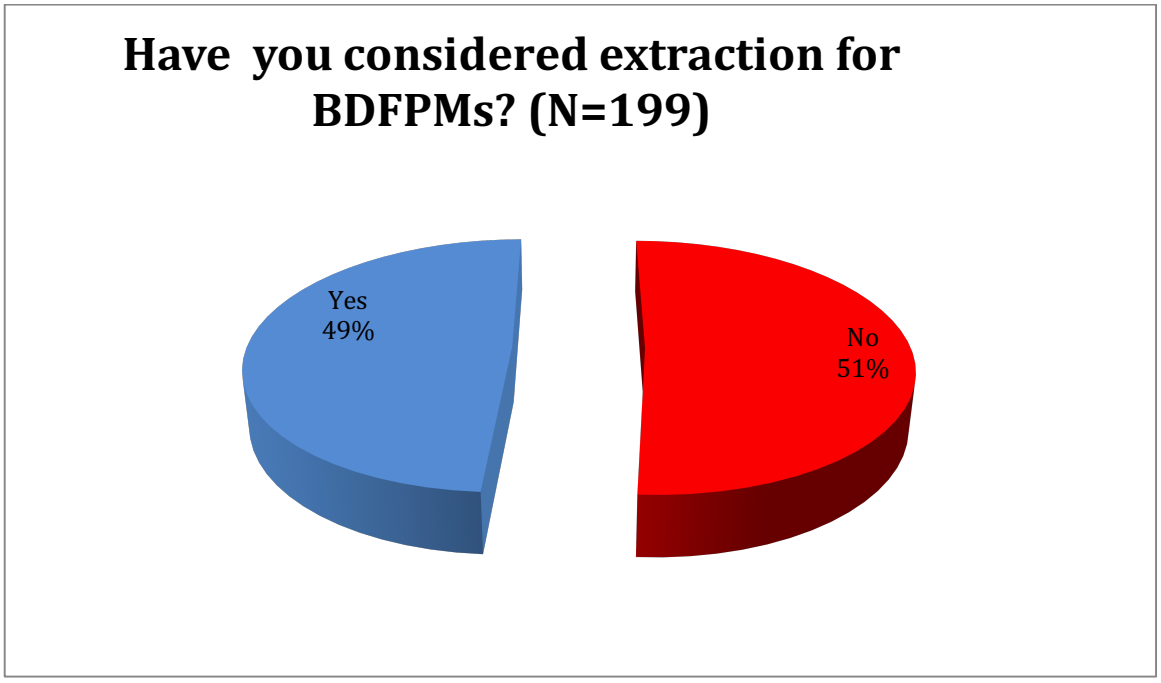

Figure 28: Overall Consideration for EExFPMs

When cross-tabulating the responses against a) training background , b) dentist gender and c) specialty; statistical significance was found with training background and specialty (p=0.001 for both). The gender of dentist had no significant bearing on the results (p=0.55).

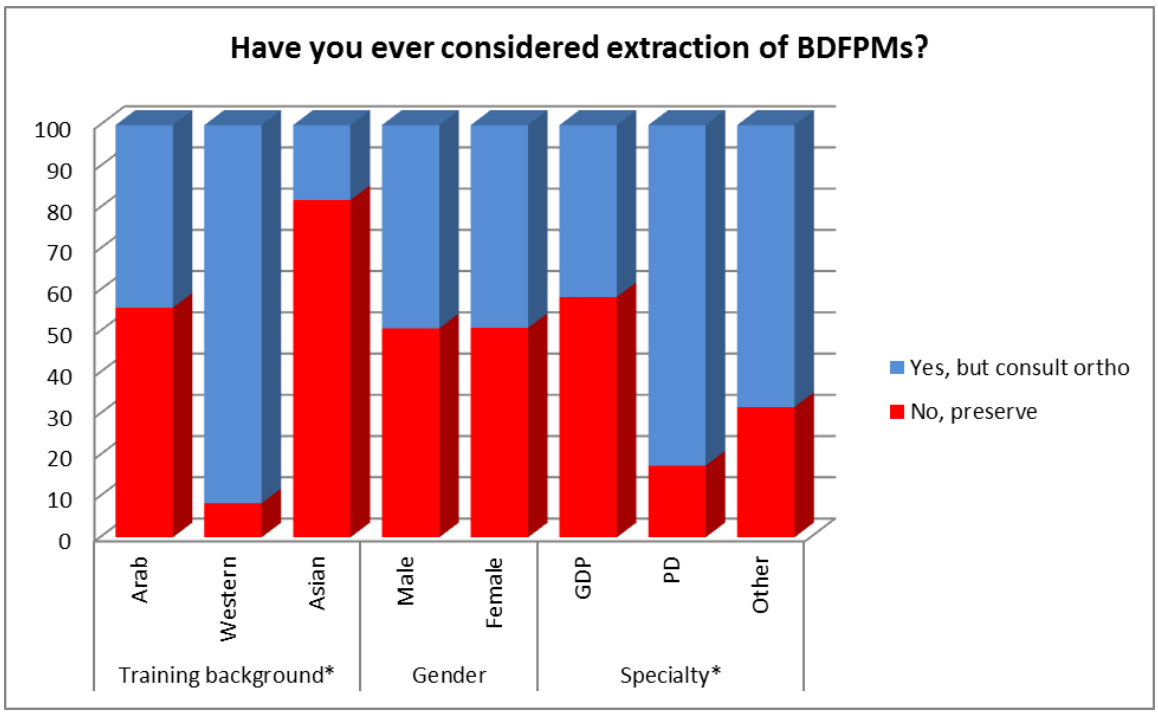

*Figure 29: Overall personal consideration for EExFPMs. * Statistically significant*

4.31.1 Training background and consideration for EExFPMs

When cross-tabulating the above question (Would you consider EExFPM for BDFPM?) against training background, the following was found (p=0.001): 55.7% (n=88) of Arab trained dentists would not consider EExFPM while 44.4% would (n=70), compared to Western ("No", 8.3%, n=2 and "Yes" 91.7% , n=22) and Asian ("No" 81.8%, n=9 and "Yes" 18.2, n=2). See Figure 30 below.

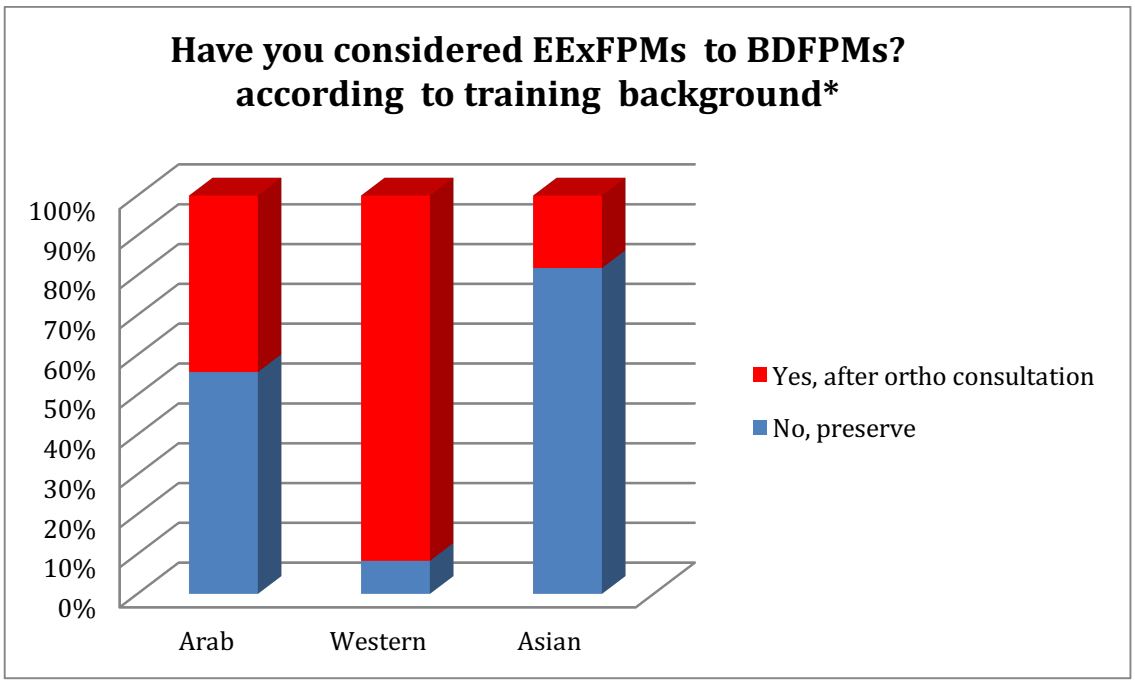

Figure 30: Training background and consideration for EExFPMs . Statistically significant (p=0.001).

A. Consideration of EExFPM of BDFPMs and Arab group

The majority of responses were: "Yes, after orthodontic consultation" (55.7%, n=88) and 44.3% (n=70) would prefer to preserve the teeth.

B. Consideration of EExFPM of BDFPMs and Western group

The majority answered "Yes, after orthodontic consultation" (91.7%, n=9) and the manority believed in keeping the teeth as much as they can (8.3%, n=2).

C. Consideration of EExFPM of BDFPMs and Asian group

The majority of responses were: "Yes, after orthodontic consultation" (81.8%, n=9) and the rest would preserve the teeth (18.2%, n=2).

4.31.2 Dentists gender and consideration for EExFPMs

When tabulating the responses against dentists gender, majority of both male (50.7%, n=38) and female (50.8%, n=62) would not consider EExFPM while 49.3% (n=37) male and 49.2% (n=60) female dentists would. Figure 31.

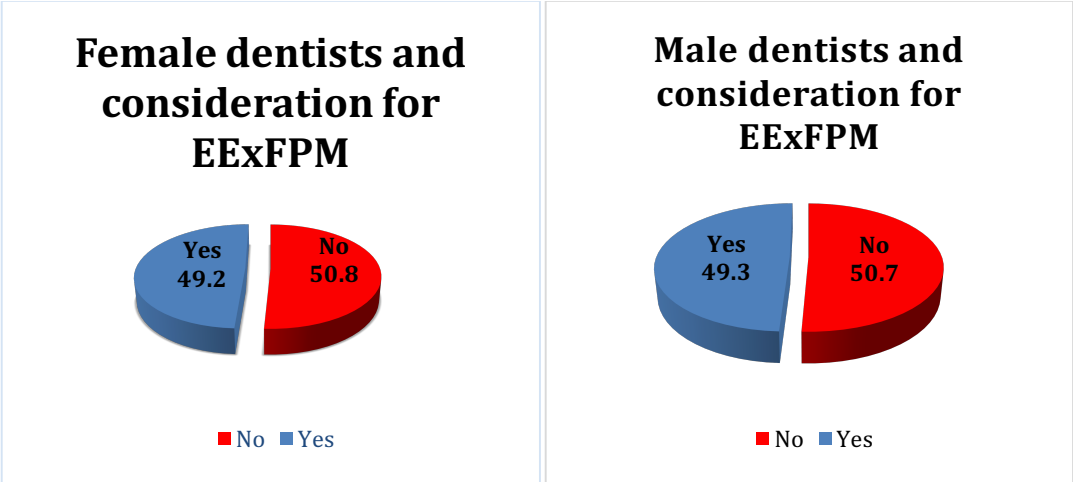

Figure 31: Dentist gender and consideration for EExFPMs

4.31.3 Dental specialty and consideration for EExFPMs

When cross tabulating the above question (Would you consider EExFPM for BDFPMs?) against specialty the following results were found (p=0.001): 58.3% of GDPs (n=91) would not consider EExFPM while 41.7% (n=65) would, compared to PDs ("No" 17.4%,

n=5 and “Yes” 82.9%, n=19) and other specialties (“No” 31.6%, n=6 and “Yes” 68.4%, n=13). See figure 32 below.

