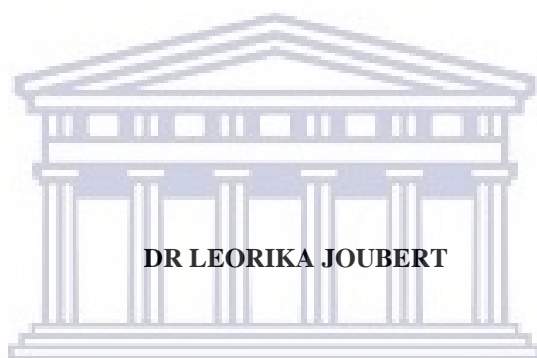


**FACTORS INFLUENCING THE IMPLEMENTATION OF
INTERCEPTIVE ORTHODONTIC TREATMENT AT THE
LEVEL OF THE GENERAL DENTIST:
24 CASE STUDIES FROM THE METROPOLITAN AREA OF
TSHWANE,
SOUTH AFRICA**



DR LEORIKA JOUBERT

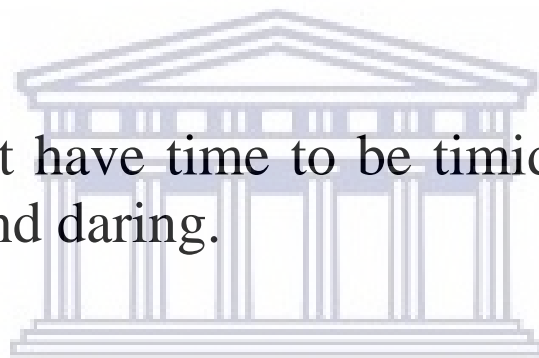
**UNIVERSITY of the
WESTERN CAPE**

A thesis submitted in fulfilment of the requirements for the degree Master of Science Dentistry in
the Department of Orthodontics, Faculty of Dentistry, University of the Western Cape.

Supervisor: Prof AMP Harris

November 2019

You don't have time to be timid. You must
be bold and daring.



-Lumière, Beauty and the Beast
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KEYWORDS

General dentist

Interceptive orthodontics

Malocclusion

Orthodontic treatment

Socio-economic factors

South Africa



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ABSTRACT

Factors influencing the implementation of interceptive orthodontic treatment at the level of the general dentist: 24 case studies from the metropolitan area of Tshwane, South Africa.

L Joubert

MSc Dent Thesis, Department of Orthodontics, Faculty of Dentistry, University of the Western Cape

Introduction: General dentists in practice (both public and private) are often reluctant to perform interceptive orthodontic procedures on patients that present to their practices. As interceptive orthodontic treatment (IOT) can be of great benefit to some patients, it validates the need to assess the factors that influence the implementation of such treatment.

Aims: This study aimed to understand the factors that influence the implementation of interceptive orthodontic treatment in general dental practices in the metropolitan area of Tshwane, South Africa.

Methodology: A total of 24 general dental practitioners (case studies) were selected through a convenience sampling method. A list of the participants was drawn up by dividing the case studies into three subdivisions. The first subdivision was the sector in which the general dentists practised (public or private). The second subdivision was the socio-economic area in which they practised (lower, middle or higher socio-economic area). The third subdivision was based on the number of years of experience of each general dental practitioner (0-5 years, 6-10 years, 11-15 years and 16-20 years). One-on-one interviews, guided by a questionnaire, were conducted with the participants at their place of work or in a public location. They answered structured questions regarding the treatment plans for five paper patient scenarios to test their knowledge on interceptive orthodontics (IO). They also answered questions regarding their confidence of self-efficacy, attitude and other factors that may influence their willingness to use IOT in their practices.

Results: No statistically significant differences were found between private and public sector dentists in terms of the average percentage of correct answers per

scenario and the average percentages across the scenarios. Based on the average scores across the scenarios, all the dentists in the study had “Good knowledge” (>50%) of the need for orthodontic treatment. The overall percentage of correct answers (knowledge) from all three socio-economic classes combined was 70.9% with a 95% confidence interval of 68.3% to 73.4%. The overall percentage of correct answers (knowledge) from all four periods of experience combined was 70.9% with a 95% confidence interval of 68.3% to 73.4%. Collectively, in 66.7% of the responses to the four questions on confidence of self-efficacy, the dentists indicated that they were very confident about their ability to offer interceptive orthodontics. Collectively, in 93.1% of the responses to the three questions on attitude, the dentists expressed a positive attitude.

Conclusion: Overall, the general dental practitioners’ knowledge of IO was good across the dentists practising in the public and private sectors. Knowledge in the middle socio-economic group and in those with 11 to 15 years of experience was less than that of their colleagues in the other groups. The general dental practitioners in this study were confident in implementing IOT in their practices and they had a good attitude toward interceptive orthodontics. Other factors that played a role in the implementation of IOT were the monetary amount paid by medical aids and patient compliance.

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DECLARATION

I, Leorika Joubert, declare that *Factors influencing the implementation of interceptive orthodontic treatment at the level of the general dentist: 24 case studies from the metropolitan area of Tshwane, South Africa* is my own work, that is has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Leorika Joubert

November 2019

Signed

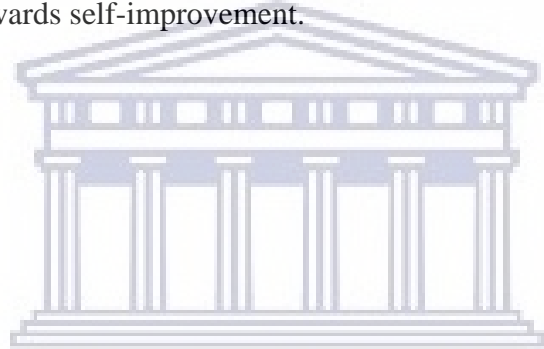


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Figure 4.1: Schematic representation of the general dental practitioners used as study sample

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LIST OF ACRONYMS AND ABBREVIATIONS

IC	Maximal intercuspatation
IO	Interceptive orthodontics
IOT	Interceptive orthodontic treatment
PO	Preventative orthodontics
RC	Retruded contact
SCT	Social cognitive theory
TPB	Theory of planned behaviour



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CHAPTER 1: INTRODUCTION

1.1 OUTLINE OF CHAPTERS

This thesis is divided into the following chapters:

Chapter 1: This chapter provides an overview of preventative orthodontics and interceptive orthodontics, and the role of general dental practitioners in diagnosing problems that could potentially benefit from interceptive treatment.

Chapter 2: The literature review provides an understanding of work already done in the field of preventative and interceptive orthodontics.

Chapter 3: The reasons for undertaking this study are explained in this chapter.

Chapter 4: This chapter outlines the research methodology underpinning this thesis.

Chapter 5: The results of the investigation are presented.

Chapter 6: The discussion in this chapter covers the factors that influence the implementation as well as non-implementation of interceptive orthodontic treatment.

Chapter 7: The conclusions and recommendations are provided in this chapter.

1.2 INTRODUCTION

Malocclusion of the teeth is not a disease. Instead, it is an abnormal alignment of the teeth and the way the maxillary and mandibular teeth occlude. The prevalence of malocclusion varies, but studies have shown that nearly 30% of the population have some form of malocclusion that warrants orthodontic treatment (Borzabadi-Farahani and Eslamipour, 2009). Orthodontic treatment will ultimately be beneficial to the patient, improving the function and aesthetics of the dentition (Akram *et al.*, 2015). The primary dentition has a main function of maintaining arch length to allow for sufficient space for the eruption of the permanent dentition. The goals and objectives of early treatment must be established firmly in order to prevent unnecessary, prolonged treatment that may burn out the patient during the second phase of treatment that may follow later.

Preventative orthodontics (PO) can be defined as the branch of orthodontics that prevents orthodontic problems from occurring. Hence, it is the branch of orthodontics where treatment is undertaken when orthodontic problems are anticipated (Borrie *et al.*, 2014).

Interceptive orthodontics (IO) can be defined as the branch of orthodontics concerned with the implementation of early interventions to eliminate minor occlusal problems currently present or to prevent major malocclusions from occurring in the future. In other words, IO is

performed to prevent a minor orthodontic problem from progressing into a more severe one (Borrie *et al.*, 2014).

IO differs from PO in the sense that preventative treatments will prevent orthodontic problems from occurring, while interceptive treatment will correct small problems that are already present (Borrie *et al.*, 2014).

The general dental practitioner is a key role player in the timeous identification and diagnosis of orthodontic problems that can potentially benefit from preventative and interceptive treatment. If orthodontic problems are intercepted and properly managed during the mixed dentition phase, many malocclusions may be corrected or reduced in severity, ensuring ease of treatment as well as shorter treatment periods at a later stage (al Nimri and Richardson, 2000).



CHAPTER 2: LITERATURE REVIEW

2.1 PREVENTATIVE VERSUS INTERCEPTIVE ORTHODONTICS

Interceptive orthodontics (IO) can be defined as a branch of orthodontics concerned with intervening early enough to eliminate minor occlusal problems in the dentition to prevent major malocclusions in the future. IO is the timeous treatment of unfavourable features of an occlusion that is still developing. Timeous treatment may indeed make the difference in reaching a good result through simple treatment at a later stage with shorter treatment periods as well as ensuring better function, aesthetics and stability (Athanasidou, 1990). The percentage of children who would benefit from interceptive treatment has been reported to range from 14% to 49% (Popovitch, 1975; Ackerman and Proffit, 1980; al Nimri and Richardson, 1997; Bahrami *et al.*, 2008).

IO differs from PO in the sense that preventative treatments will prevent orthodontic problems from occurring while interceptive treatment will correct small problems that are already present. Preventative treatment will involve educating patients, monitoring the growth and development of the jaws and dentition, and diagnosing and implementing preventive measures when one anticipates that a problem could arise (Borrie *et al.*, 2014).

Interceptive treatment is used when a problem is already present. The aim of interception is to prevent the malocclusion from worsening and to ensure ease of treatment, should further treatment be needed (Iyyer *et al.*, 2012).

Common preventative procedures include space maintenance, monitoring for abnormal habits like thumb sucking and the management thereof, removal of active frenae, monitoring the exfoliation schedule of the teeth, caries control and extraction of supernumerary teeth, if present (Iyyer *et al.*, 2012).

Interceptive orthodontic procedures include serial extractions, crossbite corrections, further management of habitual behaviour, treatment to address soft-tissue or hard-tissue interference from preventing tooth eruption, muscle exercises, the treatment of unfavourable skeletal (jaw) relationships, as well as space regaining where this has been lost (Iyyer *et al.*, 2012). General dentists can assist with most interceptive procedures, but in the case of threatening unfavourable jaw relationships, it would be better to refer to an orthodontist. This is more complex treatment and if not managed correctly can lead to long term damage and extended treatment times in order to correct the damage caused (Ch, 2011).

2.2 PREVENTATIVE ORTHODONTIC TREATMENT

Preventative orthodontic procedures include the following (Iyyer *et al.*, 2012; Proffit *et al.*, 2013):

- Educating the parents
- Controlling the development of caries
- Taking care of the primary dentition
- Managing any ankylosis of teeth
- Maintaining a proper tooth shedding schedule when comparing quadrants
- Breaking habits
- Eliminating occlusal interferences
- Preventing damage to the occlusion by the Milwaukee brace
- Removing supernumerary teeth
- Doing space maintenance
- Managing a first permanent molar that is deeply locked
- Managing abnormal frenal attachments.

2.2.1 Educating the parents

This part of prevention should commence long before child birth. The expecting mother should be educated on diet and nutrition before the birth of her baby. Shortly after birth she should be educated on nursing, if breast-feeding, or educated on the use of physiologic nipples as opposed to conventional nipples, if the child is being bottle fed. Conventional nipples promote a sucking action that can lead to orthodontic problems, whereas physiological nipples allow for a suckling action by allowing movement of the tongue and mandible, as it normally would be during breast feeding. The parents should be warned against the lengthy use of pacifiers as this can have deleterious effects on dentition. Oral hygiene instructions should be given to the parents, and the prevention of baby bottle caries should be discussed (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.2.2 Controlling the development of caries

Arch length will be lost if interproximal caries are not restored timeously. The teeth will move mesially and result in a discrepancy between the available arch length and the tooth material. A clinical assessment as well as radiographs (bitewing radiographs) are valuable in detecting and diagnosing the presence of caries. Restoring the carious lesions immediately is recommended (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.2.3 Maintenance and prevention of early loss of primary teeth

Primary teeth are brilliant space maintainers. The aim should therefore be to maintain the primary dentition at all costs. Caring for the primary dentition includes the restoration of caries as well as the performance of regular preventative treatments such as topical fluoride and the placement of fissure sealants, if needed (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.2.4 Managing any ankylosis of the teeth

Ankylosis of a tooth is defined as the absence of a section or absence of the whole periodontal ligament surrounding the tooth. This is more common in the primary dentition, and the tooth appears in infra-occlusion, if the problem is not managed for an extended period of time. There are various reasons for ankylosis. This includes the congenital absence of the permanent successor, infection, trauma and failure of the resorptive process of the root of the primary tooth. An ankylosed primary tooth will not exfoliate and therefore either prevent the successor from erupting or divert the eruption path thereof. This results in the successor erupting in an abnormal position. If the ankylosed tooth is deeply submerged, it can affect the surrounding teeth. The adjacent teeth can tip toward the site and the opposing tooth can become over-erupted. If a tooth is ankylosed, diagnosis thereof is important as the tooth will need to be surgically removed at the right time to allow for the successor to erupt (if present). If the successor is congenitally absent, care should be taken to build up the vertical dimension of the tooth in order to retain it and to bring it into the occlusion. Alternatively, it can be extracted. The health of the ankylosed tooth can also determine whether it should be retained or extracted (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.2.5 Maintaining a proper tooth shedding schedule

No more than three to six months should pass between the exfoliation of a primary tooth and the eruption of its successor when one compares one quadrant to the others. If this is the case, there is a delay in the eruption of the successor.