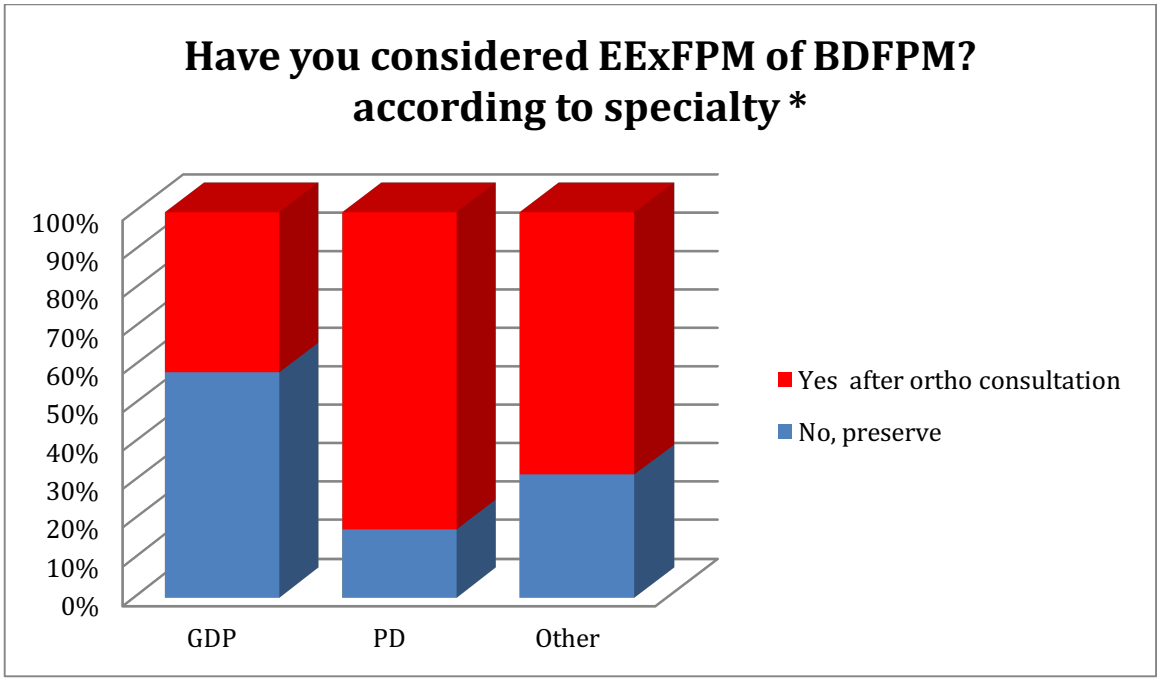

*Figure 32: Specialty and consideration for EExFPMs. *Statistically significant (p=0.001).*

4.32 The second question: awareness of the concept of EExFPMs

In response to the question” Have you ever heard about the concept of EExFPM?”, overall the following were the responses: “Yes” (68.9%, n=137) and “No” (31.2%, n=62). See figure 33.

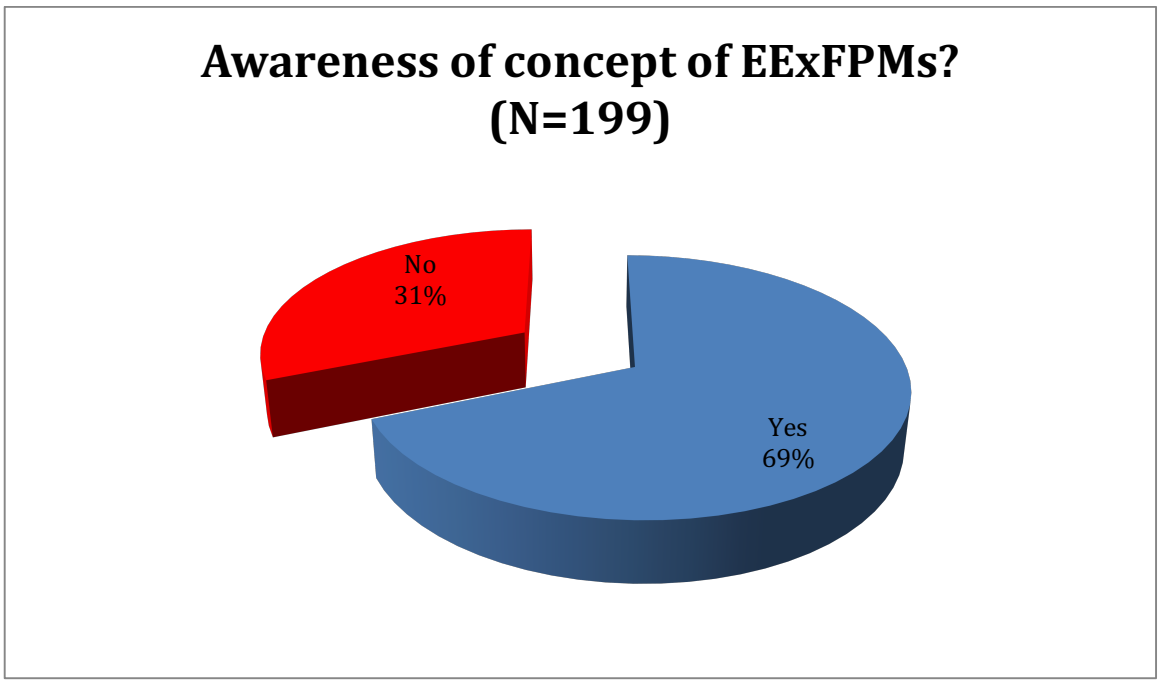

Figure 33: Overall awareness of concept of EExFPMs.

Out of the those who responded yes, 31.2% (n=62) said they were not practicing EExFPM, 19.1% (n=28) said they were familiar with the guidelines and are practicing it, and 18.6% (n=37) said they do not agree with the concept of EExFPM (Figure 34).

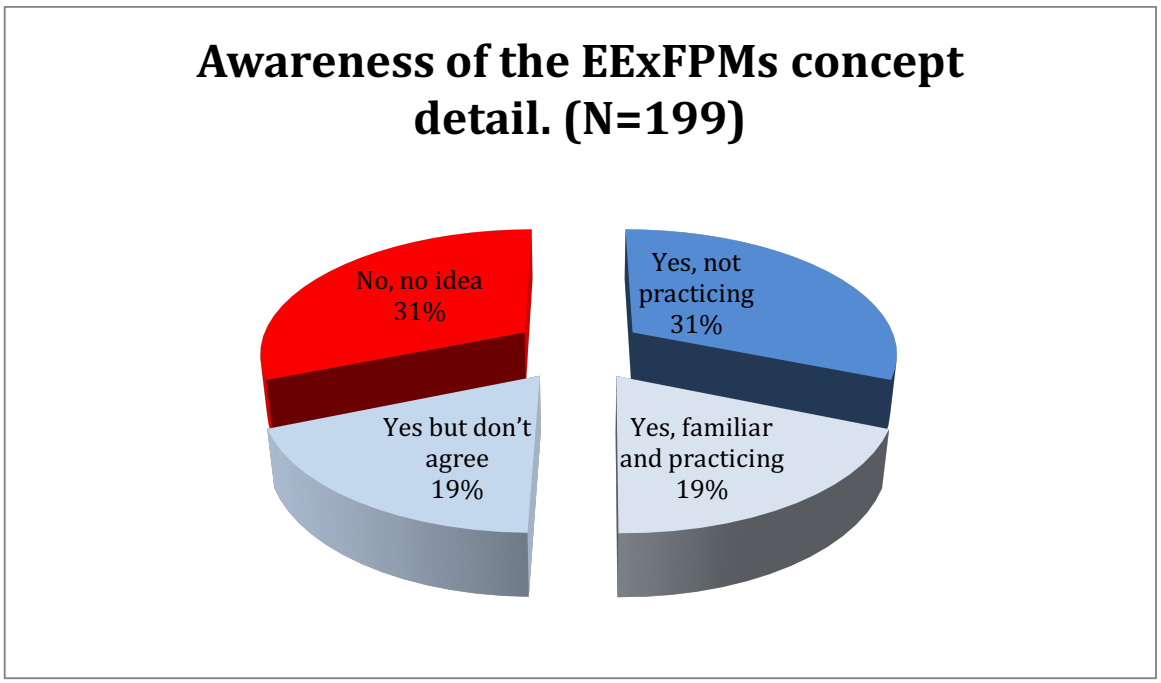

Figure 34: Detailed awareness of EExFPMs concept results.

When cross-tabulating the responses against training background, dentist gender and specialty, a statistically significant result was found (p=0.002) with specialty only. Training background and gender of dentist had no significant baring on the results (p=0.132 and p=0.052 respectively).

4.32.1 Training background and awareness of concept of EExFPMs

When cross-tabulating the above question (Have you ever heard about the concept of EExFPM?) against training background, the following was found (statististically not significant (p=0.132) (figures 35 and 36):

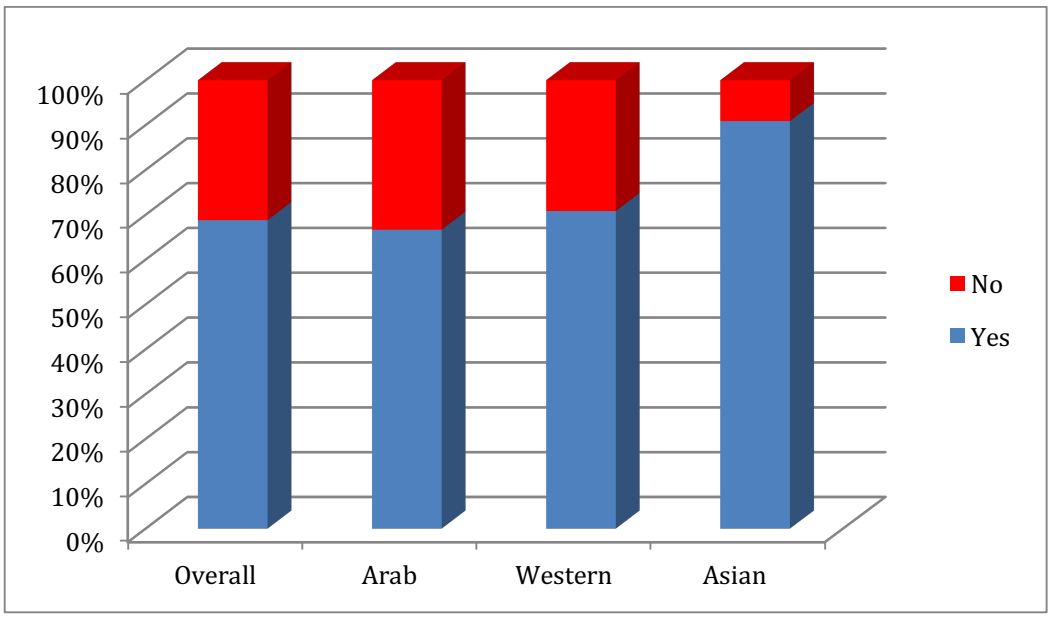

Figure 35: Awareness of concept of EExFPMs and training background.