Various reasons are cited for the delayed eruption of permanent teeth. This can include the following: the primary tooth is over-retained, retained unresorbed root fragments, the primary tooth is ankylosed, a supernumerary tooth or a cyst/tumour is present, an overhang of the restorations on the primary tooth is present, or there is fibrosis of the gingiva.

The delay in eruption will improve once the cause, as mentioned above, has been removed. An over-retained primary tooth can deflect the path of eruption and result in the ectopic eruption of the successor (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.2.6 Breaking habits

If a habit is broken early enough it will not affect the permanent dentition. Timing is thus very important.

Digit sucking, where children soothe themselves by sucking on a digit (usually the thumb), is a habit that has a psychological component. This psychological component needs to be sorted out as part of the treatment plan. Timing is crucial as the habit needs to be broken before the permanent incisors erupt. The force of the digit sucking will ultimately allow for retroclination of the lower incisors and proclination of the maxillary incisors. Furthermore, a narrow V-shaped palate will develop. Orthodontic treatment will entail a fixed or removable tongue gate where the acrylic on the palatal mucosa as well as the tongue gate itself will prevent the suction from occurring and thus render the thumb sucking useless (Proffit *et al.*, 2013).

A postural pseudo class III (in the antero-posterior direction) will allow for the patient to shift the jaw forward into a class III position, although the patient is not a skeletal class III. This is usually due to some form of occlusal interference, mainly incisal interferences. If left untreated, the continual dislodging of the condyles will stimulate growth in the area and the patient will ultimately end up in a skeletal class III pattern. Treatment would be to flatten the primary canines once the problem has been noted (Proffit *et al.*, 2013).

The lateral midline shift that occurs just as intercuspation occurs, is usually also due to canine interference and will require the same treatment, i.e. flattening the cuspal tips of the canines as soon as possible (Proffit *et al.*, 2013).

2.2.7 Eliminating occlusal interferences

If present, occlusal interferences can lead to the deviation of the mandible and can even lead to bruxism. If functional prematurities are present, they need to be removed by using articulating paper to detect the premature contact. These areas are selectively grinded to eliminate the premature contact. Enamel pearls and large cingulums also need to be removed (Iyer *et al.*, 2012).

2.2.8 Preventing damage to the occlusion by the Milwaukee brace

The Milwaukee brace, which is used in the treatment of scoliosis, exerts a huge amount of force on the mandible and the occlusion. Care should be taken to prevent mandibular growth retardation and other deformities when using functional appliances (Iyer *et al.*, 2012).

2.2.9 Removing supernumerary teeth

Supernumerary teeth are extra teeth present in the dentition which are not part of the normal set of teeth. These are more common in the permanent dentition, in the maxillary jaw and in male patients (Ch, 2011; Iyyer *et al.*, 2012; Proffit *et al.*, 2013). Supernumerary teeth can interfere with the normal eruption of successors and should therefore be removed. If the supernumerary tooth is unable to erupt, surgical removal thereof is recommended. Supernumerary teeth can lead to crowding in the dentition and to abnormal positioning or delayed eruption of the permanent teeth. A midline supernumerary tooth is called a mesiodens; it prevents the two central incisors approximating (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

The developmental causes for a midline diastema are the developing lateral incisor that exerts pressure on the distal portion of the central incisor or an abnormal frenal attachment between the two central incisors (Ch, 2011). This is transient and corrects when the maxillary permanent canines erupt. This is called the “ugly duckling stage” (Ch, 2011).

2.2.10 Doing space maintenance

When a primary tooth is lost prematurely, space maintenance can be done providing the permanent successor is present and is still unerupted. The aim of space maintenance is to keep the space that was occupied by a primary tooth in order to allow for enough space for the permanent successor (Proffit *et al.*, 2013).

It is important to ensure that a child stays caries free when space maintenance is anticipated. Interproximal caries create interproximal spacing and, if untreated, will ultimately allow for space loss through arch length loss. Eruption times are important with the treatment of carious primary teeth to ensure the correct course of action is taken, i.e. rather extract a severely carious primary tooth if it is mobile and due to exfoliate soon. Restoring it has no point and will ultimately make no difference. If a tooth is extracted, depending on whether the 6s are erupted, numerous appliances can be used to keep the space in place (Proffit *et al.*, 2013).

When a D has been lost and the 6s are erupted, the E will not drift mesially and thus no space maintainer is needed. If the 6s are unerupted, a space maintainer will be needed as the eruption thereof places a mesial force on the E, which will ultimately then drift forward and close the space partially, as primary teeth do not drift, like adult teeth would (Proffit *et al.*, 2013).

When an E is lost, a space maintainer is always needed as a permanent tooth will drift into the open space if already erupted, and if it is unerupted the mesial force applied during eruption will allow for a more mesial eruption. Both will close the space partially (Proffit *et al.*, 2013).

Possible appliances may include the following (Proffit *et al.*, 2013):

- **Lingual arch:** This can only be used if the lower incisors are fully erupted, as their normal eruption pattern is to erupt lingually and then move into position (fixed space maintainer).
- **Nance appliance:** The Nance is used for bilateral maxillary space maintenance and has the benefit of an anchorage palatal acrylic button. This will prevent rotation of the teeth but needs to be thoroughly cleaned to prevent soft-tissue irritation (fixed space maintainer).
- **Trans-palatal arch:** This is indicated for bilateral maxillary space maintenance, but without added anchorage like the Nance (1947). It will not prevent the rotation of the teeth (fixed space maintainer).
- **Band and loop:** Unilateral loss in the maxilla or mandible (fixed space maintainer). Can be used if the first or second or both primary molars is lost on one side.
- **Distal shoe:** Unilateral loss in the maxilla or mandible (fixed space maintainer). Can be used when a primary second molar is lost.
- **Partial denture:** Ideal for bilateral loss in the maxilla or mandible. It is an excellent replacement for the lingual arch if the permanent incisors are unerupted (removable space maintainer).
- **Hawley apparatus:** To ensure space maintenance, the acrylic plate is allowed to fill the spaces where the tooth/teeth were lost. Retention is via 2x Adams clasps and a labial bow (removable space maintainer).

2.2.11 Managing a first permanent molar that is deeply locked

When a primary second molar has a distinctive distal bulge, this can prevent the permanent first molar from erupting. As a preventative procedure, the distal aspect of the primary second molar can be sliced in order for the first permanent molar to erupt. This process guides the first permanent molar into position (Iyyer *et al.*, 2012).

2.2.12 Managing abnormal frenal attachments

If the maxillary labial frenum is thick and attaches low on the gingiva, it will result in a midline diastema, as it prevents the maxillary central incisors from approximating. This abnormal frenum is usually hereditary, which makes early diagnosis and intervention important. A blanch test can be performed by pulling on the lip. If the frenum blanches, the test is positive and the frenum is abnormal. On a radiograph, a notch on the interdental bone can also be used to diagnose an abnormally thick frenum.

If the lingual frenum extends further than normal towards the tip of the tongue, ankyloglossia or a tongue tie can be diagnosed. The tongue is limited in forward and upward movement.

This is usually hereditary, like the abnormal maxillary labial frenum. This can lead to breastfeeding problems as the infant's tongue cannot extend past the lower gum margin. It can also lead to speech problems at a later stage, and difficulty in swallowing.

Abnormal labial or lingual frenae should be surgically treated to prevent any malocclusion developing (Iyyer *et al.*, 2012; Proffit *et al.*, 2013).

2.3 INTERCEPTIVE ORTHODONTIC TREATMENT (IOT)

2.3.1 Indicators of an ideal dental situation

Indicators of good dental development in the primary dentition are spacing, primate spaces (mesial to the upper canine and distal to lower canine) and a flush terminal plane or mesial step relationship of the primary second molars (El-Nofely *et al.*, 1989; Kurol and Koch, 1993; McNamara and Brudon, 1993;). Early orthodontic treatment is performed to enhance dentoalveolar, skeletal and muscular development before complete eruption of the permanent dentition (McNamara and Brudon, 1993). Early orthodontic intervention can be broadly classified into two categories: preventive orthodontic treatment and interceptive orthodontic treatment (IOT).

2.3.2 Dental abnormalities

Dental abnormalities that need to be investigated and intercepted, if present, include the following (Ch, 2011):

- Crossbite (anterior and posterior)
- Crowding
- Early loss of primary teeth
- Habits
- Ectopic eruption of maxillary canine (and other teeth)
- Midline diastema
- Localised problems like impacted upper first molars, scissor bite of first molars, retained primary teeth, and the delayed eruption of permanent teeth.

2.3.3 Interceptive orthodontic procedures

Interceptive orthodontic procedures include the following (Iyyer *et al.*, 2012; Proffit *et al.*, 2013):

- Crossbite correction
- Serial extractions
- Space regaining
- Management of habitual behaviour

- Treatment of soft-tissue and hard-tissue interferences
- Muscle exercises
- Management of unfavourable jaw relationships
- Treatment of an ectopically erupting maxillary canine.

2.3.4 Crossbite

2.3.4.1 Definition

A crossbite can be defined as an abnormal positioning of the tooth/teeth either in a buccal, lingual or labial position, in relation to the opposing tooth/teeth. Crossbite can be anterior or posterior, dental or skeletal, and it can involve one tooth or many teeth (Proffit *et al.*, 2013).

2.3.4.2 Aetiology

Crossbite can be anterior or posterior, dental or skeletal and have various etiological factors: i.e. lack of space for the eruption of the permanent successor (due to the early loss of the primary tooth, for example), an abnormally positioned tooth bud or over-retained primary teeth (see Table 2.1). Treatment options will depend on whether the patient is in the permanent dentition or not (Proffit *et al.*, 2013).

Table 2.1: Aetiology of crossbites

	Anterior crossbite	Posterior crossbite
Dental causes	1. Abnormal tooth bud positioning (can be due to trauma to primary teeth) 2. Lack of space for permanent incisors (arch length discrepancies) 3. Over-retained primary incisors 4. Supernumerary teeth 5. Cleft lip repair	1. Over-retained primary teeth or early loss of primary teeth 2. Ectopic eruption of first molar 3. Abnormal eruption sequence of permanent teeth 4. Cleft palate 5. Abnormal habits, e.g. digit sucking
Skeletal causes	1. Genetics 2. Stunted maxillary growth in an anterior direction 3. Accelerated mandibular growth in an anterior direction	1. Genetics 2. Stunted maxillary growth laterally (e.g. cleft palate cases) 3. Accelerated mandibular growth laterally
Functional causes	1. Pseudo class III (canine cuspal interferences, habits or early loss of primary incisors)	1. Occlusal interferences (mandible shifts from RC to IC)

(Proffit *et al.*, 2013)

A crossbite is quite common during the mixed dentition phase with a prevalence of up to 22% (Petrén *et al.*, 2011). Early treatment is crucial to prevent lasting effects, like craniofacial asymmetry, when the patient is in permanent dentition (Proffit *et al.*, 2013).

Anterior crossbite:

When dental causes are due to some primary teeth still left, extract those adjacent to the problem area to allow for space. It might be necessary to do this bilaterally to prevent a midline shift. If eruption has been completed, interproximal splicing can be attempted. Over-retained primaries need to be extracted or, if the problem is dental, tipping the tooth can be achieved via a Hawley apparatus and a Z-spring/jackscrew and a posterior bite plane. If a skeletal problem exists, fixed orthodontic treatment is needed (Proffit *et al.*, 2013).

Posterior crossbite:

Dental causes are due to space loss or incorrect tooth bud position. Skeletal causes are due to a narrow V-shaped palate and mouth breathers (Proffit *et al.*, 2013).

Dental posterior crossbite can be unilateral or bilateral. When the problem is unilateral and involves only one tooth, through-the-bite elastics and buttons is the course of treatment. When multiple teeth are involved unilaterally, expansion with a jackscrew and bite plane is indicated. When multiple teeth are involved bilaterally, bilateral expansion with a jackscrew and bite plane is indicated, a fixed quad helix or a W-arch can be used. When the problem is skeletal, slow or rapid palatal expansion will be necessary (Proffit *et al.*, 2013).

2.3.4.3 Anterior crossbite

Dental: Class I, type 3 or a pseudo class III (Proffit *et al.*, 2013):

- i) **Class I, type 3:** Skeletal and dental relationship is Angle class I with proclination of the lower incisors and retroclination of the upper incisors (one tooth or multiple teeth). Treatment will depend on whether the patient still has the primary incisors or if the permanent incisors are present. If the patient still has the primary incisors, the overbite is not yet established and treatment is only occasionally indicated. This is due to the fact that primary teeth often exfoliate before being successfully moved and that severe crowding in the primary dentition is rare. Treatment options in the primary dentition will be to extract the adjacent primary teeth to allow for space. The anterior crossbite issue will then usually resolve spontaneously. Bilateral extractions should be performed to prevent a midline deviation. Dental anterior crossbites usually develop as the permanent incisors erupt. When the permanent incisors are present, the overbite has been established and treatment will be necessary (Usually reducing the width of teeth, extraction of adjacent primary teeth or opening space orthodontically). The diagnostic workup will determine if tipping will correct the crossbite, tipping is often needed

because the eruption paths of the permanent incisors have been deflected. If only tipping is performed and bodily movement is truly needed, the stability of the correction is uncertain. If removable appliances can be used, and only tipping and tilting of the incisors are needed, a Hawley apparatus with a jackscrew or Z-spring can be used (activated once or twice a week). A posterior bite plane can be added to jump the bite easier. Overcorrection and retention are needed until the overbite has been established. Lastly, ensure that there is enough space for the tooth/teeth to move into the desired space (interdental splicing can be performed to create space). When bodily movement is needed, fixed appliances will be used (Proffit *et al.*, 2013).