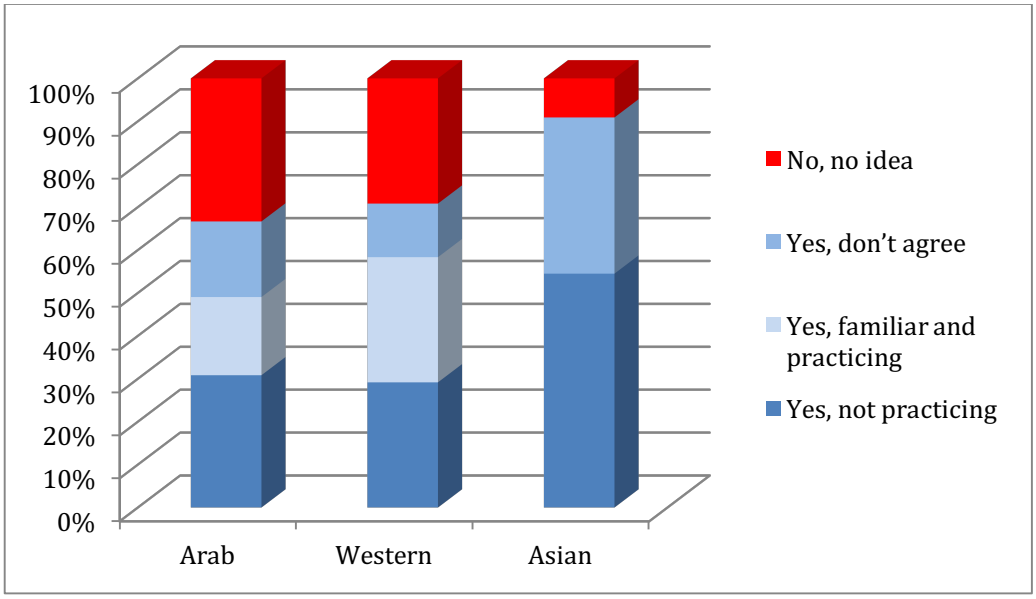

Figure 36: Awareness of concept of EExFPMs and training background detail.

A. Awareness of concept of EExFPMs and Arab group

This group responses were: "Yes" (66.6 %, n=106) and "No" (33.3%, n=53). Out of the those who responded yes, 30.8% (n=49) said they were not practicing EExFPM, 18.2% (n=29) said they were familiar with the guideines and are practicing it, and 17.6% (n=28) said they do not agree with the concept of EExFPM (Figure 36).

B. Awareness of concept of EExFPMs and Western group

The responses were: "Yes" (70.9%, n=17) and "No" (29.2%, n=7). Out of the those who responded yes, 29.2% (n=7) said they were not practicing EExFPM the same as dentists who said they were familiar with the guidelines and are practicing it, and 12.5% (n=3) said they do not agree with the concept of EExFPM (Figure 36).

C. Awareness of concept of EExFPMs and Asian group

The responses were: "Yes" (90.9%, n=10) and "No" (9.1%, n=1). Out of the those who responded yes, 54.5% (n=6) said they were not practicing EExFPM and 36.4% (n=4) said they do not agree with the concept of EExFPM (Figure 36).

4.32.2 Dentists gender and awareness of concept of EExFPMs

When tabulating the responses against dentists gender , 32% (n=24) of male dentists and 30.9% (n=38) of female dentists responded yes but they were not practicing EExFPM, 14.7% (n=11) of male dentists and 22% (n=27) of female dentists said they were familiar

with the guideines and are practicing it, 12% (n=9) of male dentists and 22% (n=27) of female dentists said they do not agree with the concept of EExFPM, 41.3% (n=31) of male dentists and 25.2% (n=31) of female dentists responses were “No”. Figure 37.

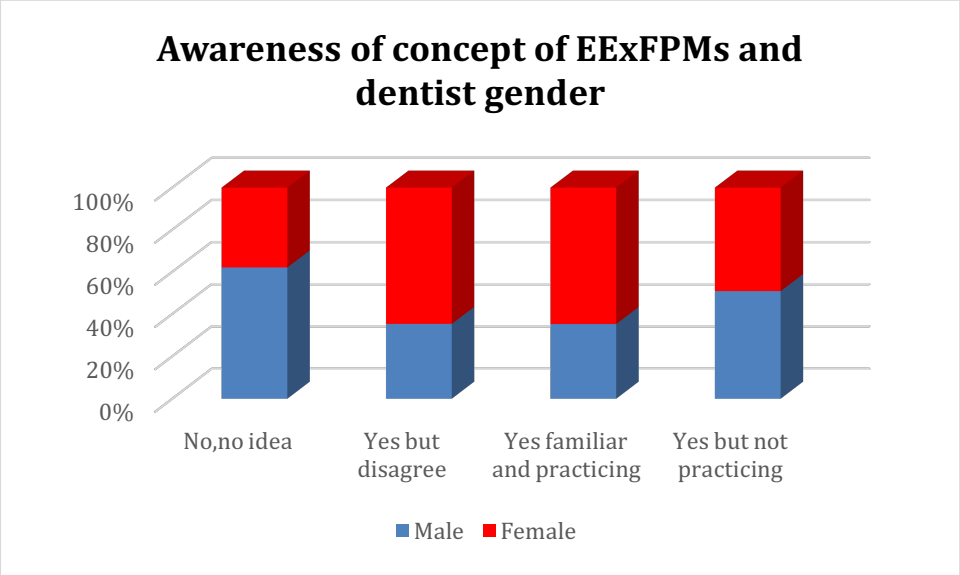

Figure 37: Dentist gender and awareness of concept of EExFPMs.

4.32.3 Dental specialty and awareness of concept of EExFPMs (p=0.002)

A. Awareness of concept of EExFPMs and GDP group

The responses were: “Yes” (66.9 %, n=105) and “No” (33.1%, n=52). Out of the those who responded yes, 32.5% (n=51) said they were not practicing EExFPM, 16.6% (n=26) said they were familiar with the guideines and are practicing it, and 17.8% (n=28) said they do not agree with the concept of EExFPMs.

B. Awareness of concept of EExFPMs and PD group

The responses were: "Yes" (95.7%, n=22) and "No" (4.3%, n=1). Out of the those who responded yes, 21.7% (n=5) said they were not practicing EExFPM, 47.8% (n=11) said they were familiar with the guidelines and are practicing it, and 26.1% (n=6) said they do not agree with the concept of EExFPM.

C. Aawareness of concept of EExFPMs and other specialists group

The responses were: "Yes" (52.6%, n=10) and "No" (47.4%, n=9). Out of the those who responded yes, 31.6% (n=6) said they were not practicing EExFPM, 5.3% (n=1) said they were familiar with the guideines and are practicing it, and 15.8.1% (n=3) said they do not agree with the concept of EExFPMs.

The above results are represented in the following graphs (Figure 38 and 39).

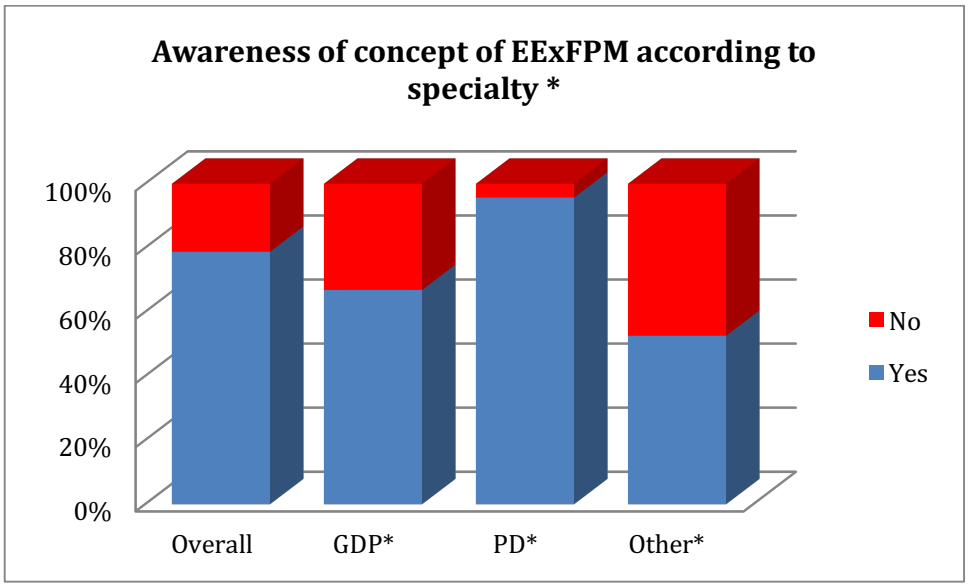

*Figure 38: Awareness of concept of EExFPMs and specialty overall. * Statistically significant (p=0.002)*

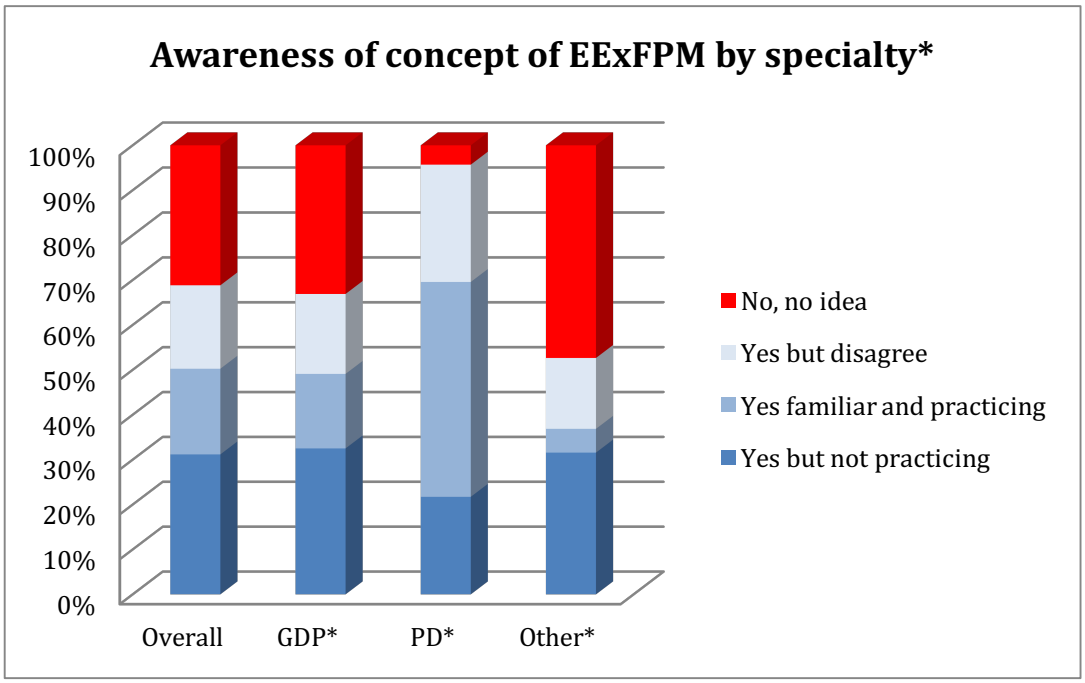

*Figure 39: Awareness of concept of EExFPMs and specialty detaled. * Statistically significant (p=0.002)*

4.3 The third question: practice of EExFPMs

In response to the question " Have you ever practiced EExFPM for BDFPMs in a child?" the overall responses were: "No" (74.2%, n=147) and "Yes" (25.8%, n=51).