- ii) **Pseudo class III:** Skeletal class I, but dentally a class III with multiple anterior teeth involved. The maxillary anterior teeth are retroclined, and retruded contact (RC) and maximal intercuspation (IC) differences are present. In RC, a straight profile (skeletal class I) is evident, but in IC a concave profile (class III) is present. There is usually no family history of a class III and the patient can bite edge to edge. If the pseudo class III is not resolved, a true class III can develop. The first line of treatment is to remove the canine cusp interferences by reducing the cusp. Further treatment may include a removable appliance (Hawley with an anterior jackscrew or Z-spring and posterior bite plane) (Proffit *et al.*, 2013).

Skeletal – true class III:

- i) A true class III has a strong family history of class III and presents with no RC and IC difference (both present with a concave profile). It is usually due to a protrusive mandible and retroclined mandibular teeth. No absolute occlusal interference is present, and the situation will worsen until the patient has stopped growing. Early treatment is important. Before the age of 8, reverse headgear and a facemask or a chin cup will be used to restrict mandibular and enhance maxillary growth. Treatment at a later stage will entail surgery and fixed orthodontic treatment (Proffit *et al.*, 2013).

2.3.4.4 Posterior crossbite

Potential treatment for dental posterior crossbite:

- i) Single tooth involvement: Treatment with through-the-bite elastics in the case of a scissor bite or palatal crossbite (Proffit *et al.*, 2013; Fricker *et al.*, 2013).
- ii) Multiple teeth involvement: Treatment options include fixed, rapid palatal expansion or slow palatal expansion with a removal appliance or fixed quad helix appliance (Proffit *et al.*, 2013).

During the treatment with the slow palatal expansion method, a bite plane is added to allow for free movement. An anterior bite plane is indicated if the patient is a horizontal grower or

has a deep bite, while a posterior bite plane is indicated if the patient is a vertical grower or has an open bite. When evaluating the success of treatment and how the occlusion has changed after treatment, one needs to consider the role of normal growth, as correction of a posterior crossbite is done as an interceptive treatment in a growing child. Whether a patient is treated with a quad helix or a removable expansion plate, it has little significance as the success of treatment and long-term stability of the occlusion is favourable in both treatment modalities. The average maxillary width in these subjects do not compare to that of a normal control (Petrén *et al.*, 2011).

Potential treatment for skeletal posterior crossbite:

- i) Treatment needs to be done with rapid palatal expansion to open the mid palatine suture and stimulate palatal growth. Treatment is performed before the age of 9, as the suture will start to close thereafter. A midline diastema will develop as a result of treatment, but will close spontaneously due to the pull of the trans-septal fibres of the periodontium (Proffit *et al.*, 2013).

2.3.5 Serial extractions

If there is no spacing in the primary dentition, there is a 70% chance of crowding of the permanent teeth. If the spacing is less than 3mm, there is a 50% chance of crowding (Leighton, 2007).

Serial extractions can be defined as the timeous removal of deciduous and permanent teeth to relieve crowding in the permanent dentition. This is done according to a carefully planned schedule (timing and sequence), and will resolve incisor crowding and help unerupted permanent teeth to erupt in a more aligned and favourable position. Therefore, serial extractions are also referred to as guided extractions as teeth are “guided” into the correct position. Serial extractions are performed during the mixed dentition phase and will allow for a more functional and aesthetically pleasing permanent dentition. In the instance that active appliance therapy is still needed, serial extractions will shorten treatment, and ensure easier and less complicated fixed treatment cases of use with fixed appliances (Proffit *et al.*, 2013; Feldman *et al.*, 2015).

2.3.5.1 Indications and contraindications of serial extractions

Table 2.2: Indications and contraindications of serial extractions

Indications	Contraindications
Only after eruption of permanent first molars at age 6 Severe crowding (>8-10mm) Favourable overbite and skeletal profile Discrepancy between tooth size and jaw size Loss of a canine unilaterally and a midline shift Palatal eruption of a maxillary lateral incisor due to tooth malpositioning Lingual eruption of a mandibular lateral incisor Abnormal primary canine root resorption and mesial eruption of permanent canines Any other abnormal eruption sequence or malpositioning of teeth	Mild to moderate crowding (<8mm) Deep bite or open bite, Class II or III skeletal relationship History of a cleft lip or palate Spacing between teeth Congenitally absent teeth Caries Midline diastema

(Fricker *et al.*, 2013; Feldman *et al.*, 2015)

2.3.5.2 Advantages and disadvantages

Advantages: Psychological issues in individuals can be avoided with early treatment, improvement in oral hygiene, reduction in cost and duration of the follow-up treatment. Results of serial extractions are stable, and the retention period needed is kept to a minimum (Feldman *et al.*, 2015). Tooth movements are physiologic in nature and periodontal tissue and alveolar bone integrity is maintained (Feldman *et al.*, 2015).

Disadvantages: Treatment will span two to three years and will require multiple visits. Patient compliance is very important, and the extraction process can be traumatic. Furthermore, a deep overbite can occur together with lingual tipping of the incisors. Tongue function can be altered, scar tissue can form in the extraction sites and excess space can be present after treatment has been performed (Feldman *et al.*, 2015).

2.3.5.3 Diagnosis and patient selection

Diagnosis and correct patient selection are crucial when performing serial extractions as the treatment entails removal of teeth, which cannot be reversed.

According to Graber (1971), the proportions of the face are very important when making the decision to perform serial extractions, and ideally an orthognathic facial proportion is required.

The relationships between the following should be ideal and in normal ranges:

- Maxilla and mandible,
- Upper and lower dentitions, and
- Maxilla and mandible with their respective teeth

Alveodental proportions in prognathic (maxillary or mandibular) or retrognathic (maxillary or mandibular) relationships, or if the skeletal relationship is not in a class I, serial extractions are usually not indicated and hence should not be considered as a treatment option (Proffit *et al.*, 2013).

2.3.5.4 Treatment

A complete workup should be done before treatment and should involve clinical photos, radiographs (panoramic and cephalometric radiographs) and a study model analysis (Proffit *et al.*, 2013). Treatment is done in two phases:

- Phase 1 is still reversible in a sense, as it involves the removal of primary teeth to allow for the alignment of the permanent incisors.
- Phase 2 is irreversible and involves the removal of permanent teeth to allow alignment of the posterior teeth.

2.3.5.5 Sequence of extractions

The sequence of extractions varies amongst researchers, and Tweed (1944), Dewel (1971) and Nance (1947) all suggested different sequences. Tweed suggested a sequence of DC4 while Dewel suggested CD4 and Nance suggested D4C (Iyyer, 2012). “C” indicating the primary canine, “D” indicating the primary 1st molar and “4” indicating the permanent 1st premolar.

According to Dewel (1971), at the age of 8 years and 6 months, the primary canines are removed followed by the removal of the first primary molars about one year later. Upon eruption of the first premolar, it is extracted to allow the permanent canine to erupt in a favourable position (Loriato *et al.*, 2009). Tweed (1944) suggested removing the first primary molar at the age of 8 years, and when the first premolar erupts (about 10 months later), extracting it together with the primary canine. Finally, Nance’s sequence (1947) of serial extractions entails the removal of the first primary molar at age 8 upon first premolar eruption, the extraction of the first premolar follows. The extraction of the primary canine follows to allow the eruption of the permanent canine in the ideal position.

According to Proffit *et al.* (2013), the ideal sequence of extraction is the one described by Dewel (1971). Firstly, extract the primary incisors if needed, followed by the primary canines to allow for the permanent incisors to erupt in alignment. Spontaneous alignment will happen, and no problems will be present for about one to two years. The next phase will occur when the first premolar has half to two-thirds root development. The first primary molar is extracted to speed up eruption of the first premolar, to allow for its subsequent removal before the permanent canine erupts (Bell and Sonis, 2014). The canines will align and erupt in a favourable position. If it becomes apparent that the canine will erupt first,

enucleation of the first premolar can be done to prevent this from happening (Proffit *et al.*, 2013).

Some authors suggest late premolar extractions instead of serial extractions. The process of serial extractions is started in the early mixed dentition followed by fixed treatment when the patient is in the permanent dentition (Wagner and Berg, 2000). Late premolar extractions is only started in the permanent dentition, primary canines and primary 1st molars are left to exfoliate naturally and the extraction of the 1st premolars follows in the permanent dentition (Wagner and Berg, 2000).

Serial extractions can best be viewed as an adjunctive treatment to later fixed treatment. However, it will ensure that follow-up treatment is quicker and easier. When performing serial extractions, the treatment time with fixed appliances is greatly reduced, although the execution of the whole treatment plan spans over a longer period of time versus late premolar extractions (Wagner and Berg, 2000). Retention and the outcome of the soft tissue profile are similar in both treatment modalities (Wilson *et al.*, 1999).

Serial extractions performed as a sole treatment option can lead to the mispositioning of the roots of teeth, a deep overbite and excess space. As serial extractions are done only in severe crowding cases with normal skeletal relationships, the space created will be used to align teeth. This means that little opportunity exists for tipping and tilting of teeth or other uncontrolled movement (Proffit *et al.*, 2013; Feldman *et al.*, 2015).

2.3.6 Space regaining

If a primary tooth in the posterior region is lost before it is due to exfoliate, the surrounding teeth may drift and close the space where successors are supposed to erupt. Proper space maintenance is needed to prevent this from occurring. However, if this is not done, space regaining procedures will be necessary to regain the space lost. Up to 3mm space can be regained in a local area with simple appliance therapy, and the outcomes are good. More than 3mm loss will need more extensive treatment, which is usually more specialised in nature. If interception is not done, the successors cannot erupt or may erupt in an abnormal position which will lead to the need for specialised treatment to create space for the impacted teeth to erupt (Proffit *et al.*, 2013).

2.3.6.1 Maxillary space regaining

This is much easier than treatment in the mandible as the palate serves as a good source to anchor the appliance (when a removable appliance is used). Permanent molars that have tipped and rotated mesiopalatally, can be tipped and tilted distally to regain space that has been lost. A removable appliance with Adams clasps for retention (spring Adams- or Adams clasps on the premolars) and a helical finger spring can easily distalise the drifted molar 3mm over a period of three to four months. If bodily movement is needed, fixed therapy is needed.

After the teeth have been distalised with removable or fixed appliances, space maintenance is very important to prevent relapse. A fixed space maintainer is ideal, and it would be best not to use the initial appliance for this purpose (Proffit *et al.*, 2013).

2.3.6.2 Mandibular space regaining

Theoretically and practically, treatment with removable appliances in the mandible is more difficult than treatment with removable appliances in the maxilla. Anchorage is less and appliances are more prone to breakage. Patients may struggle to cope with the appliance, and tissue irritation occurs more frequently. Therefore, fixed appliance therapy is the treatment of choice to distalise molars in the mandible (Proffit *et al.*, 2013).

When space loss has been unilateral, a fixed appliance with an archwire is recommended. A lingual arch (for anchorage and to support tooth movement) with a coil spring and segmental archwire is recommended. If space is lost bilaterally, an adjustable lingual arch or a lip bumper can be used. When a lingual arch moves teeth posterior, incisors can easily tip buccally as these teeth are used for anchorage of the appliance. The lip bumper appliance contacts the lip. The lip acts as the anchorage of the appliance and generates the force to distalise the molars without affecting the incisors. During this process, the natural forces that the lip exerts on the incisors are removed and thus some anterior movement can occur. When comparing the two appliances, the resultant effects and outcomes of treatment are similar (Proffit *et al.*, 2013). Space maintenance after treatment is important and although the lingual arch can be kept as a space maintainer, the lip bumper cannot. Ideally, it should then be replaced with a lingual arch for space maintenance (Proffit *et al.*, 2013).

2.3.7 Management of habitual behaviour

The habit of sucking a thumb, digit or pacifier needs to be broken before the resultant damage is carried over to the permanent incisors. The habit is normally broken by age 4 or 5. If not, the pressure of social interaction when the child starts school acts as a major deterrent to continue the habit. If the habit is not broken, because the child does not want to, the damage will be carried over to the permanent dentition. Boys tend to have a higher prevalence of habitual behaviour than girls, which can be attributed to the fact that boys tend to test boundaries and rebel against social rules (Proffit *et al.*, 2013). If the habit is broken before the eruption of the permanent incisors, the damage will resolve spontaneously, and no sign of the sucking habit will be present in the permanent dentition (Proffit *et al.*, 2013; Kamdar and Al-Shahrani, 2015; Sharma *et al.*, 2015).

Sucking habits during the primary and mixed dentition phases can lead to the deformation of the alveolus and primary dentition, but the concern is the ultimate deformation of the permanent incisors. The severity of the deformation is dependent on time and frequency of the sucking habit. The longer the habit continues and the more frequent the sucking occurs,

the more severe the effects on the permanent dentition will be. The result of a sucking habit is labial tipping of the maxillary anterior teeth and the lingual tipping of the mandibular teeth (Yokoo *et al.*, 2002). The resultant overjet will increase and the overbite will be negative, thus an open bite can be present. Maxillary incisors are flared and lip closure is difficult, with a secondary tongue thrust present in severe cases. The maxilla becomes narrow and V-shaped due to the sucking force and the pressure exerted from the buccinator muscles. The intermaxillary and intercanine width can be reduced, leading to a posterior crossbite as well (Proffit *et al.*, 2013; Kamdar and Al-Shahrani, 2015).

Intervention, especially when removable appliance therapy is planned, should only be considered if the child wants to stop the habit. Otherwise, the treatment will be unsuccessful as patient motivation is non-existent. Intervention can be in the form of a non-dental approach or appliance therapy (Proffit *et al.*, 2013; Kamdar and Al-Shahrani, 2015).

If a *non-dental approach* is used, a few treatment modalities can be tried. A discussion can be had with the child, especially if the child is older and can comprehend the reasoning behind stopping the habit. One can also try to remind the child not to suck the finger. A good reminder is adhesive tape around the finger. Lastly, a reward system can be put in place to encourage the child not to suck the finger (Kamdar and Al-Shahrani, 2015).

Appliance therapy can be used if the non-dental approach is unsuccessful. One should try to avoid a removable appliance as it will usually also be unsuccessful, especially in a child that does not want to stop the habit. A fixed appliance can be a useful aid where the child wants to stop the habit, as it serves as a reminder to not suck the digit. It is important that the child sees the appliance as an aid and not a punishment to avoid psychological damage (Proffit *et al.*, 2013; Kamdar and Al-Shahrani, 2015).

When the habit is broken, the appliance should be retained for approximately six months to ensure that the habit is truly broken.

Other habits to consider is nail biting, lip biting, bruxism and tongue thrusting. Careful consideration should be given to these habits to prevent damage to the permanent dentition in the long term (Sharma *et al.*, 2015).

2.3.8 Treatment of soft-tissue and hard-tissue interferences to aid tooth eruption

Teeth need to erupt according to a predetermined sequence and timetable. Delayed eruption can be defined as a tooth that has not erupted three months after the predetermined time for the tooth eruption or if the concurrent tooth in the adjacent quadrant has already erupted (Proffit *et al.*, 2013).

2.3.8.1 Aetiology

This can be local, systemic or genetic in origin. Under each, various reasons can be implicated as cause for the delay in eruption (Proffit *et al.*, 2013). The local aetiology can be attributed to either soft-tissue causes or hard-tissue interferences:

Soft-tissue causes:

Essentially, this is a thickened gingival barrier that resulted from trauma or surgery. This gingival hyperplasia leads to a thicker gingival layer to erupt through, which can delay eruption of the tooth. A thicker gingival barrier can result from premature loss of a primary tooth that leads to the gingiva closing as the successor is not ready to erupt. Other causes of gingival hyperplasia can be due to chewing forces on the gingiva after the early exfoliation. Other soft-tissue interferences that can delay eruption include the failure of the follicle of the developing tooth to fuse with the overlying gingiva, and acellular collagen physically impeding the tooth from erupting (Proffit *et al.*, 2013).

Hard-tissue interferences:

Odontogenic tumours can impede eruption. These tumours can be classified as either odontomas or adenomatoid odontogenic tumours (Proffit *et al.*, 2013).

An odontoma is a calcified mass of hard tissue that can be categorised as a benign tumour. It overlies the erupting tooth and is surrounded by a radiolucent area. Odontomas occur more in the maxilla than in the mandible and are usually not symptomatic.

Odontomas can also be compound (proper demarcation between the tooth layers, resemble teeth) or complex (does not resemble the tooth layers and no clear demarcation is present). Both types require removal as the developing tooth will not erupt without it being done (Proffit *et al.*, 2013).

Adenomatoid odontogenic tumours appear radiographically as a radiolucent, unilocular area surrounding an unerupted tooth, beyond the cemento-enamel junction. Some radio-opacities can be present inside the tumour. This is not a cyst. Treatment involves enucleation thereof to allow for eruption of the tooth. These tumours occur mainly in the anterior maxilla (Proffit *et al.*, 2013).

Ankylosis of a primary tooth can impede its exfoliation and subsequent eruption of the successor. An infra-occlusion will be seen clinically if the tooth has been ankylosed for an extended period of time. Radiographically, a fusion of the cementum/dentin with the alveolar bone can be seen (no lamina dura). Removal of this primary tooth is indicated if the successor is present or left if no permanent successor is present. It will necessary to build the primary tooth up in order to maintain vertical dimension. Maxillary ankylosis occurs more than

mandibular ankylosis, and this is the most common local cause of delayed eruption (Proffit *et al.*, 2013).

Residual roots of a primary tooth can impede eruption of the successor. When this is the case, removal of these root rests is indicated (Proffit *et al.*, 2013). Furthermore, radiation treatment of the head and neck can delay eruption, but it can also lead to ankylosis and malformation of the permanent teeth.

Lastly, clefts can delay eruption of the permanent teeth (Proffit *et al.*, 2013). Systemic causes include nutritional deficiencies, cerebral palsy, HIV and endocrine disorders, while genetic causes include amelogenesis imperfecta, Down's syndrome, osteopetrosis and cleidocranial dysplasia.

2.3.9 Muscle exercises

Normal muscle development is important as the soft tissue of the skeleton ultimately has an influence on the hard tissue of the skull. Thus, the muscular elements have an influence on the dentition. To ensure optimal muscle strength in an individual whose muscles are hypotonic, muscle exercises are recommended.

To strengthen the masseter muscle, clenching on the teeth at repeated, 10-second intervals is recommended. Lip exercises are recommended to ensure normotonic lips that have an effective seal and are not hypotonic or strained in function. Button pull or tug of war exercises are helpful and involve a button attached to thread being placed behind the lips. During the button pull exercise and tug of war exercise, thread is fastened to a button and pulled while movement is resisted by the patient trying to keep the button behind the lips. During the tug of war exercise, the thread is tugged by an assistant, and during the button pull exercise, the patient pulls the thread. Tongue exercises are important to ensure proper swallowing. One or two elastics can be used to hook around the tongue to practise swallowing and strengthen the tongue muscle. Lastly, the hold and pull exercise can stretch the lingual frenum. This is performed by holding the tongue in the palate and opening the mouth to stretch the frenum (Proffit *et al.*, 2013).

2.3.10 Unfavourable jaw relationships

Interception of class II or class III skeletal relationships is important as manipulation of growth can reduce the need for future surgical or extensive orthodontic treatment. It is very important to perform treatment during the growth spurts, otherwise little change or no change will occur as little growth is taking place outside of these periods (Proffit *et al.*, 2013).

2.3.10.1 Class II skeletal relationship

Treatment options for a class II skeletal relationship include growth modification (if growth is still occurring), camouflage (if the patient is beyond the point of growth) and surgical correction of the skeletal relationship in severe case (Iyyer *et al.*, 2012). Intercepting a developing class II jaw relationship will involve growth modification and proper diagnosis is important. The problem can lie in an overdeveloped maxilla, an underdeveloped mandible or a combination of the two. If the maxilla is prognathic, a face bow in with headgear can be used and should ideally be worn for 12 to 14 hours a day. The maxilla is restrained by the headgear, allowing the unrestrained mandible to catch up with growth and correct the skeletal malocclusion (Iyyer *et al.*, 2012). If the mandible is underdeveloped, a functional appliance can be used to accelerate growth in the mandible. Removable appliances include the Frankel II, Activator, Bionator and the Twinblock, while fixed treatment options include the Herbst, Mara and Twinforce. The functional appliance positions the mandible downwards and forward and stimulates the growth of the mandible in length and through remodelling in the glenoid fossa. A headgear action is indirectly applied to the maxilla by the stretching of the facial muscles and soft tissue (Iyyer *et al.*, 2012). If a patient has a combination of an overdeveloped maxilla and underdeveloped mandible, a combination of a functional appliance with headgear is used (Iyyer *et al.*, 2012). A patient should be selected carefully for a functional appliance, with selection criteria including the following: The patient should be in a growth spurt, the overjet should be less than 10mm, patient motivation should be excellent, the overbite should be normal, dental arches should be aligned, and incisors should be in a normal position (upper and lower) (Proffit *et al.*, 2013).

Evidence has shown that no real difference exist in the treatment outcome of a skeletal class II jaw relationship when treated early versus late. Therefore, treatment can be commenced in when the patient is in the mixed- or permanent dentition with a similar outcome (Proffit and Tulloch, 2002; Cha *et al.*, 2019).

The role of the general dentist is to identify these cases that require interceptive orthodontic treatment of the developing class II skeletal relationship and refer to an orthodontist as treatment is complex and need specialist management.

2.3.10.2 Class III skeletal relationship

Treatment options for a class III skeletal relationship include growth modification (if growth is still occurring), camouflage (if the patient is beyond the point of growth) and surgical correction of the skeletal relationship if a severe malocclusion exists (Iyyer *et al.*, 2012). If the patient is a growing child with a developing class III skeletal relationship, it is important to recognise whether the problem is maxillary retrognathism, mandibular prognathism or a combination of both. If the problem lies with the maxilla, a face mask can accelerate maxillary growth. It anchors to an intra-oral splint and allows for protraction of the maxilla

(Iyyer *et al.*, 2012). If the problem is mandibular prognathism, a chin cup and can stunt the mandibular growth to allow the maxillary growth to “catch up” (Iyyer *et al.*, 2012). If a combination of issues is present, a myofunctional appliance can be used or a combination treatment of a first a facemask followed by a chin cup can be used to allow for growth manipulation to obtain a normal skeletal relationship between the maxilla and mandible (Iyyer, 2012; Proffit *et al.*, 2013).

Early interceptive treatment is indicated for patients who has good facial aesthetics, is cooperative, is still growing, only has a mild problem (if severe, surgery is indicated), no family history of maxillary prognathism, an anterior-posterior functional shift is present, and they have a convergent facial type. If any contra-indications exist; the option of surgery when growth has stopped should be explored to advance the maxilla or to set back the mandible. This will be done when the patient is in the permanent dentition, thus only at a later stage (Iyyer *et al.*, 2012).

The role of the general dentist is to identify these cases that require interceptive orthodontic treatment of the developing class III skeletal relationship and refer to an orthodontist as treatment is complex and need specialist management.

However, the challenge with the above-mentioned appliances in the treatment of skeletal class II and III relationships is patient cooperation. Wearing these appliances is not aesthetically pleasing. When children are teased because of this, they might simply refuse to wear the appliance.

2.3.11 Ectopic eruption of the maxillary canine

If the permanent canines are impacted or erupt buccally/palatally and the dentition is in a class I relationship with no crowding, the best treatment option is to extract the primary canines at age 10 (Jacobs, 1992). A resolution rate of 62% in terms of canine positioning was shown and a further improvement rate of 17% was shown in terms of the canine repositioning when the primary teeth were removed (Power and Short, 1993). The success rate is dependent on the age diagnosed and the degree to which the canines are impacted (Jacobs, 1992).

In general, if the overlap of the maxillary canine exceeds more than the half of the width of the adjacent lateral's root, the chances for complete correction is poor (Power and Short, 1993). Studies have shown that a palatally impacted canine can be resolved in 91% of cases, if the crown of the canine is positioned distally to the midline of the lateral incisor (Rohlin and Rundquist, 1984). The resolution rate drops to 64% if the crown of the canine is mesial to the midline of the lateral incisor (Rohlin and Rundquist, 1984).

The canine angulation and crowding in the arch, also plays a role in the prognosis of the impacted canine. The angulation should be viewed in a vertical and horizontal direction. If the angle from the vertical is increased, the chance for successful eruption of the impacted

canine is less favourable after the extraction of the primary canine (Ericson and Kurol, 1988; Power and Short, 1993). It was found that if the angle exceeds 31% or more from the vertical the chances for normal eruption is greatly reduced (Power and Short, 1993). The degree of horizontal overlap of the impacted canine with the lateral incisor has more influence on the prognosis of the outcome rather than the angulation of the impacted canine upon eruption (Power and Short, 1993). If the cuspal tip of the canine is more mesially positioned, it is associated with more resorption of the lateral incisor root (Ericson and Kurol, 1988). Crowding within the arch also need to be assessed, as moderate to severe crowding can only be resolved with complex orthodontic treatment to resolve both the impaction, crowding and resultant malocclusion (Power and Short, 1993).

As seen from the above information, it is critically important to assess a patient for possible interceptive treatment as soon as a problem presents itself as the failure to intervene will lead to orthodontic problems in the permanent dentition. Failure to correct orthodontic problems during the mixed dentition phase can lead to expensive, time-consuming fixed appliance therapy and might even require surgical intervention. Ideally, treatment is performed in the mixed dentition phase. Regular check-ups during this phase is helpful, as the patient is not always aware that a problem exists. Timely treatment will therefore lessen the load of future treatment, both on the operator and patient.

2.4 TIMING OF ORTHODONTIC TREATMENT: IS EARLY TREATMENT REALLY NECESSARY?

The timing of orthodontic treatment has been a debatable topic for quite a while (Fleming, 2017). Some specialists and general practitioners are committed to the routine of providing early orthodontic treatment, with a more definitive phase of treatment in the late mixed or early permanent dentition, as this period corresponds with a phase of maximal growth (Fleming, 2017).