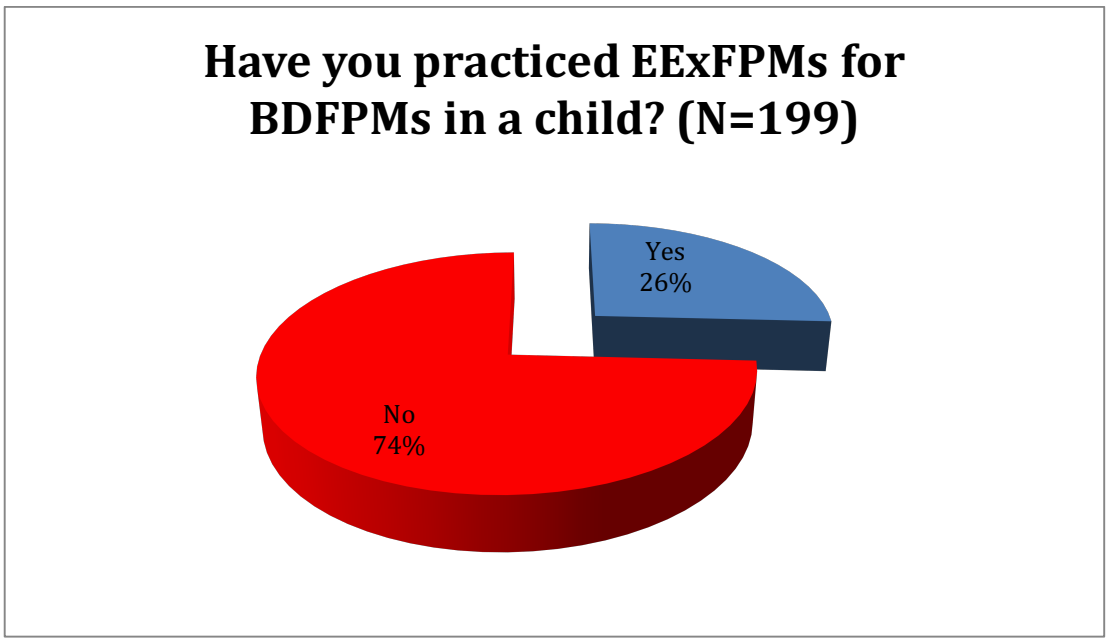

Figure 40: Practice of EExFPMs. Overall results.

When cross tabulating the responses of the above question against a) training background b) dentist gender and c) specialty, no statistical significant differences were found (p=0.342, p=0.289 ,and p=0.077 respectively). See figure 41 below.

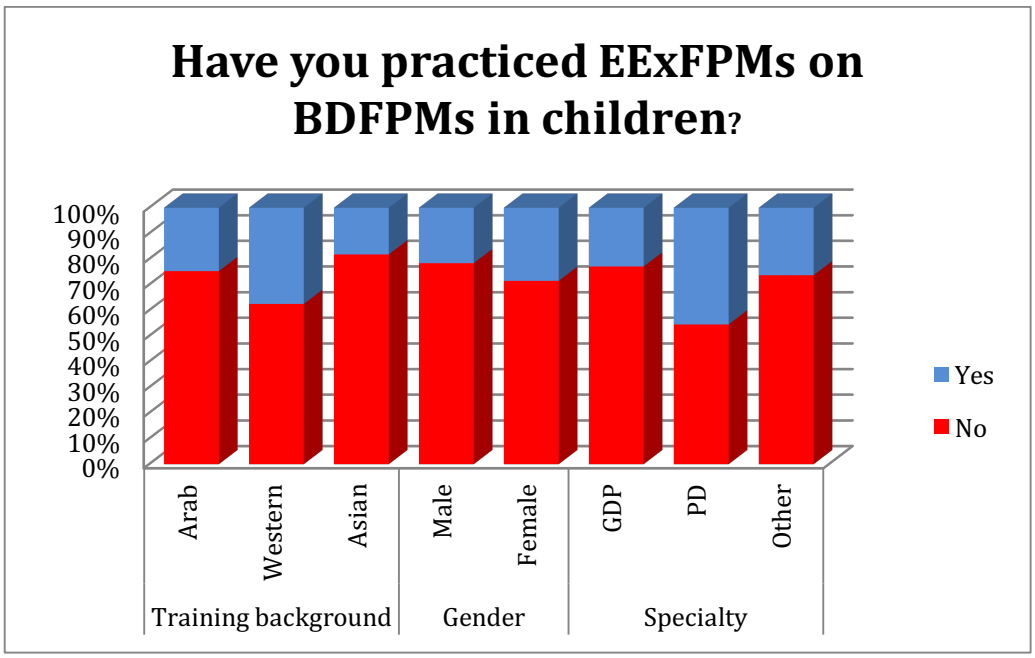

Figure 41: Practice of EExFPMs. No statistical significant difference noted.

4.33.1 Training background and practice of EExFPMs

When cross tabulating the above question (Have you ever practiced EExFPM for BDFPM in a child?) against training background, the following was found: 75.3% (n=119) of Arab trained dentists never done EExFPM in children while 24.7% did (n=39), compared to Western ("No", 62.5%, n=15 and "Yes" 37.5% , n=9) and Asian ("No" 81.8%, n=9 and "Yes" 18.2, n=2).

4.33.2 Dentists gender and practice of EExFPMs

When tabulating the responses against dentists gender, majority of both male (78.4%, n=58) and female (71.5%, n=88) did not practice EExFPM in children while 21.6% (n=16) male and 28.5% (n=35) female dentists did.

4.33.3 Dental specialty and practice of EExFPMs

When cross tabulating the above question against specialty the following results were found : 77.1% of GDPs (n=121) did not practice EExFPM in children while 22.9% (n=36) did, compared to PDs ("No" 54.5%, n=12 and "Yes" 45.5%, n=10) and other specialties ("No" 73.7%, n=14 and "Yes" 26.3%, n=5).

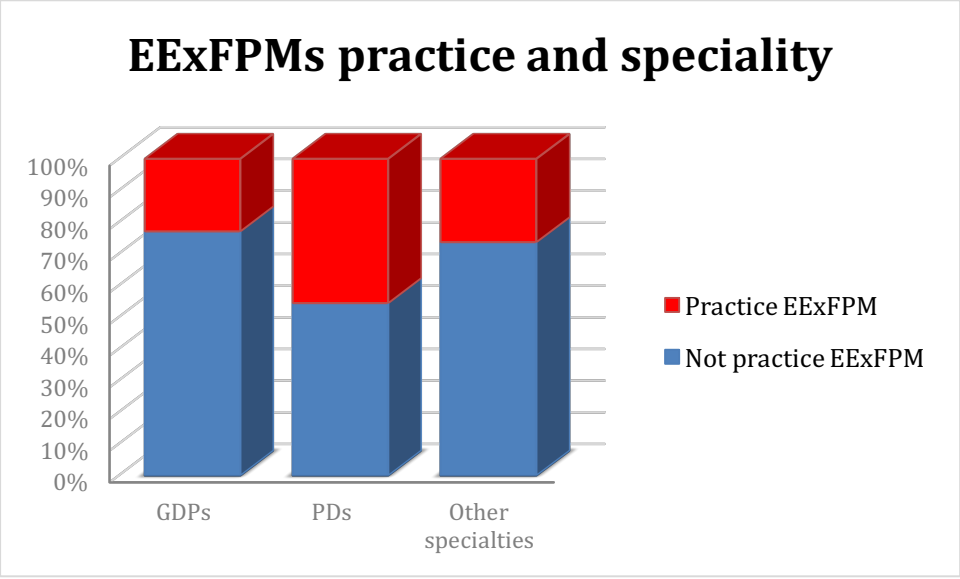

Figure 42: Specialty and practice of EExFPMs.

4.34 Awareness of the 2014 UK guidelines for EExFPMs

In response to the question " Are you aware of the UK 2014 guidelines of the EExFPM in children?" 81.8% (n=163) were not aware of such a guideline, while 18.1% (n=36) were fully aware. Out of those who never knew of the guidelines, 21.6% (n=43) knew that the UK supports the concept EExFPM. See figures 43 and 43 below.

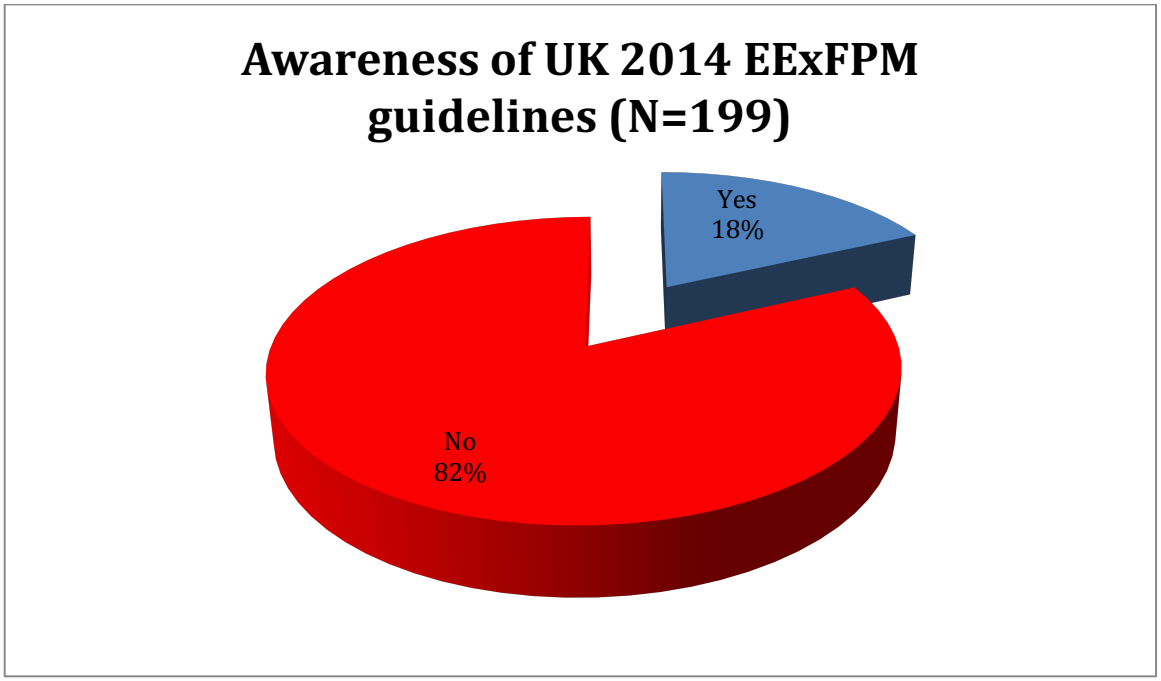

Figure 43: Aware of UK EExFPMs guidelines. Overall results.