Most interceptive treatments are, as mentioned, only the first phase of treatment and done purely to make the second phase of treatment easier.

A significant amount of research has been done to answer this question: Is early, interceptive treatment necessary and effective, especially with class II and class III malocclusions? Definitive orthodontics can only be performed when the patient is in the late mixed- or permanent dentition, but interceptive treatments can be started in the mixed dentition phase and have been shown to rectify localised problems like anterior and posterior crossbite, crowding or ectopically erupted teeth. Interceptive treatments are generally accepted to be useful and have an important place in the correct management of orthodontic patients, general dentists should avoid treatment of early skeletal discrepancies and these cases are complex and unpredictable and should be referred to an orthodontist. A significant amount of

interceptive treatment modalities are performed before the age of 11 years, which has positive and negative parallels.

The merits of early orthodontic treatment are usually characterised by rigid opinion with little evidence. Little evidence is available to show that early orthodontic treatment (before the age of 10) is more beneficial than treatment at a later state, the exception being the treatment of localised malocclusions (Fleming, 2017).

The aim of orthodontic treatment is to obtain a normal occlusion that is functional and aesthetically pleasing at the same time. The factors that influence the final treatment outcome include the type of malocclusion, the severity of the malocclusion, how the operator approached the treatment plan, timing and patient cooperation (Proffit *et al.*, 2013; Fleming, 2017).

Compliance is of the utmost importance when treating skeletal malposition. Patient motivation is therefore crucial to ensure successful outcomes. Furthermore, the earlier the treatment is started, the more the growth and growth spurts can be utilised in a favourable manner to rectify orthodontic problems. The major drawback to early treatment includes drawn out treatment times. Fatigue and lack of motivation can become an issue even in the most dedicated patients. Another factor to consider is post treatment relapse, as studies have shown that without proper retention and follow-up, the possibility strongly exists (Proffit *et al.*, 2013; Fleming, 2017).

It has been suggested that treatment should be done in various phases and, if possible, start at an early age instead of during adulthood, i.e. treatment should start as soon as a problem has been noticed. In children, treatment is more preventative and interceptive in nature and will occur in two or more phases. In adults, a more comprehensive approach will be needed, normally with only one phase. Treatment in children is normally aimed at severe issues that need immediate management to prevent the situation from worsening (Proffit *et al.*, 2013).

Early treatments and interventions might only be the first line of treatment, with follow-up specialised treatment becoming necessary during a later stage. It is important to act timeously to prevent more issues arising due to lack of recognising possible treatment avenues that will benefit the patient in the long run. Full fixed treatment will ideally start during adolescence or adulthood, and should preferably be done by a specialised and experienced orthodontist (Proffit *et al.*, 2013).

When preventative or interceptive orthodontics are not successful, the patient will require fixed, specialised treatment which will take much longer and is costlier. Sometimes this is unavoidable due to the patient being a bit older or due to unsuccessful treatment during the initial phase. However, the preventative or interceptive treatment could also form part of the treatment plan where this first line of treatment is only done to ensure ease of treatment during the second phase in adolescence or adult life (Proffit *et al.*, 2013).

Treatment at a later stage allows for effective correction of occlusal anomalies related to growth problems, and for the utilisation of leeway space and a definite correction of any

malocclusion. Early treatment for the prevention or correction of skeletal discrepancies has been widely advocated, but early orthodontic treatment has not been proven to be superior to treatment at a later stage. Due to the long treatment time of early treatment as well as the additional burden of undergoing a second phase of treatment at a later stage, some evidence shows that early treatment should be done only for localised issues while the definitive treatment phase should only start in the late mixed or early permanent dentition period (Fleming, 2017, Cobourne, 2017).

Early orthodontic treatment, before the patient reaches the late mixed dentition phase, has been suggested for scenarios such as the following:

- **A relief of crowding to allow better oral hygiene:** Although the relief of crowding ensures the ease of oral hygiene regimens, it has not been proven that crowding in the mixed dentition phase influences periodontal health over time (Bollen *et al.*, 2008; Fleming, 2017).
- **Psychosocial benefits:** It has been shown that individuals suffering from anomalies like an increase in the overjet/overbite, open bite and spacing in the anterior region are more exposed to bullying. As this can have a negative socio-psychological effect on the individual, early treatment is recommended (O'Brien *et al.*, 2003; Seehra *et al.*, 2011).
- **Growth response:** The elasticity of the skeleton in the short and medium term is debateable and has been a topic of discussion for a long time. Some think that sustaining the treatment will lead to more meaningful skeletal changes and growth modifications. Currently, no evidence backs this method of treatment (Proffit, 2006; Fleming, 2017).
- **Aetiology:** Advocates of early treatment, especially those supporting sustained growth modification, consider the aetiology of malocclusion to be purely environmental. Some malocclusions, for example thumb sucking, are purely environmental in nature while most malocclusions are due to interactions between genetic and environmental factors (Depew *et al.*, 2002).

The timing of orthodontic treatment is critical to ensure treatment starts at the right time to minimise the time and costs associated with orthodontic treatment and to ensure ease of treatment (Proffit *et al.*, 2013).

Note that it is always necessary to recognise if other disciplines are needed to ensure the successful outcome of the treatment plan. This may include the involvement of an ear, nose and throat specialist if a mouth breather presents as a patient as this can indicate polyps, chronic sinusitis or adenoid problems (Proffit *et al.*, 2013).

2.5 LIMITATIONS AND CONTRAINDICATIONS OF IOT

Limitations of early interventions include unfavourable craniofacial growth, persistent habits, severe ectopic eruption and congenitally malformed or missing permanent teeth (Barrer, 1971). These factors should be considered in the treatment plan. Some of the contraindications of early treatment are changes that cannot be retained by stable occlusion, e.g. unfavourable soft-tissue or skeletal growth and persistent habits (White, 1998). Patient factors such as immaturity, lack of motivation or parental supervision, small mouth size, low pain threshold and poor oral hygiene could influence the success of IO (White, 1998).

2.6 THE ROLE OF THE GENERAL PRACTITIONER IN IOT

The general practitioner plays a crucial role in identifying the need for interceptive treatment. If a diagnosis is made early enough, and treatment is commenced timeously, the need for future, more advanced treatment can be minimised or eliminated.

Although general practitioners can play an important role in implementing interceptive treatment, literature suggests that general practitioners were not comfortable diagnosing or performing interceptive treatment (Borrie *et al.*, 2014). General practitioners felt they had the skill to correctly refer patients. Although they had knowledge of the indications and use of removable appliances, they did not feel they had the clinical skill to implement the treatment modalities themselves. Thus, the lack of self-confidence, experience and skill of the operator led to minor interceptive treatments being referred, or worse, left until a major malocclusion developed (al Nimri and Richardson, 2000; Sutton *et al.*, 2005; Borrie *et al.*, 2014).

2.7 SELF-PERCEIVED NEEDS OF THE GENERAL DENTIST

Sutton and his co-researchers (2005) looked at the self-perceived educational needs of general dental practitioners and found that 11% of general practitioners perceived themselves to have a good level of knowledge in terms of orthodontics while 59% thought their knowledge level was average and 30% felt it was poor. Of those who felt their knowledge of orthodontics was poor, 28% felt it was due to a lack of clinical practice, 25% felt it was due to a lack of undergraduate training, 19% felt it was due to a lack of postgraduate training, 19% felt they lacked interest in the field while 9% felt it was due to a lack in patient demand for treatment or that they themselves lacked job satisfaction (Sutton *et al.*, 2005).

Another investigation found 63% of general dentists were satisfied with the academic component of their orthodontic course and 54% were satisfied with the clinical component (Fleming and Dowling, 2005). Interestingly, 69% felt they can adequately complete an orthodontic assessment while 60% felt competent about managing an orthodontic emergency. Also, 96% of general dentists felt they were capable to refer patients appropriately while 76% felt they have the knowledge to use removable orthodontic appliances. Curiously, only 24%

would correct an anterior crossbite and 15% would fit a space maintainer, suggesting that there is a discrepancy between knowledge and clinical application of interceptive as well as preventative orthodontic treatment (Fleming and Dowling, 2005).

2.8 REFERRAL OF PATIENTS

In 2009, a survey assessed how general dentists refer patients. The study showed that 52% of dentists were correct in assessing the need for treatment, but only 20% of general practitioners referred patients at the correct time. However, there was no proper understanding of the barriers or facilitators of the implementation of IOT in the general dental practice (Jackson *et al.*, 2009).

Various studies assessed the orthodontic curriculum at undergraduate level in dental schools across the United Kingdom. It was found that there was a significant difference in the content covered, course length in terms of hours dedicated to orthodontics as a subject, as well as the way students were assessed and examined across the different universities (Derringer, 2005; Derringer, 2006; Borrie *et al.*, 2014).

2.9 UNDERGRADUATE ORTHODONTIC TRAINING

In 2006, a study investigated the orthodontic knowledge and skill vocational dental practitioners acquired as undergraduates in the UK (Patel *et al.*, 2006). Only 58% felt the theoretical information they received was adequate, 45% felt that their practical experience had been relevant to their current practice and 46% felt that they would be able to treat simple cases with removable appliances. In addition, 40% felt that their undergraduate course could have been improved by gaining more clinical experience.

2.10 TWO THEORIES: TPB AND SCT

To better understand the apparent reluctance to implement IOT in the general practice, two established psychological theories – the **Theory of Planned Behaviour** (TPB) (Bandura and Adams, 1977; Bandura, 2004; Borrie *et al.*, 2014) and **Social Cognitive Theory** (SCT) – may help to shed light on the matter (Bandura, 2004; Bonetti *et al.*, 2007; Bonetti *et al.*, 2009). See Table 2.3 in this regard.

Table 2.3: Theory of Planned Behaviour and Social Cognitive Theory

	Theory of Planned Behaviour	Social Cognitive Theory
Definition	Attitude toward behaviour, peer pressure and perception of the ability to perform the behaviour shape an individual's behavioural intentions and behaviours (Ajzen, 1991, Ajzen, 2002).	Individuals are more likely to perform a desired behaviour if they are self-assured (have high self-efficacy) and feel confident in their ability to execute the behaviour (Bandura and Adams, 1977). Individuals observed others performing certain behaviours as well as the consequences of those behaviours. They would remember the sequence of events and use this as a subsequent guide when they performed the same behaviour. Thus, individuals did not only learn behaviours by trying it themselves, but by observing others. They could then choose to perform the behaviour or not, depending on the success or failure of the modelled behaviour (Bandura and Adams, 1977).
Components of the theory	<p>The Theory of Planned Behaviour (TPB) consists of six components that represent control over a given behaviour (Ajzen, 1991).</p> <ol style="list-style-type: none"> 1. Attitude: An individual's evaluation of whether the situation was favourable or unfavourable and what the outcome of the situation would be if the specific behaviour was performed. 2. Behavioural intention: The factors that motivated an individual to perform the behaviour. The stronger the motivation was, the more likely it was that the behaviour would be performed. 3. Subjective norms: This was the consideration to whether other people (especially peers and people of importance) would approve of the behaviour. 4. Social norms: This referred to the expected standard of behaviour in a specific group of people. 5. Perceived power: This was how an individual perceived the factors that may improve or impede the performance of the selected behaviour. The perceived power correlated to the perceived control over these identified factors. 6. Perceived behavioural control: This referred to how easy or difficult an individual think performing the specific behaviour would be if they observed they behaviour performed by someone else. If the performance of the behaviour was successful, they would then perform the behaviour in the same way. 	<p>Social Cognitive Theory (SCT) consists of five theoretical components (the construct of self-efficacy was added later) (Bandura and Adams, 1977):</p> <ol style="list-style-type: none"> 1. Reciprocal determinism: This is the central concept of SCT. It refers to the dynamic and reciprocal interaction of a person (individual with a set of learned experiences), environment (external social context) and behaviour (responses to stimuli to achieve goals). 2. Behavioural capability: This is the person's ability to perform the behaviour through their core knowledge and skill set, i.e. to perform the behaviour, the person needs to know how to do it and when to do it. 3. Modelling: This is when an individual observes a behaviour performed by someone else. If the performance of behaviour was successful, they would then perform the behaviour in the same way. 4. Reinforcements: This refers to the internal or external responses to a person's behaviour that affect the likelihood of continuing or discontinuing the behaviour. Reinforcements could be self-initiated or in the environment. Reinforcements could also be positive or negative. This is the construct of SCT that most closely ties to the reciprocal relationship between behaviour and environment. 5. Expectations: This refers to the outcome the individual expects from performing the behaviour. Consequences of a performed behaviour can influence the implementation of the behaviour. 6. Self-efficacy: This refers to people's confidence in their ability to successfully perform a selected behaviour. Self-efficacy is determined by the individual's capabilities as well as the environment in which the behaviour is performed.

(Bandura and Adams, 1977; Bandura, 2004; Bonetti *et al.*, 2007; Bonetti *et al.*, 2009)

A 2009 study used the TPB in relation to dental decontamination. It discussed how the theory 'predicted an individual was more likely to intend to follow the best practice if they intend to do so, and that they were more likely to intend to do so if they believe that they were able to overcome likely barriers, if they think that doing so will result in consequences that they value, and if they believe that other people they respect want them to' (Bonetti *et al.*, 2009).

The SCT theory has been used in dentistry to further an understanding of the beliefs supporting intention to become a trainer in the field of dentistry (Hiles, 1985). This study used the predictive measures of attitude towards becoming a trainer, attitude towards attending a trainer course and confidence in the ability to train (training self-efficacy). The psychological model of SCT provided a basis for understanding intention to become a trainer (Hiles, 1985).

The proposed study will use the TPB and SCT as frameworks to further an understanding of factors that may influence the implementation of IO in the general dental practice.

2.11 JUSTIFICATION OF THE NEED FOR FURTHER STUDIES

Further studies will need to be conducted to shed more light on the debatable topic of interceptive orthodontic treatment. No clear answer is available to whether early treatment is really necessary. The limitations and contraindications pertaining to IO is another topic that warrants further studies. Very little evidence-based information is available in the literature. IOT is a useful tool in the practice to reduce or eliminate the need for more extensive orthodontic treatment in future. However, general practitioners are reluctant to implement these interceptive treatments as part of their normal scope of practice. Various studies have been conducted on the knowledge of practitioners on the topic, but little evidence is available in the literature to why this is the case.

2.12 CONCLUSION

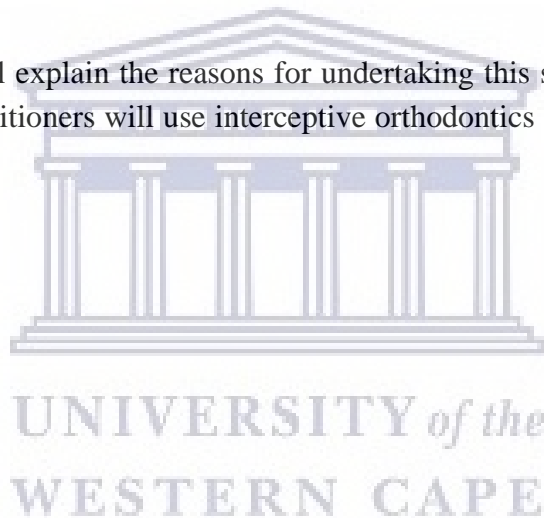
The literature review looked at studies on preventative and interceptive orthodontic treatments to determine the need for such treatments and what these treatments entailed. The review also looked at two theories – the Theory of Planned Behaviour (TPB) and Social Cognitive Theory (SCT) – that can underpin an understanding of the factors that may influence the implementation of interceptive orthodontics in the general dental practice.

To summarize:

- Preventative orthodontics can be defined as the branch of orthodontics concerned with preventing occlusal problems before they occur.

- Common preventative procedures include space maintenance, monitoring for abnormal habits like thumb sucking and the management thereof, removal of active frenae, monitoring the exfoliation schedule of the teeth, caries control and extraction of supernumerary teeth, if present.
- Interceptive orthodontics can be defined as a branch of orthodontics concerned with intervening early enough to eliminate minor occlusal problems in the dentition to prevent major malocclusions in the future. IO is the timeous treatment of unfavourable features of an occlusion that is still developing.
- Interceptive orthodontic procedures include serial extractions, crossbite corrections, further management of habitual behaviour, treatment to prevent soft-tissue or hard-tissue interference from preventing tooth eruption, muscle exercises, the treatment of unfavourable skeletal (jaw) relationships, as well as space regaining where this has been lost.

The following chapter will explain the reasons for undertaking this study about the extent to which general dental practitioners will use interceptive orthodontics as part of their treatment plans.



CHAPTER 3: AIMS AND OBJECTIVES

3.1 INTRODUCTION

This study wanted to gain a better understanding of the use of interceptive orthodontic treatment in general dental practices. With the literature review providing a better understanding of the advantages of both interceptive and preventative orthodontics, the reasons for undertaking this study can now be explored.

3.2 RATIONALE FOR THE STUDY

It seems that general dental practitioners do not readily incorporate interceptive orthodontic treatment (IOT) as part of their normal scope of practice. Subsequently, patients end up receiving costly and time-consuming specialist treatment where those cases could have been treated with simple interventions in a general practice. By studying the reasons behind the lack of implementation of simple IOT in the general practice, measures can be put in place to improve the percentage of cases treated by general dentists. This can save patients time, limit the costs of specialist treatment and ultimately shorten fixed orthodontic treatment times at a later stage, if needed.

3.3 AIM AND OBJECTIVES OF THE STUDY

The aim of this study was to understand the factors that influence the non-implementation of IOT in 24 general dental practices in the metropolitan area of Tshwane, South Africa. This led to the formulation of the primary research question:

Why do general dental practitioners not implement interceptive orthodontic treatment (IOT) as part of their normal scope of practice and why do they, subsequently, rather refer patients to an orthodontist?

The study therefore set out to investigate the knowledge, confidence of self-efficacy and attitude of dentists, as well as the socio-economic area of the practice and number of years of experience as potential reasons why general dental practitioners will either perform IOT or refer patients to an orthodontist, if at all. The following secondary research questions therefore guided the study:

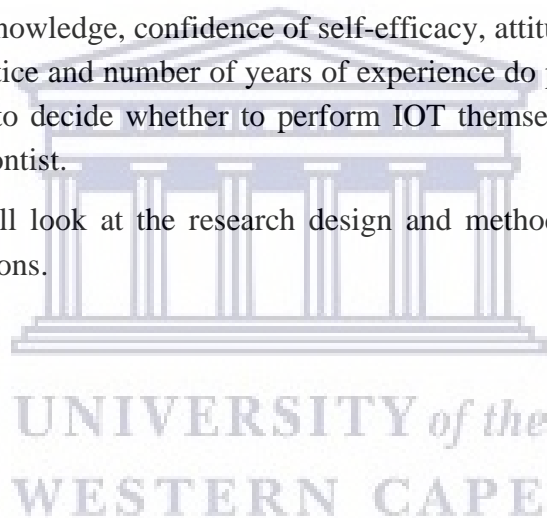
- What knowledge (specifically in the field of orthodontics) do general practitioners have in terms of diagnosing and treating patients requiring IO?

- What are the thoughts of general practitioners regarding confidence of self-efficacy when diagnosing and performing IO in their practices?
- What is the general practitioners personal attitude towards IO?
- What other factors influence the non-implementation of IO? Does the practitioner have a keen interest in orthodontics? Do medical aid payments and monetary remuneration play a role in the implementation of IO? Does the practice's infrastructure play a role in the implementation of IO?
- Does the socio-economic area in which the general practitioner is practising play a role in the decision to treat or to refer?
- Does the general practitioner's number of years of experience play a role in the decision to treat or to refer?

3.4 CONCLUSION

The hypothesis was that knowledge, confidence of self-efficacy, attitude, other factors, socio-economic area of the practice and number of years of experience do play a role when general dental practitioners need to decide whether to perform IOT themselves or whether to refer their patients to an orthodontist.

The following chapter will look at the research design and methodology used in order to answer the research questions.



CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This study wanted to find if general dental practitioners in the metropolitan area of Tshwane were hesitant to use interceptive orthodontic treatment in their practices. The following sections will therefore explain the research design and methodology used to gather and analyse data in order to gain insight into the situation.

4.2 STUDY SAMPLE

The study was based on the views and opinions of general dental practitioners currently practicing in the public and private sectors in three socio-economic areas and in four levels of experience categories, as shown in the diagram below (see Figure 4.1). This called for a mixed quantitative and qualitative study. The study sample included the following subdivisions:

- **Stage 1:** The public and private sectors
- **Stage 2:** The socio-economic environment in which the general practitioner is working, i.e. lower, middle or higher income group. The groups were established through evaluation of the national census conducted in 2011.
- **Stage 3:** Number of years of experience, i.e. 0-5 years, 6-10 years, 11-15 years and 16-20 years. (No other number of years of experience was considered during this study).

4.3 SCHEMATIC REPRESENTATION OF STUDY SAMPLE

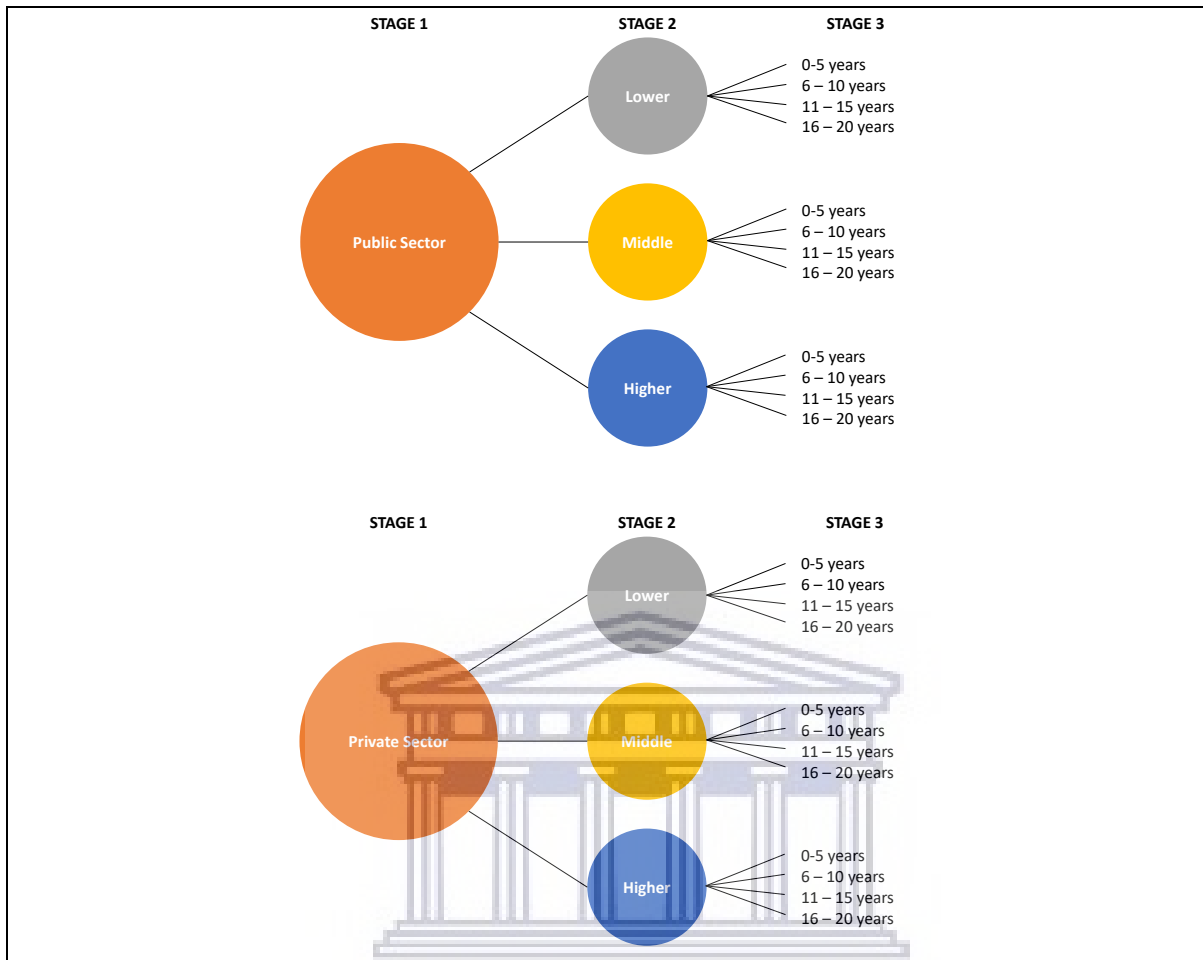


Figure 4.1: Schematic representation of the general dental practitioners used as study sample

4.4 SAMPLE SIZE

A convenience sample was drawn from a list of potential participants. This list was drawn up from the private and public sectors. The private dental practitioners were obtained via telephone numbers in the telephone book while the public dental practitioners were obtained via the telephone numbers of public health clinics.

As mentioned, the first subdivision was the public and private sectors (Stage 1).

The second subdivision was the socio-economic area in which the practitioners were practising: low, middle or higher income group (Stage 2). This was established through the evaluation of the results of the national census in 2011, as mentioned above. The practitioners from the low-income group were selected from the area of Danville. The practitioners from the middle-income group were selected from the area of Riveria while the practitioners from the higher income group were selected from the area of Waterkloof.

The third subdivision was the four groups based on the number of years of experience: 0-5 years, 6-10 years, 11-15 years and 16-20 years (Stage 3).

Sampling was done in stages, as shown in the diagram above. To obtain the correct sample size of 24, one practitioner from each category in Stage 3 was selected. A participant with the appropriate experience level was then selected from each of the suburbs listed above and was selected for both the public and private sectors.

4.5 QUESTIONNAIRE

The questionnaire assessed the general dental practitioners' knowledge on providing interceptive treatment for five paper patients (scenarios) by assessing answers given to five paper patient scenarios presented to them. Their thought on confidence of self-efficacy, attitude and other factors that may have influenced their choice to perform IOT on patients was also assessed.

The development of the questionnaire was based on orthodontist input to compile the paper patients as well as an 'answer sheet' of possible outcomes for each of the scenarios.

Follow-up questions were posed to the practitioners to obtain information on their thoughts on confidence of self-efficacy, attitude and other factors that may play a role in the decision-making process of whether to treat a patient with interceptive orthodontics or not.

4.6 DATA COLLECTION

Verbal one-on-one interviews were conducted with each selected individual. Each interview lasted for 30 minutes. The in-depth interviews were conducted in person at the respondent's place of work or in a public location and documented on the questionnaire used during the interview.