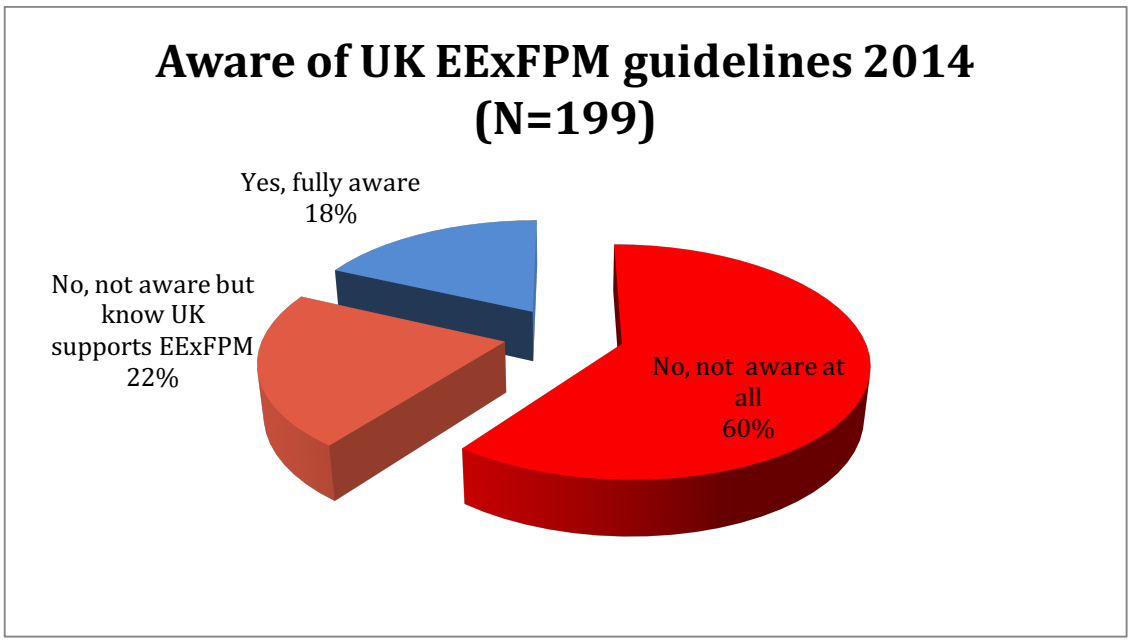

Figure 44: Aware of UK EExFPMs guideline. Breakdown of overall results

When cross tabulating the above responses against a) training background b) dentists gender and c) specialty, statistically significant results were found with specialty (p=0.007). The training background and gender had no significant baring on the response (p=0.09 and p=0.958 respectively).

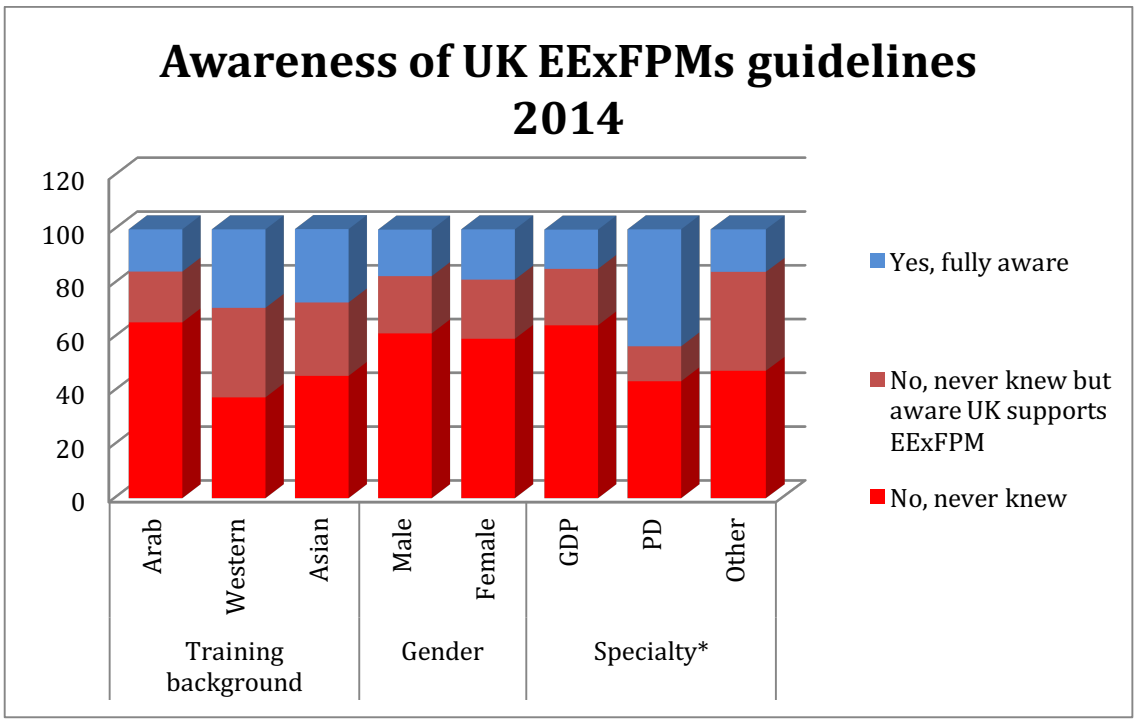

*Figure 45: Awareness of the UK EExFPMs 2014 guideline. *Statistically significant (p=0.007)*

4.34.1 Training background and awareness of UK guidelines for EExFPMs

When tabulating the responses against training background (Arab, Western and Asian), the majority of dentists were not aware of the EExFPMs UK guidelines (65.4%, n=104), 37.5% (n=37.5) and 45.5% (n=5) respectively). While 18.9% (n=30) Arab, 33.3% (n=8) Western, 27.3% (n=3) Asian background trained dentists were not aware of UK guideline but they knew that UK dentists support and practice EExFPMs. The rest were fully aware of this guideline (15.7% (n=25), 29.2% (n=7) and 27.3% (n=3) respectively).

4.34.2 Dentists gender and awareness of UK guidelines for EExFPMs

When tabulating the responses against dentists gender, the majority of both male and female dentists were not aware about EExFPMs UK guideline (61.3%, n=46 and 59.3%, n=73 respectively). 21.3% male dentists(n=16) and 22% female dentists (n=27) were not aware of this guideline but they knew that UK dentists support and practice EExFPMs, and 17.3% male dentists (n=13) and 18.7% female dentists (n=23) were fully aware of this guideline.

4.34.3 Dental specialty and awareness of UK guidelines for EExFPMs

When tabulating the responses against specialty (GDPs, PDs and others) , the following statistically significant result was found (p=0.007): 64.3% GDPs (n=101), 47.4% other specialities (n=9) and 43.5% PDs (n=10) never knew about EExFPMs UK guideline. On the other hand, 14.6% GDPs (n=23), 43.5% PDs (n=10), and 15.8% of other specialities (n=3) were fully aware of this guildeline. Although amongs these groups about 21% GDPs (n=33), 13% PDs (n=3), 36.8% other specialties (n=7) were not aware of UK guideline but they knew that UK dentists support and practice EExFPMs.

4.40 Knowledge question: The ideal time for extraction of a lower FPM

One question was tabled in the questionnaire to evaluate participants' knowledge regarding the ideal age to extract lower FPMs in a child if needed. The question was "If you have to do extraction of a lower FPM in a child, what will be the ideal age?". For this question, there is only one correct answer out of four answers, which was "8.5 to

10.5 years old". 61% (n=117) of participants answered this question correctly. (See Fig. 46).

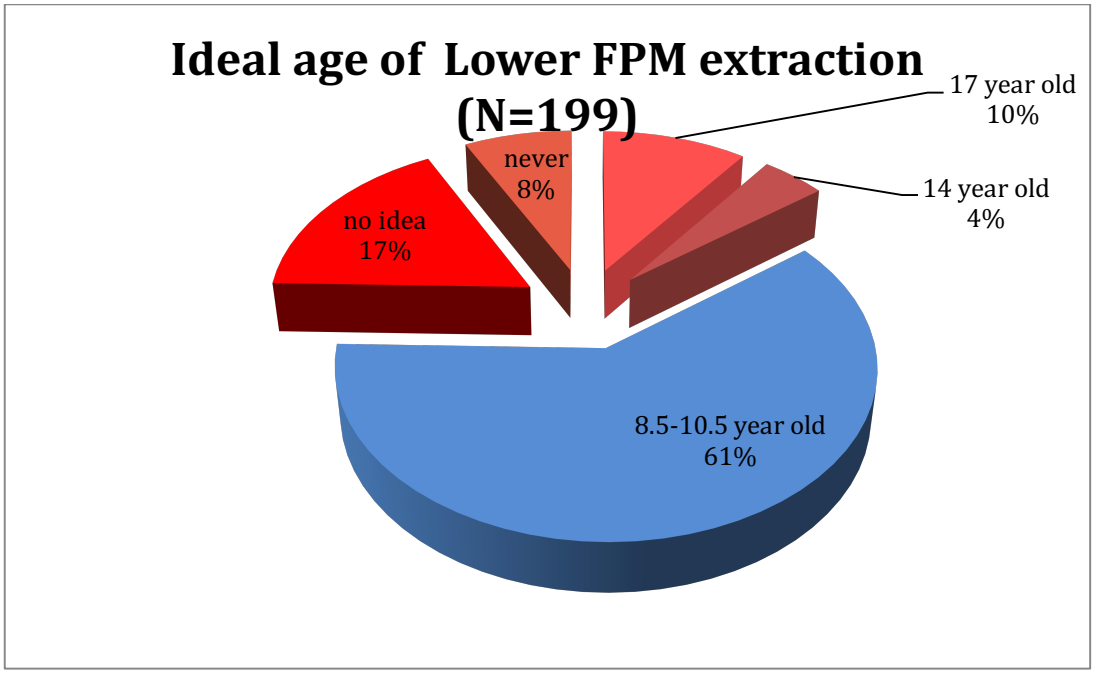

Figure 46: Ideal time to extract lower FPM. Overall results.

When cross tabulating the responses of the above question against a) training background, b) dentists gender and c) specialty, statistical significance was found with the training background (p=0.001). There was no statistical significance when cross tabulating against dentist gender or specialty, (p=0.355 and p=0.099 respectively).

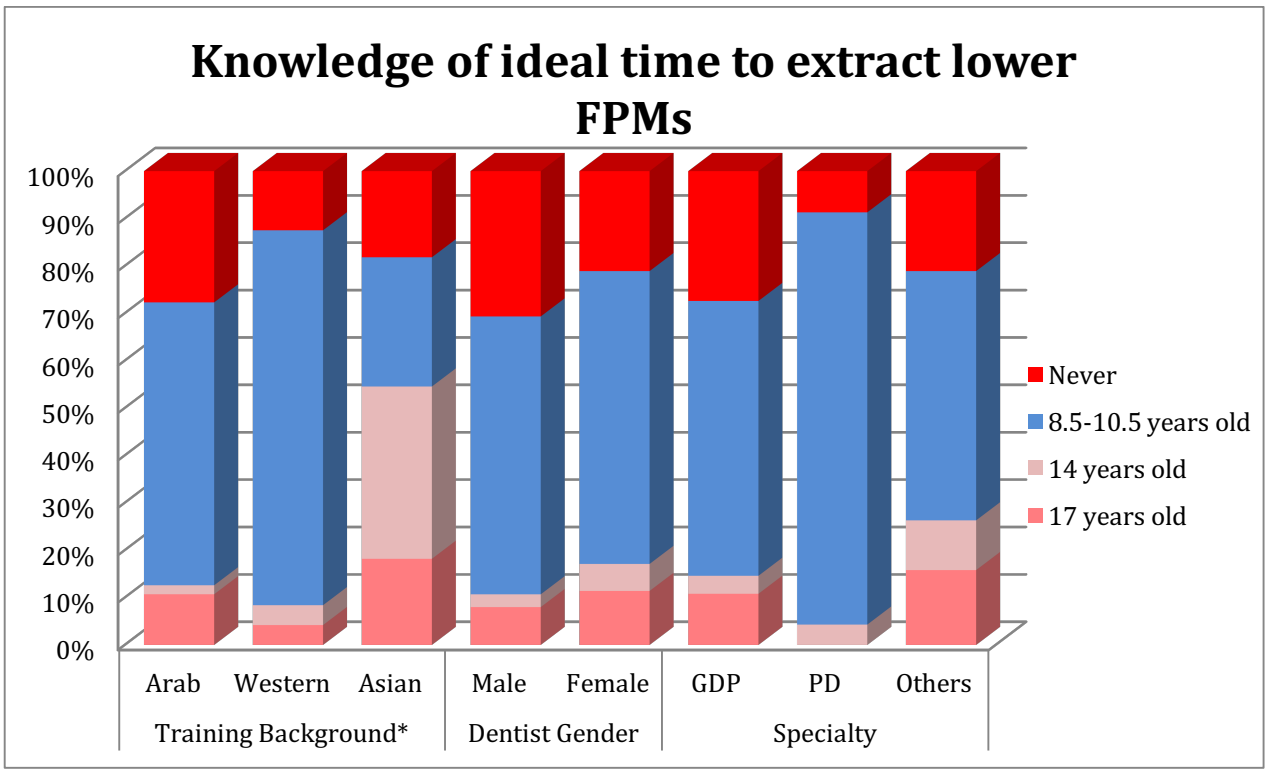

*Figure 47: Knowledge of ideal time of extraction of lower fpm in child. * denotes statistical significance (p=0.001)*

4.41 Training background and ideal age to extract lower first molar

When tabulating the responses against training background (Arab, Western and Asian), the following statistically significant result was found (p=0.001): 59.7% of Arab (n=95), 79.2% of western (n=19) and 27.3% of Asian (n=3) trained dentists chose the correct answer. The Western trained dentists were significantly more aware of the ideal age. P-value of 0.001.

4.42 Dentists gender and ideal age to extract lower first molar

When tabulating the responses against dentists gender, the majority of both male and female dentists chose the right answer (56.7% (n=44) and 61.8% (n=76) respectively).

4.43 Dental specialty and ideal age to extract lower first molar

When tabulating the responses against specialty (GDPs, PDs and others) , the following was found (not statistically significant): The majority in all the three groups chose the correct answer: 58% GDPs (n=91), 87% PDs (n=20) and 52.6% other specialities (n=10), although there was a tendency for PDs to be more aware of this ideal age.

5.00 DISCUSSION

5.10 Introduction

FPM are unique teeth in that they form the corner stone of occlusion[173] and it is for this reason that they deserve special attention. Children, in all the phases of the mixed dentition (6-12 years), may exhibit one or a combination of multiple conditions in their FPMs. These conditions may include dental caries, hypomineralization, hypoplasia; all of which may necessitate interventionist treatment including restoration[182] or extraction[3,8,76] . The treatment of FMPs with poor prognosis is a daily practice for most dentists worldwide, however, there is no agreement in the dental profession regarding treatment of these teeth. This may be because of their lack of knowledge about different types of treatment approaches and the most appropriate one based on the age of the patient[178]. While many advocate restoration of such teeth, in the right circumstances, others advocate that FPM extraction can be followed by successful eruption of second permanent molar to provide the suitable replacement[178]. Ultimately, the third molar would erupt to complete the molar dentition and balance the occlusion[74]. Therefore, it is important for practicing dental surgeons to access and use appropriate clinical guidelines that outline the extraction management of FPMs.

This study was a questionnaire based survey and such surveys have their specific problems and limitations for example Abramson (1990) reported that the problems encountered with mailed questionnaires may include refusal or delay in replying and difficulty in understanding the questions[201]. The limitations of this study are summarized below in section 5.10.

5.20 Why is this study important?

Dental guidelines are intended to educate health care providers about the management of important aspects of oral health care needs[167]. Guidelines, while they do not provide the answer to every question or guarantee successful outcome, they do serve as an aid to clinical judgement. The ultimate decision about a particular clinical procedure or treatment will always depend on each individual patient's condition, circumstances and wishes, and the clinical judgment of the healthcare team[183]. The AAPD guidelines outline many management options for young immature permanent teeth (including molars) such as apexogenesis and apexification[182]. The UK based National Institute for Health and Care Excellence (NICE), published a set of guidelines in 2009 and updated it in 2014; these guidelines raised the importance of EExFPMs. So, it is crucial for dental practitioners to familiarize themselves with the proper treatment plan regarding long term ideal prognosis of BDFPMs with the available guidelines.

If extractions were considered, it should be noted that a treatment plan should ideally be made following input from both the pediatric dentist and the orthodontist based on EExFPMs guideline[74]. Besides some brief tributes in the literature[11,127,178,179,184], there are no available specific guidelines from European, American or international associations on this matter. The American Academy of Pediatric Dentistry, AAPD, primarily focused on saving the FPMs based on their guideline on pulp therapy for primary and immature permanent teeth[182]. A leading American textbook in pediatric dentistry, *Macdonald and Avery's Dentistry for the Child and Adolescent*, briefly described the extraction of the affected molar as a treatment approach for FPMs with poor prognosis[185]. Regarding European literature, journals of orthodontics[2,166] and

pediatric dentistry[127,184] did publish some of the leading articles on EExFPMs of FPMs but mostly in the context of MIH. In addition, on the same context a study in the UK and two studies in Saudi Arabia explored dentists' knowledge regarding different treatment approaches[178–180]. Therefore, this study was set out to assess the UAE dentists' knowledge of extracting BDFPMS and their knowledge about the 2014 UK guidelines of EExFPMs.

5.30 Discussion of the study population

Based on the authority of the UAE National Statistics Board, there were around 2,500 dentists working in the UAE in 2016[186]. This study aimed to explore a wide range of opinions from UAE dentists working at one of the four regulatory authorities in the UAE which include: Ministry of Health of the UAE (MOH), Health Authority of Abu Dhabi (HAAD), Dubai Health Authority (DHA) and finally Dubai Healthcare City Authority (DHCA). Because of the different authorities present in the country, the access to information and contact details of those dental surgeons and practitioners are not available in the public domain. Therefore, we resorted to access a convenience sample of dentist's representative of different educational levels attending popular dental conferences held in the UAE and through an online survey. With a power calculation of 166 dentists in mind, we targeted 300 dentists. We obtained a satisfactory 199 (66.3%) return rate, which was high enough to achieve strong statistical calculations to make a judgment in comparison with a few similar studies done in the region and the West. However, our study, to our knowledge, was the only study in the region and the world done exclusively to target knowledge of dentists regarding EExFMPs. A similar study

was conducted in Saudi Arabia in which only clinical consultants and pediatric dentists at King Abdulaziz University were surveyed with high return rate of 80% out of 150 participants[178]. The return rate was high from such studies as the participants were narrowed down to a specific group and place. In line with a later study (Kalkani et al, 2015) the authors assessed the views and experience of 37 UK dentists specializing in pediatric dentistry (trainees) with a total response rate of 71%[179].

5.31 Gender distribution

Worldwide, we are seeing an upward trend in women dentists over the past 40 years[187]. Some studies have shown that gender differences influence the choice of specialization, practice patterns, and professional attitudes[188,189]. various other studies revealed that women favor primary care management practices rather than other dental specialties[190]. The number of female dentist participants was high in our study (62%). In consonance with our study El Meligy *et al.* reported the greater number of female participants (n=66) than males (n=54)[178].

5.32 Specialty distribution

In any country, the majority of dentists in are GDPs in comparison to specialists; for example in the UK, there are around 41,000 registered dentists with around 4,500 specialist; GDPs count for about 89% of the dentist workforce[168]. This is reflected in our study as the majority of our participants were GDPs (79%). A major workload of GDPs

involves the assessment and management of children's teeth[151]. However, pediatric dental specialists deal exclusively with children and are expected to see a wide spectrum of pediatric dental conditions regularly, both in primary (general) and secondary (specialist) care[179]. Therefore, the long-term management of a child's developing occlusion often benefits greatly from the collaboration of dentists; cases benefit from a good working relationship between the GDP, the pediatric dentist and the orthodontist in order to conduct the best treatment plan and prognosis for the young patients who suffer from BDFPMs. The orthodontists may suggest treatment plans that are based on the enforced extractions (premolars for example) to relieve crowding and for compensation and balancing purposes[9] . They may also suggest this course of action to correct the occlusion; and if BDFPMs are present, this should be taken into account.

In the UAE, many dentists, despite their specific interest, may see child patients[186]. Therefore, we justifiably included all specialties to capture as many GDPs, specialists in pediatric dentist and others who may treat children, to capture a wide range of knowledge across specialties. All those surveyed in this study were treating children, or had treated children in the past.

5.33 Place of qualification distribution

The UAE is a cosmopolitan society, and home to 200 nationalities. As a result, we expected to see dentists from different nationalities, cultures and backgrounds. This was reflected in our study; the majority of participant's qualification belonged to various Arab countries, followed by Western and Asian countries respectively. Previous studies

conducted in the region had not considered the nationality of the participants, thus excluding an important variable. The issue of loss of FPMs as an elective procedure, what is known as the EExFPM is a recently developed concept[9,74] and does not represent all schools of thought in dentistry and therefore has its opponents[10] and supporters. Therefore, it is important to consider if the UAE dentists are familiar with EExFPMs concept and if they consider it as one of the best treatment options in the "ideal time" to achieve optimal long-term oral health for the child.

5.34 Experience of participants

In our study, the mean job experience of the participants was 7.07 (±6.89) years. In this regard, none of the few previous similar studies had mentioned the mean job experience of the participants. However, a study conducted by Silva *et al.* studied the mean years of specialists' experience, which was 5 years and the GDP's was less than 5 years[180]. Another study conducted by El Meligy *et al*. only surveyed clinical consultants (specialists) and pediatric dentists whom are faculty of KSU University; it can safely be assumed that those surveyed already had ample experience as dental practitioners[178]. In the Kalkani *et al.* study they surveyed the knowledge of trainees of pediatric dentistry and GDPs without revealing the number of years in practice[179]. The effect of the years of experience variable was not assessed in our study.

5.40 Discussion of management of BDFPMs

There is little known regarding the way dentists are adopting treatment decisions developed for management of BDFPMs. Hence, clinical scenario based surveys can be useful in exploring the ways in which dentists are making decisions and providing dental services in their routine based practice. The clinical scenario in our study provided clinical pictures and panoramic radiographs of a 7-year-old patient with sensitive teeth and BDFPMs due to MIH. We found out that there was no agreement amongst those surveyed about how to exactly manage this scenario. In fact, the results indicated there to be a spectrum of solutions for the clinical problem tabled. For example, only 29% considered EExFPMs, while the majority (65%) would restore the teeth. There was a tendency to preserve the BDFPMs in the given case; this was later confirmed in a separate question as 85% of the participants (across all variables) believed in preserving BDFPMs rather than extracting them. Interestingly, specialty and dentist gender had an effect on the responses to the scenario with female dentists and PDs being more likely than male dentists and other specialty dentists to consider the option of SSC and later EExFPMs. Overall, in the scenario question a majority (65%) recommended a more conservative treatment, such as temporary dressing, root canal treatment and composite built up. This conservative tendency could be attributed to their educational background which encourages the preservation of the BDFPM and not their extraction. For example, the AAPD guideline on management of young permanent teeth lists the treatment options as protective liner, partial pulpotomy, direct and indirect pulp cap, apexogenesis and apexification; this clearly shows the guidelines conservative tendency[182]. This very important guideline is taught throughout the world and is likely to influence the

participant's choices, although this cannot be confirmed. This is despite the fact that that another famous American resource, "*MacDonald and Avery's Dentistry in the Child and Adolescent*" book highlighted the option of extraction of FPMs with a subsequent favorable eruption position of second permanent molars at the right time[185]. As was expected, more than 60% of PDs who participated in our study would preserve the BDFPMs by placing SSC in a 7-year-old, to decide later to extract or not when the child reaches the ideal age. This was significantly more than GDPs (25%) and other specialties (26%), indicating that more PDs are willing to consider EExFPMs as a treatment option. In contrast, in the Silva *et al.* study found that 100% of the participants opted for restorative options. SSCs were the treatment option for majority of dental professionals in this study (63.6%) in cases of moderate to severe young BDFPMs due to MIH, however, EExFPMs was not considered[180].