To ensure anonymity, no personal information or information on the participants' practices was recorded. The interviews were identified via a numbering system and stored in a secure, online location to further ensure anonymity. The questionnaire guiding the interviews covered the following fields:

Knowledge

Knowledge, defined as the understanding of a subject, was assessed with this question: *Which procedures do you think should ideally be carried out for this patient?*

Each scenario offered the possibility of 10 behaviours. For each behaviour, the practitioner could answer either yes or no. The responses were compared to those of the expert (orthodontist). One point was allocated for each correct response. The total number of correct

responses was determined for each scenario and was converted to a percentage out of 10 for each dentist. This served as the measure of the dentist's knowledge in terms of the specific scenario, and was called the knowledge score. For each scenario the overall percentage knowledge across the sample was calculated as the overall percentage of correct answers given, together with a 95% confidence interval. The overall knowledge across all five scenarios and across the sample was calculated in a similar way, together with a 95% confidence interval.

Based on the knowledge shown by the general practitioner, he/she was classified accordingly as a display of good, average or poor knowledge on the orthodontic subject dealt with in the paper case (scenario).

To obtain a classification of *good knowledge*, more than five of the possible answers given needed to be answered correctly in terms of the yes or no answers. *Average knowledge* constituted a score of five correct answers while less than five correct answers classified the knowledge of the practitioner as *poor*. Overall, more than 50% correct answers were considered as good knowledge, 50% as average and less than 50% as poor.

No negative marking was implemented. The possible score obtained by the general practitioner could therefore range from 0 to 10 correct answers. (See appendices for the answer sheets for the five paper patient cases.)

Confidence of self-efficacy

Confidence of self-efficacy, defined as the belief in one's own ability and level of comfort to perform a given task, was assessed by answering a series of questions to establish whether the practitioners avoided interceptive treatment in their practices due to a lack of confidence in designing and implementing a treatment plan, or due to a lack in the skills obtained from undergraduate training. The percentage responses in each category were calculated.

Attitude

Attitude, defined as a settled way of thinking or a feeling toward something, was also assessed on the scenario-specific outcomes. This section focused on the effectiveness of the chosen plan, the importance of IO for the patient and the likelihood of the patient being worse off if nothing was done. The percentage responses in each category were calculated.

Other factors

Other factors might also have been responsible for the lack of implementation of IO in these dentists' practices. This could include a practitioner's lack of interest in orthodontics, a smaller monetary reward from patients on medical aid, or practices whose infrastructure did not support the implementation of IOT. During this part of the interview, the respondents

were given the opportunity to raise any concerns or reasons not listed as reasons why they did not implement IOT in their practices. The percentage of responses in each category was calculated.

Confidence of self-efficacy, attitude and other factors were assessed on a personal scale based on the answers provided by the general practitioners referring to the paper patients (scenarios).

The practitioners answered a series of questions to establish whether they deemed themselves confident and self-efficient, what their attitude was towards the paper cases (scenarios) and what other factors influenced their decision-making process.

Ultimately, this showed how self-efficient and confident the practitioners were, what their attitude towards a specific paper case (scenario) was, and whether or not other factors influenced the implementation of IOT in their practices.

The performance of the dentists in the public and private sectors were compared. Likewise, the performance of the dentists in the various socio-economic classes as well as their performance based on their years of experience was compared.

4.7 DATA ANALYSIS

For the assessment of Section A (the section on the dentists' knowledge levels), a specialist opinion was used to develop a system for the scoring of the selected answers for a specific scenario. This was called the knowledge score. The scenarios were posed to the practitioner via the five paper patient cases in the questionnaire. If the general practitioner, completing the questionnaire, selected a correct answer for the treatment of the paper patient, a point was allocated. When the selected answers were incorrect, no points were allocated. The total number of correct responses was converted to a percentage value. The outcome measure (dependent variable) was the intention to provide the correct behaviour (select the correct procedure to be done), as measured by the knowledge score.

The scenario knowledge scores were combined into a global knowledge score. All statistical analyses were performed on SAS (SAS Institute Inc, Carey, NC, USA), Release 9.4.

To assess Section B, the responses in terms of confidence of self-efficacy, attitude and other factors were summarised by frequency counts and percentage calculations.

4.8 CONCLUSION

A total of 24 dentists from three different socio-economic areas in Tshwane were asked to respond to questions pertaining to their use of interceptive orthodontics in their practices. This chapter explained the formulation of the questionnaire that guided the one-on-one interviews with the dentists in order to gather data on their knowledge levels, confidence of

self-efficacy, attitude and other factors impacting their decision whether to use interceptive orthodontics or not.

The following chapter will analyse the results.



CHAPTER 5: RESULTS

5.1 INTRODUCTION

Primary data for the study was gathered via interviews with 24 dentists to determine their knowledge of the need for interceptive orthodontics and the potential use of interceptive orthodontics in their practices. The results are outlined below.

5.2 STUDY RESULTS

The results are summarised in the tables below.



Table 5.1: Percentage of correct answers per scenario for dentists in the private and public sectors

Dentist	Percentage correct answers for					Average across scenarios
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	
Private sector						
1	80	70	80	60	30	64
2	90	90	60	70	90	80
3	80	50	70	50	60	62
4	100	100	80	100	100	96
5	50	60	80	80	80	70
6	60	70	40	80	50	60
7	50	70	50	40	70	56
8	60	90	60	60	60	66
9	100	50	70	90	60	74
10	70	100	70	90	50	76
11	60	80	60	60	60	64
12	90	80	60	90	100	84
Average per scenario	74.2	75.8	65.0	72.5	67.5	71.0
Public sector						
13	60	80	50	70	40	60
14	90	70	70	50	70	70
15	100	80	100	50	60	78
16	80	90	60	70	60	72
17	100	90	80	80	60	82
18	70	90	70	80	70	76
19	50	80	60	50	50	58
20	50	80	50	80	40	60
21	70	90	70	70	60	72
22	90	90	80	60	80	80
23	70	90	70	50	60	68
24	90	80	70	70	60	74
Average per scenario	76.7	84.2	69.2	65.0	59.2	70.8
P value*: Private vs. Public	0.764	0.146	0.583	0.265	0.228	1.000

*Fisher Exact test

Interpretation

- No statistically significant differences were found between private and public sector dentists in respect of the average percentage correct answers per scenario, as well as in respect of the average percentages across the scenarios.
- The overall percentage correct answers from dentists in the private sector was 71.0% with a 95% confidence interval of 67.2% to 74.5%.
- The overall percentage correct answers from dentists in the public sector was 70.8% with a 95% confidence interval of 67.1% to 74.3%.

- The percentages from the private and public sectors (71.0% and 70.8% respectively) do not differ significantly (p=1.000).
- The overall percentage correct answers (knowledge) from both the private and public sectors is 70.9% with a 95% confidence interval of 68.3% to 73.4%.
- Based on the average scores across the scenarios all the dentists in the study had “Good knowledge” (>50%) of the need for orthodontic treatment.

Table 5.2: Percentage of correct answers per scenario for the socio-economic classes

Dentist	Percentage correct answers for					Average across scenarios
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	
Higher socio-economic class						
1	80	70	80	60	30	64
2	90	90	60	70	90	80
3	80	50	70	50	60	62
4	100	100	80	100	100	96
13	60	80	50	70	40	60
14	90	70	70	50	70	70
15	100	80	100	50	60	78
16	80	90	60	70	60	72
Average per scenario	85.0	78.8	71.3	65.0	63.8	72.8
Middle socio-economic class						
5	50	60	80	80	80	70
6	60	70	40	80	50	60
7	50	70	50	40	70	56
8	60	90	60	60	60	66
17	100	90	80	80	60	82
18	70	90	70	80	70	76
19	50	80	60	50	50	58
20	50	80	50	80	40	60
Average per scenario	61.3	78.8	61.3	68.8	60.0	66.0
Lower socio-economic class						
9	100	50	70	90	60	74
10	70	100	70	90	50	76
11	60	80	60	60	60	64
12	90	80	60	90	100	84
21	70	90	70	70	60	72
22	90	90	80	60	80	80
23	70	90	70	50	60	68
24	90	80	70	70	60	74
Average per scenario	80.0	82.5	68.8	72.5	66.3	74.0
P value*: All three classes	0.001**	0.810	0.378	0.611	0.734	0.029**

* Fisher Exact test

** Statistically significant (p value <0.05)

Interpretation

- For scenario 1, the average number of correct answers (knowledge) for the middle-income socio-economic class (61.3%) differed significantly from the percentage for the higher income class (85.0%, $p=0.001$), and also differed significantly from the percentage for the lower income class (80.0%, 0.015). [P values are less than a Bonferroni-adjusted significance level of 0.017.]
- No statistically significant differences were found between the three socio-economic classes in respect of the average percentage correct answers for scenarios 2 to 5.
- In respect of the average percentage across the scenarios, the percentage for the middle-income socio-economic class (66.0%) was significantly lower than the percentage for the lower income class (74.0%, $p=0.017$). [P value is less than a Bonferroni-adjusted significance level of 0.017.]
- The overall percentages of correct answers from the three socio-economic classes were as follows:
 - Higher class: 72.8%, 95% confidence interval 62.8% to 76.9%
 - Middle class: 66.0%, 95% confidence interval 61.2% to 70.5%
 - Lower class: 74.0%, 95% confidence interval 69.5% to 78.1%.
- The overall percentage of correct answers (knowledge) from all three socio-economic classes combined was 70.9% with a 95% confidence interval of 68.3% to 73.4%.

Table 5.3: Percentage of correct answers per scenario based on years of experience

Dentist	Percentage correct answers for					Average across scenarios
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	
1 – 5 years of experience						
1	80	70	80	60	30	64
13	60	80	50	70	40	60
9	100	50	70	90	60	74
21	70	90	70	70	60	72
5	50	60	80	80	80	70
17	100	90	80	80	60	82
Average per scenario	76.7	73.3	71.7	75.0	55.0	70.3
6 – 10 years of experience						
2	90	90	60	70	90	80
14	90	70	70	50	70	70
10	70	100	70	90	50	76
22	90	90	80	60	80	80
6	60	70	40	80	50	60
18	70	90	70	80	70	76
Average per scenario	78.3	85.0	65.0	71.7	68.3	73.7
11 – 15 years of experience						
3	80	50	70	50	60	62
15	100	80	100	50	60	78
11	60	80	60	60	60	64
23	70	90	70	50	60	68
7	50	70	50	40	70	56
19	50	80	60	50	50	58
Average per scenario	68.3	75.0	68.3	50.0	60.0	64.3
16 – 20 years of experience						
4	100	100	80	100	100	96
16	80	90	60	70	60	72
12	90	80	60	90	100	84
24	90	80	70	70	60	74
8	60	90	60	60	60	66
20	50	80	50	80	40	60
Average per scenario	78.3	86.7	63.3	78.3	70.0	75.3
P value*: All years	0.552	0.169	0.781	0.005**	0.284	0.017**

* Fisher Exact test

** Statistically significant (p value <0.05)

Interpretation

- No statistically significant differences were found between the average percentages of correct answers for scenarios 1, 2, 3 and 5.
- For scenario 4 the average number of correct answers (knowledge) with 11-15 years of experience (50.0%) differed significantly from the percentage for 1-5 years of experience (75.0%, p=0.008), and also differed significantly from the percentage for

16-20 years of experience (78.3%, $p=0.002$). [P values are less than a Bonferroni-adjusted significance level of 0.008.]

- In respect of the average percentage across the scenarios, the percentage for 11-15 years of experience (64.3%) was significantly lower than the percentage for 16-20 years of experience ($p=75.3%$, $p=0.004$). [P value is less than a Bonferroni-adjusted significance level of 0.008.]
- The overall percentages of correct answers from the four periods of experience were as follows:
 - 1 – 5 years of experience: 70.3%, 95% confidence interval 64.9% to 75.2%
 - 6 – 10 years of experience: 73.7%, 95% confidence interval 68.4% to 78.3%
 - 11 – 15 years of experience: 64.3%, 95% confidence interval 58.8% to 69.5%
 - 16 – 20 years of experience: 75.3%, 95% confidence interval 70.2% to 79.9%
- The overall percentage of correct answers (knowledge) from all four periods of experience combined was 70.9% with a 95% confidence interval of 68.3% to 73.4%.

Table 5.4: Confidence of self-efficacy

Question	Number (%)			Total
	Very confident	Not confident	Unsure	
How confident are you that you have designed the correct treatment plan?	18 (75)	-	6 (25)	24 (100)
How confident are you that you can carry out the treatment plan?	18 (75)	1 (4)	5 (21)	24 (100)
How confident are you that you have chosen the correct treatment option?	18 (75)	-	6 (25)	24 (100)
How confident are you that your undergraduate training is sufficient?	10 (42)	9 (38)	5 (21)	24 (100)
Collective confidence	64 (66.7)	10 (10.4)	22 (22.9)	96 (100)

Interpretation

- Collectively, in 66.7% of the responses to the four questions, the dentists indicated that they were very confident.
- Collectively, in 33.3% of the responses to the four questions, the dentists indicated that they were not confident or unsure.