5.50 Discussion of referral outcomes in cases of BDFPMs

When a referral is made, recognizing one's own boundaries and competencies is a moral and professional responsibility and the referral must be made in the patients' best interests. A referring dentist has a duty of care to refer a patient to the specialty best suited to treat the case if the case falls outside the boundaries of their competency (General Dental Council, 2013)[168]. If the tooth is deemed non-restorable, then case management does become increasingly more complex. Severe enamel breakdown of FPMs require extensive treatment, ranging from prevention to restorations and extractions, often under general anesthesia. Such teeth need frequent dental treatments which can considerably affect a child's overall well-being. A Swedish study by Jalevik *et*

al. (2001) investigated the effect of severe enamel hypomineralization on dental treatment and dental fear in 9-year-old children and suggested that those children who were affected were also at an increased risk of developing dental fear and anxiety as well as behavior management problems,[155] which necessitated input from pediatric dentists. Furthermore, a multidisciplinary cooperation with orthodontics is often required, particularly for extractions of FPMs, when orthodontic consequences, in particular, need to be considered[154]. Also, the EExFPMs guidelines clearly urge dentists, if in doubt, to seek an orthodontic opinion[8]. Therefore, we included the assessment of referral options in the case of BDFPMs in our study. Reassuringly, our study showed that the majority (89%) of the participants would involve other specialties by consulting them or referring their patient to them in the case of BDFPM. This being said, there was lack of agreement to whom a referral or consultation would be.

Specialty and training background were significant influencing factors. Our study showed that Western trained dentists, PDs and other specialties' top choice was to involve orthodontists in the decision making process (50%, 39% and 37% respectively) compared the remaining groups. This is in contrast to Arab trained dentists and GDPs who would consider consulting and discussing the case with PDs (38% and 39%respectively). It can be argued that a referral to orthodontics was an expected outcome as the orthodontic dimension of the BDFPM case should be taken into account and in the decision making process in particular; this is expected because of the "cornerstone of occlusion" characteristic of the FPM[173]. However, in comparison, GDPs would consult/discuss/refer to a PD (66%) rather than an orthodontist (27%). It was postulated that GDPs may have not seen the need to refer to orthodontists in such cases

because of the belief that PDs were able to save the BDFPMs restoratively hence the referral to them instead. The latter result is in line with the findings of Hussein *et al*. which showed that nearly 60% of the dentists would refer a child with MIH to a pediatric specialist[191]. On the other hand, the GDPs in Kalkani *et al*. study were shown not to liaise with specialists and may self-treat or refer such cases too late[179]; Albadri *et al.* (2007) raised the late referrals issue[11]. They highlighted that the mean age for extraction of the FPMs, according to GDPs in three centers, was 11 years old, which is older than the widely-recommended age for extraction (8-10 years old). They concluded that the reason for this result is the lack of national guidelines regarding the management of BDFPMs. The aforementioned study was conducted in 2007 and the first UK guideline regarding EExFPMs was published in 2009. However, in our study, GDPs were less aware of the existing relevant 2014 EExFPMs guidelines (see below) that clearly stressed on the appropriate referral times and options.

5.60 Discussion of the child's age and EExFPMs

If a lower BDFPM is to be extracted, the ideal time for its loss is with the commencement of calcification of the bifurcation of the second permanent molars[192], which usually occurs at a chronological age of eight to ten years[165]. This should facilitate mesial movement of the second permanent molar into the FPM area when hopefully a good contact will be established with the second premolars[2]. Earlier extraction before the age of eight years might result in distal drifting and rotation of the un-erupted second premolar, especially in the spaced dentition or when there has been early loss of the second primary molar [193]. Conversely, late extraction (which is during or after the

eruption of the second permanent molars) will result in an unsatisfactory space closure[2]. In our study 63% of the participants were aware that extracting FPMs was age related. This was the same across all the demographic variables (no statistically significant difference). However, when we probed into this aspect more specifically, 61% knew the specific ideal age for extraction of lower FPMs (8.5-10.5 years). It was clear that Western trained dentists were more aware of the latter compared to the other groups (p=0.001). Furthermore, PDs had a tendency for knowing this age, although the latter was not significant. In addition, it is important to recall that, in the BDFPMs scenario case, (60.9%) of PDs (more than any other group) would consider SSC over EExFPMs in the "ideal time" and this was statistically significant difference (p=0.021). Our interpretation for this is that the concept of EExFPMs is taught in the undergraduate dental curriculum of many Western countries[9,185,194] but the knowledge of the timing of extraction FPM remained elusive to many others in our study. It is also important to highlight that amongst dentists, extraction of premolars (at a later age) and not FPMs remain the most popular choice[195], and that many feel anecdotally that extracting teeth for orthodontic purposes ruins a patient's profile and compromises their facial aesthetics[196] . This may explain why many of our participants did not think that extraction of BDFPMs were age related nor did they know the ideal extraction time of BDFPMs (37% and 39% respectively).

5.70 Discussion of awareness of concept of EExFPMs

The FPM is rarely the tooth of choice for extraction prior to orthodontic treatment. However, there are various clinical situations in which FPM extraction should be

considered[166]. An experienced clinician should have the knowledge about when to enforce the extraction option while making decisions concerning BDFPMs. Also, they need to have the ability to predict and compare the likely effects of enforced extraction of FPMs during the mixed dentition stage of dental development. It is essential that the clinician has a broad knowledge about dental development to predict, with reasonable certainty, the timing and direction of tooth eruption, and how teeth are likely to drift or change their position after they have erupted[184].

In the present study, 69% of participants claimed they were "aware" of enforced extraction option but surprisingly only 26% claimed they had practiced it, suggesting a gap between knowledge and practice. As we expected, and significantly so, 96% of PDs were familiar with the EExFPMs but only 48% had practiced it, which was much higher than the remaining groups. Currently, there are no available studies regarding the dentists' knowledge about EExFPMs concept although some studies investigated the knowledge of dentists regarding the management of BDFPMs and showed a deficiency in knowledge. A study by Albadri *et al.* investigated the reasons for and pattern of extraction of FPMs in three UK dental hospitals. The main reason for extraction was caries with poor prognosis (70%); MIH was the reason for extraction in 11% of cases. The children who attended dental hospitals for extraction of FPMs tended to be older than the optimal age for achieving space closure. Based on this study more than half of the children received an orthodontic assessment. However, no significant relationship was found between orthodontic assessment and the number of FPMs extracted. They found out that primary care dentists did not have enough knowledge of optimum time to extract FPMs in children. Therefore, in conclusion it was found that primary care dentists may

benefit from a set of guidelines advising when to refer children for extraction of FPMs[11].

Based on El Meligy *et al*. there was little known regarding the way dentists were adopting treatment decisions developed for management of badly decayed FPM. Beyond this, there were noticeable controversies among dentists when it came to decision-making in management of badly decayed FPMs for 6 to 9 year old patients. Most of the respondents recommended a more conservative treatment such as a protective liner and indirect pulp capping, for badly decayed FPMs for 6 to 9 year-old patients than enforced extraction. In this study, the guidelines published by the AAPD were recommended to help dentists make appropriate decision for the management of badly decayed FPMs in children[178]. This study is one of a few studies that had investigated the knowledge and experience of EExFPMs among specialists in paediatric dentistry and general dental practitioners in the world. Interestingly, in our study a similar proportion of GDPs and others claimed awareness of the concept of EExFPMs but actually disagreed with it. This strengthens the overall perception of the majority in our study population to maintain BDFPMs rather than remove to them.

5.80 Discussion of the practice of EExFPMs

In general, many current restorative techniques may fail to help the child patient to conserve the BDFPM. For example in Australia, more than 50% of children over the age of 11 years have some caries experience in this tooth[166]and have amalgam and composite restorations to deal with these defects. Such restorations generally have a limited life and may need to be replaced within 5-10 years because of the possibility of secondary

caries[184]. The second cavity preparation will need to be larger than the first due to the necessity to remove more carious structure, and this undoubtedly weakens the remaining tooth substance and thus threatens the life of the molar's pulp (the restorative cycle). Therefore it would be expected in many cases that the FPM would require extraction[184]. In our study, the majority of participants (85%) believed in preserving rather than extracting the BDFPM, and when asked separately, only 49% had "considered" EExFPMs. The latter differed according to specialty and background training: It is statistically noticeable that (91.7%) Western trained dentists and 82.9% of PDs of the sample group considered EExFPMs after orthodontic consultation more than the other groups. GDPs in considering EExFPMs were more in favor of preserving the BDFPMs (a majority of 58.3%), falling in line with overall consensus to maintain these teeth. Moreover, consideration of EExFPMs is one thing, and the practice of EExFPMs is another. This study went further in probing this aspect and asked the participants if they had actually practiced EExFPMs of BDFPMs, the majority (74%) clearly said no, confirming the conservative approach of the majority of those surveyed. In line with our study, in the study by El Meligy *et al.* a majority of the respondents recommended a more conservative treatment such as a protective liner, and indirect pulp capping, for BDFPMs for 6 to 9 years old patients than enforced extraction[178].

5.90 Discussion on awareness of the actual UK's EExFPMs guideline

There are significant controversies among dentists when it comes to decision making in management of BDFPMs. The "The Enforced Extraction Of First Permanent Molar In Children" UK guideline (2014) is an easily available online document via the Royal

College of Surgeons of England website (www.rcseng.ac.uk) for dentists to assist them in cases of BDFPMs. Particularly, primary care dentists may benefit more from the guideline's advice when in doubt as they go about either treatment planning or when in doubt as to when to refer children for extraction of FPMs. In our study, surprisingly only 18% of responders were fully aware and familiar with this guideline, indicating a very low knowledge level across all groups. However, significant differences were found between GDPs , PDs and other specialties (p=0.007). Although PDs showed better overall awareness, a majority 56.5% of them were not aware of this guideline, while on the other hand 85.3% of GDPs and 84.2% of other specialists never heard of such guideline. When we compared this result to the actual awareness of the concept of EExFPM discussed above (in section 5.70), we noted the findings followed a similar pattern, with PDs showing more awareness of the concept of EExFPMs than GDPs and other specialties. Interestingly, this was also mirrored in the scenario findings (section 5.40) as PDs were most likely to consider EExFPM compared to the other groups.

The EExFPM 2014 guidelines are based on evidence and it had been reported that evidence based dentistry and guidelines are not concepts that every dentist is familiar with[197], and access to such information is not methodically disseminated. It is also worth noting that the guidelines were not addressed to a specific specialty, indicating that they are for open use by all dentists whether GDPs, PDs, orthodontists, etc. Therefore, this may explain the deficiency in dentists' knowledge. However,even in ideal situations does this gap exists. It had been reported that guidelines improved dentists' knowledge but not their clinical decision-making skills[198]. In addition, it has been found that the knowledge of some guidelines does not necessitate that the guidlenes are transfered into

actual clinical practice[199,200]. Concerns have been raised about the gap between what we know and what we do, with calls for clinical guidleines and research findings to be translated from knowledge to action more effectively[199]. Other studies have shown inconsistencies between knowledge and actual practice; Meligy *et al*. in their study in 2016, found out that the respondents' recommendations were slightly inconsistent in clinical scenario survey. Surprisingly, their possible explanation was the lack of conclusive treatment guidelines in the literature regarding BDFPMs.

5.10 Study limitations

The limitations for this study would be as follows:

- The study sample was a convenient one, of dentists who had attended dental conferences or filled out the online survey. Although this group is not truly representative of the whole community of UAE dentists, they represent around 7.96% of the total UAE dentist workforce. It would have been beneficial if all UAE dental authorities were linked together and a questionnaire was sent to everyone who was qualified as a dentist in UAE. This was not possible in this study due to authority regulations, and time restraints for only one researcher to collect data.

- The survey was conducted both through paper and electronic means; this might have influenced the results. A single method of conduction for the survey would be preferred. In general surveys have their specific limitation include refusal or delay in replying and difficulty in understanding the questions.

6.00 CONCLUSIONS

Consequent to surveying a group of dentists in the UAE, the following can be concluded:

- Against a background of preserving the BDFPMs, and despite knowledge of the concept and ideal age of extraction of BDFPMs, there was a reluctance for UAE dentists sampled to consider or practice extraction of BDFPMs. Training background, specialty and to a lesser extent, dentist gender were influencing factors.
- The majority (85%) believed in preserving the BDFPMS rather than extracting in children. There was no consensus on how to manage a given example scenario of BDFPMs, however, PDs were more likely to consider SSCs then EExFPMs compared to other groups [p-value 0.021].
- In cases of BDFPMs, a large majority (89%) would refer/discuss/consult with either a PD or an orthodontist. GDPs were more likely to refer to a PD, while PDs and Western trained dentists were more likely to refer to an orthodontist [p=0.003].
- The majority (63%) believed that the decision to extract or keep BDFPMs is age related and 61% knew (especially Western trained dentists [p=0.001]) the most appropriate age to extract lower FPMs (8.5-10.5 years).
- Despite a majority (69%) being aware of the concept of EExFPMs in general (especially PDs [p=0.002], a majority (51%) had not considered EExFPMs (except PDs and Western trained dentists [p=0.001]) and 74% had not practiced EExFPMs in children. In addition, there was a majority lack of awareness of the actual UK 2014 EExFPMs guidelines.

7.00 RECOMMENDATIONS

- Further studies need to be conducted to investigate in depth the variety of factors affecting the process of decision making for the management BDFPMS among UAE dentists.
- Future studies are needed to evaluate and explain the interactions between the multiple factors influencing the process of the decision making in treatment of badly decayed FPM.
- Further work is needed to assess the lack of understanding of the conditions (MIH, caries) and prevent implications of late diagnosis.
- Further investigation of the barriers that dentists encounter when accessing specialist services for advice and development of ways to overcome these.
- Further investigations to assess the confines of guideline's availability for the dentists.
- Further investigations to evaluate dentist's reliance on guidelines in clinical decision making.
- Increase in the awareness of UAE dentists regarding the UK guidelines of EExFPMs through educational sessions is recommended to further explain the rationale and the clinical implications of the guidelines.

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Appendices

Appendix I

Hamdan Bin Mohammed College of Dental Medicine
Mohammed Bin Rashid UMHS

كلية حمدان بن محمد لطب الأسنان
جامعة محمد بن راشد للعلوم الصحية

Age: _____
Gender:
- ☐ Male
- ☐ Female

Specialty:
- ☐ General practitioner
- ☐ Paediatric Dentist
- ☐ Others (detail _____)

Country of practice: _____

Years in practice: _____

Where did you Qualify: _____

1. If a 7-year-old boy visits your dental clinic with very sensitive teeth and no significant medical history, the examination revealed lower FPMs (first permanent molars) to be severely hypomineralized with post eruption breakdown as well as a class I malocclusion. What would your first line of treatment be?
   - ☐ Do nothing
   - ☐ Build up the crowns with composite
   - ☐ RCT and crown the teeth
   - ☐ Put SSCs over these teeth and wait till the child gets older and extract these teeth
   - ☐ Place GIC temporary dressing only

2. Have you ever considered extraction of broken down FPMs?
   - ☐ No, I should preserve the tooth as much as I can
   - ☐ Yes, but first I should consult with orthodontics

3. Have you ever heard about the concept of enforced extraction of FPMs?
   - ☐ Yes but I am not practicing it
   - ☐ Yes and I am familiar with all its related guidelines and practicing it
   - ☐ Yes, but I do not agree with enforced extraction of any teeth (unless for orthodontic purposes)
   - ☐ No, I have no idea about it

4. Have you ever done any enforced extraction of broken down FPMs for a child?
   - ☐ Yes
   - ☐ No

5. Do you believe in preserving the FPM as much as you can instead of extracting it in a child?
   - ☐ Yes
   - ☐ No

6. Does the age of a child affect your decision regarding keeping the FPM tooth or extracting it?
   - ☐ Yes, I know the best time to extract FPMs in children
   - ☐ No, all my intention is to save the tooth no matter what age

7. If I have a case like the above
   - ☐ I will refer the patient to paediatric dental specialist
   - ☐ I will consult with a paediatric specialist
   - ☐ I will consult with an orthodontic specialist
   - ☐ I am confident enough to diagnose and treat this patient

8. If you have to extract a lower FPM what will be the ideal age to do so?
   - ☐ 17 year old
   - ☐ 14 year old
   - ☐ 8.5-10.5 year old
   - ☐ No idea
   - ☐ Never

9. **"The Enforced Extraction Of First Permanent Molar In Children" (EExFPM)** UK guideline 2014
   - ☐ I never knew there was a guideline for EExFPM
   - ☐ I know the UK supports and practices EExFPM but I never knew there was a guideline
   - ☐ I am fully aware of this guideline

THANK YOU FOR YOUR TIME
Maryam.dastouri@HBMCDM.ac.ae

Appendix II

MBRU

كلية حمدان بن محمد
لطب الأسنان
HAMDAN BIN MOHAMMED
COLLEGE OF DENTAL MEDICINE

Athanasios E. Athanasiou, D.D.S., M.S.D., Dr. Dent.
Dean
Professor & Program Director in Orthodontics
Hamdan Bin Mohammed College of Dental Medicine

Ref: HBMCDM/EC/2032
Date: March 8, 2016

Dr. Maryam Dastouri
Resident, Paediatric Dentistry
Hamdan Bin Mohammed College of Dental Medicine
PO Box 505097
Dubai Healthcare City
Dubai

Title of project: Management of the Broken Down First Permanent Molar in Children: Practice and Knowledge of United Arab Emirate Dentists
Reference: EC1115-002

Dear Dr. Maryam,

Thank you for submission of your proposal for approval to the Research & Ethics Committee.

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion, effective 9th February, 2016, on the basis described in the application form.

The favourable opinion is given provided that all data used for the study and that are archived are anonymous.

Yours sincerely,

Professor Athanasios E. Athanasiou
Chairman, Research & Ethics Committee

Appendix III

Poster (Non-Prize Category)

Method: A postal questionnaire survey of all specialists in Paediatric Dentistry on the General Dental Council dental register ($N = 234$) was undertaken. Three repeat mailings were undertaken each 1 month apart. The questionnaire consisted of three sections. Section A asked about the dentists' experience and confidence in managing paediatric dental patients and their familiarity with behavioural management techniques. Section B was the Knowledge of Behavioural Principles as Applied to Children Questionnaire (KBPACQ, O'Dell 1979) adapted for the dental setting management principles as applied to children and consisted of a 16 multiple choice questions. The 'knowledge score' obtained from this section was used as the main outcome measure. Section C gathered demographic details including the participant's age, sex, year of dental qualification and any postgraduate qualifications.
Results: A total of 97 responses (41%) were collated after the first and second mailing. Participant's knowledge ranged from 6% to 75% with a mean score of 39%.
Conclusion: This study's findings indicate that there may be gaps in paediatric dentist's knowledge of behavioural principles that should be addressed in the future through training and experience in behaviour management.

P23

Dental management of a patient presenting with severe hypodontia

L. DAKKOURI, P. ASHLEY & S. PAREKH
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Background: Hypodontia is defined as the congenital absence of one or more teeth excluding the third molars. Genetic and environmental factors can play a part in the aetiology of hypodontia. Missing adult teeth can significantly affect a young person both physically and emotionally. The main treatment aim is to improve aesthetics and function and maintain appropriate tooth space for future planning.
Presenting problem: A 15-year-old young boy was referred with his main complaints being missing adult teeth and retained primary teeth. Upon intra oral examination, he presented with 11 missing permanent teeth, 3 retained and infra-occluded primary teeth, and a microdont UR2.
Clinical management: Multidisciplinary treatment plan was arranged to idealise spaces between teeth, extract retained primary teeth and to restore the dentition by providing: composite fillings to reshape UR2, resin bonded bridges (RBB) to replace missing anterior teeth, and upper and lower partial dentures to replace posterior missing teeth.
Discussion: Patients with hypodontia requires multidisciplinary care that should start at young age. Patient has reported improvement in his appearance and function. He will have further clinical reviews for future planning.

P24

Consent for inhalation sedation. An audit within Birmingham Combined Community Dental Service

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Background: In 2012 Birmingham CCDS merged with the neighbouring regions Dudley, Sandwell and Walsall. Each locality previously followed its own guidance and used its own consent forms. Policies and procedures were reviewed and unified including those relating to sedation. The new unified document was based upon several documents including guidance from the department of health, NICE and the GDC. A universal consent form created by BCHC trust was circulated. In April 2015 Standards for Conscious Sedation in Dental Care was released.
Aim: To ensure that full written informed consent is gained for every treatment under inhalation sedation.
Standard: The standard set was 100% in accordance with all current guidance.
Method: All members of Birmingham CCDS who carry out treatment on paediatric patients under inhalation sedation were asked to participate.
Clinicians were asked to complete a data capture sheet for 10 paediatric patients.
Audit cycles were carried out in 2013, 2014 and 2016.
Results: Response rates were low. Full consent was gained in 55% of cases for the first audit and increased to 80% in the second.
Discussion: The response rate dropped from audit cycle one to two; although the percentage increased, it doesn't necessarily indicate a true increase in informed consent. Further staff training was provided and a third audit cycle carried out.
Conclusions: The response rate was generally low with some interesting and valid reasons why this was the case.
The standard was not met in cycle one therefore training and further audit cycles have been carried out.

P25

UAE dentists' knowledge and practice of management of broken down first permanent molars

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Background: The broken down first permanent molar (BDFPM) is a common problem in children. In 2014, Enforced Extractions of First Permanent Molars (EExFPMs) guidelines were published in the United Kingdom.
Aims: To assess the knowledge and practice of dentists in the United Arab Emirates (UAE) regarding management of BDFPMs in children.
Methods: A cross-sectional sample of General Dental Practitioners (GDPs) completed a self-administered questionnaire. Multiple-choice questions covered management of BDFPMs; GDPs experience of FPM extraction; knowledge and practice of the principle of EExFPMs; personal views on preservation or extraction of FPMs; to whom GDPs would refer in case of BDFPMs; knowledge of the ideal age for the EExFPMs (8–10 years) and finally actual awareness of the 2014 guidelines. Chi-square tests were conducted using SPSS software.
Results: A total of 131 from 200 questionnaires were completed (66% return rate). Provisional results significantly showed ($P \leq 0.05$) that 95% of the responders would restore BDFPMs. An 84.5% majority believed in saving FPMs rather than extraction. However, 83% would consult/refer to other specialists and 62% would consider extraction of FPMs after consulting an orthodontist. 65.4% of the responders knew the ideal timing of a lower FPM extraction. Whilst 75.2% of the participants had never carried out EExFPMs and 70.4% had heard of the EExFPMs concept, 60.5% were unaware of the 2014 guidelines.
Conclusion: GDPs in the UAE would restore rather than extract BDFPMs in children, although they would consult other specialists in case of FPM extraction. The majority were not aware of the EExFPMs 2014 guidelines.