Table 5.5: Attitude

Question	Number (%)		Total
	Positive Attitude	Negative attitude	
Would you have treated any of the paper patient cases in your practice?	19 (79)	5 (21)	24 (100)
Do you consider it important to carry out IOT in general practice?	24 (100)	-	24 (100)
Do you think patients will be worse off without IOT?	24 (100)	-	24 (100)
Collective attitude	67 (93.1)	5 (6.9)	72 (100)

Interpretation

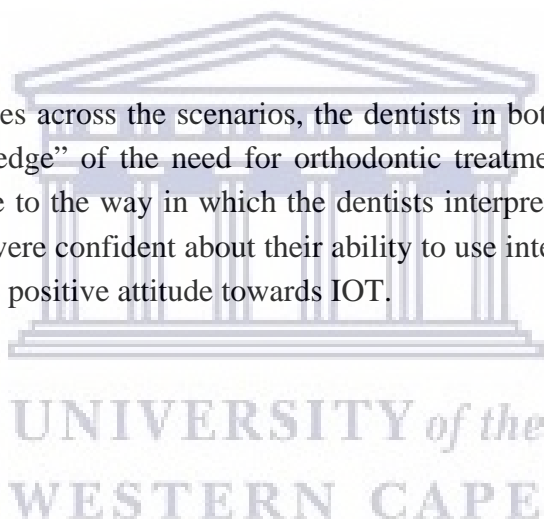
- Collectively, in 93.1% of the responses to the three questions, the dentists expressed a positive attitude.
- Collectively, in 6.9% of the responses to the three questions, the dentists expressed a negative attitude.

Table 5.6: Other factors

Question	Number (%)		
	Yes	No	Total
Do you have a keen interest in orthodontics?	12(50)	12(50)	24(100)
Does the monetary amount paid by medical aids affect your decision to perform IOT?	13(54)	9(46)	24(100)
Does the practice's infrastructure support the implementation of IO?	14(58)	10(42)	24(100)

5.3 CONCLUSION

Based on the average scores across the scenarios, the dentists in both the private and public sectors had “Good knowledge” of the need for orthodontic treatment. Years of experience mostly made no difference to the way in which the dentists interpreted the scenarios. About two-thirds of the dentists were confident about their ability to use interceptive orthodontics as treatment. Over 90% had a positive attitude towards IOT.



CHAPTER 6: DISCUSSION

6.1 INTRODUCTION

The study was conducted on a convenience sample of 24 dentists (cases) representing the public and private sectors, three socio-economic classes and four time intervals of experience.

Knowledge, confidence of self-efficacy, attitude and other factors were assessed to establish why general dental practitioners were hesitant to implement IOT as part of their scope of practice.

The results of this study correlate closely with the results of some previous studies while contradicting the results of others (Jackson *et al.*, 2009; Sutton *et al.*, 2005; Borrie *et al.*, 2014).

6.2 KNOWLEDGE LEVELS

Knowledge scores (percentage knowledge) were calculated for all 24 dentists individually for all the scenarios and summarised in Table 5.1. The following results were found:

- Based on the average scores across the scenarios all the dentists in the study had “Good knowledge” (>50%) of the need for orthodontic treatment of the five paper patients (scenarios).
- The average knowledge scores of dentists in the private and public sectors (71.0% and 70.8% respectively) did not differ significantly.
- The overall percentage of correct answers for public and private sector dentists was 70.8% with a 95% confidence interval of 67.1% to 74.3%.
- In the private sector only three individual knowledge scores reflected “Poor knowledge” (knowledge<50%). One individual scored 40% in scenario 3, another scored 40% in scenario 4 and lastly, an individual scored 30% in scenario 5.
- In the public sector only two individual knowledge scores reflected “Poor knowledge” (knowledge<50%). Both individuals scored 40% in scenario 5.

All the dentists interviewed as part of the case study showed good knowledge as all the dentists displayed a knowledge level of more than 50% across all five scenarios. This is a good indicator that undergraduate training across all dental schools at South African universities is good.

Exposure to the scope of orthodontics, especially IOT at undergraduate level, is sufficient as all the dentists answered with a good level of knowledge. The knowledge of the dentists was not affected by the sector in which they worked, as only three private and two public sector dentists scored below 50% each on one of the five scenarios. Three of these were on scenario

5. Scenario 5 stated that “A 10-year-old girl presents with early loss of the second upper primary molar on the right-hand side. No space maintenance was done for the child. What would you do for this child?” The correct answer would be to distalise the maxillary first permanent molar on the right-hand side if it was established that space was lost. This could easily be done with a removable appliance. Subsequently, space maintenance would be needed until the second premolar erupted. Based on the questionnaire, it seemed that the general practitioners that scored poorly on this scenario did not think that any treatment or space maintenance was needed, which was clearly not the case. The possibility exists that the dentist might have thought that fixed orthodontic treatment would in any case become necessary once the child is older.

In the case of knowledge, various studies have concluded that the lack of knowledge was a major reason why dentists did not implement IOT in their practices (Sutton *et al.*, 2005; Jackson *et al.*, 2009; Borrie *et al.*, 2014). This is in stark contrast to the findings of the current study as the current study shows the general dentists to have good knowledge rather than a lack thereof. On the other hand, the study of Jauhar and her co-researchers correlates with the findings of the present study as they also reported a sufficient level of knowledge among participants (Jauhar *et al.*, 2016).

6.3 DENTISTS WORKING IN DIFFERENT SOCIO-ECONOMIC ENVIRONMENTS

The knowledge scores from Table 5.1 were re-arranged according to the three socio-economic classes and summarised in Table 5.2.

The average percentages of knowledge scores for the three socio-economic classes were as follows:

- Higher class: 72.8% with a 95% confidence interval 62.8% - 76.9%
- Middle class: 66.0% with a 95% confidence interval 61.2% - 70.5%
- Lower class: 74.0% with a 95% confidence interval 69.5% - 78.1%.

The average percentage of knowledge scores for the middle socio-economic class (66.0%) was significantly lower than the percentage for the lower class (74.0%, $p=0.017$).

One possible reason why general practitioners practising in the middle socio-economic class scored lower than dentists from the upper and lower socio-economic classes may be less demand for interceptive orthodontic treatment from patients from a middle-income environment.

Patients in the higher socio-economic class (and their parents) were more knowledgeable and educated on the need for and benefits of interceptive treatments during the growth period of the patients. These parents were more demanding and wanted their children’s treatment to

prevent the need for unsightly fixed braces later. They also wanted to prevent lengthy treatment times and the inevitable pain accompanying orthodontic treatment.

The lower socio-economic class usually does not have access to medical aid or funds to put toward expensive dental treatments such as fixed orthodontic treatment. Orthodontic treatment at a public clinic is usually a dim possibility with lengthy waiting lists and prolonged waiting periods. These patients usually only get considered for treatment when they are already adults or have suffered with a functional issue due to malocclusion for many years. As functional and aesthetic issues are a big problem for these patients with no access to fixed orthodontics, interceptive treatment can indeed improve aesthetics and function and be of great benefit to them. Dentists practising in the lower-income class are under pressure to perform interceptive orthodontic treatments and need to keep their knowledge updated in order to provide a much-needed service to these patients. Hence, this might be a possible reason why they obtained the best knowledge score according to this study.

It is possible that patients from the middle-income group usually have access to medical aid but are not clued up on the benefits of interceptive treatment. Hence, these patients usually ask for fixed orthodontic treatment. These dentists are under no pressure to perform interceptive treatments and thus have little need for these treatments in their practices. As a result, they achieved lower knowledge scores on IOT.

Various studies confirmed the findings from this study, namely that there is a bigger need for orthodontic treatment among patients from the lower socio-economic group because these children believe that if their malocclusion can be corrected, it can improve their quality of life and solve other problems as well. This puts more pressure on the practicing dentists to perform treatments early. The higher socio-economic class is more shielded from the effects of malocclusion as their socio-economic status protects them from this (Agou *et al.*, 2011; Benson *et al.*, 2014). Another study also confirmed that socio-economic status plays an important role in the performance of orthodontic treatment. However, they found that parents from the higher socio-economic groups readily seek fixed orthodontic treatment for their children compared to the lower socio-economic group. The study attributed this fact to a higher education and higher need for social acceptance. This is in contrast to the findings of this study (Krey and Hirsch, 2011).

6.4 THE DENTISTS' YEARS OF EXPERIENCE IN PRACTICE

The knowledge scores from Table 5.1 were re-ranged according to the four time intervals of experience and summarised in Table 5.3.

The average percentages of knowledge scores for the four periods of experience were as follows:

- 1 – 5 years of experience: 70.3% with a 95% confidence interval 64.9% - 75.2%
- 6 – 10 years of experience: 73.7% with a 95% confidence interval 68.4% - 78.3%

- 11 – 15 years of experience: 64.3% with a 95% confidence interval 58.8% - 69.5%
- 16 – 20 years of experience: 75.3% with a 95% confidence interval 70.2% - 79.9%.

The average percentage of knowledge scores for 11-15 years of experience (64.3%) was significantly lower than the percentage for 16-20 years of experience (p=75.3%, p=0.004).

The possibility exists that the undergraduate curriculum was changed with less focus on IOT during the period in which the dentists with 11 to 15 years of experience underwent their undergraduate training. The error may have been noted and the curriculum adapted to shift part of the focus back to interceptive orthodontics treatment. Furthermore, it is possible that the group with 16-20 years of experience, had done extra training or courses as they scored the highest across the 4 groups (75.3%).

Of those who felt their knowledge of orthodontics was poor, 28% felt it was due to a lack of clinical practice or experience (Borrie *et al.*, 2014). This is supported by another study where final-year students felt they did not have enough experience to implement orthodontic treatment when they entered practice the following year (Jauhar *et al.*, 2016). Here, 56% of the group felt they needed more exposure and experience to perform fixed orthodontic treatment while 41% wanted more exposure to removable appliances (Jauhar *et al.*, 2016). This is in contrast with the current study, which suggested that those practitioners with the least amount of experience had more knowledge on the topic than those with 11 to 15 years of experience in general dental practices.

6.5 CONFIDENCE OF SELF-EFFICACY

The analysis revealed that in 66.7% of the responses, the dentists indicated that they were very confident. In 33.3% of the responses the dentists indicated that they were not confident or they were unsure. This was probably the most important reason why they did not implement IOT as part of their normal scope of practice.

People who are not confident in their ability to perform a task will naturally try to avoid the task at hand. A third of the dentists interviewed did not feel they can effectively perform IOT for the given paper patients (scenarios). Hence, they avoided implementing treatment and rather referred the patients to an orthodontist or did not treat at all.

This study found the lack of confidence of self-efficacy to be a major reason why general practitioners were reluctant to implement IOT in their practices. This correlates with the findings from other studies that also reported on practitioners' lack of confidence to implement IO (Borrie *et al.*, 2014).

6.6 ATTITUDE

The analysis revealed that in 93.1% of the responses the dentists expressed a positive attitude towards the implementation of IOT as part of their normal scope of practice. In 6.9% of the responses the dentists expressed a negative attitude.

The first attitude question asked the participants whether they would have treated any of the paper patient cases in their practice. Of the 24 participants, 19 general practitioners answered yes while only five answered no during the interview. The respondents had to then provide a reason to why they answered yes/no.

Reasons for answering yes included the following: it will be easy treatments to execute (42%), it will be quick treatments to execute (21%), they had the skill set to perform the treatment (13%), and IOT should be done by a general dentist and not by a specialist (4%).

Reasons for answering no included the following: they were not confident to perform orthodontic treatment (4%), they felt that they lacked knowledge (4%) or they had no interest in orthodontics (13%).

The dentists' responses to the first question showed that the main reason why they would perform IOT in their practices is that they felt the treatment would be quick and easy. The main reason why the participants decided not to apply IOT treatment was due to their lack of interest in the orthodontic field.

The second attitude question asked to the participants whether they considered it important to carry out IOT in a general dental practice. All 24 participants answered yes to this question.

Reasons given included: it reduced the amount of complex treatment needed at a later stage (38%), it prevented future orthodontic problems (33%), it prevented referral of patients out of the practice (17%), it reduced the financial burden on the patients with regard to future treatment (8%), and it kept patients and parents happy by resolving the problems now (4%).

It is shown through the follow-up answers to the question that the main reasons that they feel IOT is important is that IOT reduces the amount of complex treatment needed at a later stage and that IOT prevents future orthodontic problems.

The third attitude question asked the general practitioners whether they thought the patients would be worse off if no IOT was done. All 24 participants answered yes to this question.

Reasons given included the following: fixed orthodontic treatment at a later stage is expensive and more complex (25%) and orthodontic problems deteriorate with age (75%).

The study concluded that the attitude of the general practitioners was favourable. Another study concurred with the evidence from the current study (Borrie *et al.*, 2014). Yet another study found that practitioners who implement orthodontic treatment at their practices have a better attitude and interest toward the subject compared to those who do not implement the discipline in their practices (Jayaprakash *et al.*, 2019).

6.7 OTHER FACTORS

This study also assessed other factors that influence the decision to implement or not implement IOT. The general practitioners who were interviewed had a chance to answer questions and add their own opinions.

The first question raised was whether they had a keen interest in orthodontics. Half the dentists answered yes; the other half were not particularly interested in the field.

The reasons why they were indeed interested in orthodontics included the following: They loved working with children (17%), they had success with past treatments and the results were life-changing for the patients (13%), it kept patients in the practice (4%), it was an interesting field (17%), and they liked all fields of dentistry (4%).

The reasons why they had no interest in orthodontics included the following: They felt that it was difficult to understand the field (21%), it was time-consuming (8%), they did not like orthodontics (8%), or they did not like children (8%).

In term of interest in orthodontics, half of the participants had a keen interest in the field while the other half did not. Previous studies suggested that a smaller percentage of general practitioners have a keen interest in orthodontics and would like to undergo specialist training. These general practitioners felt they would benefit more by undergoing training for short-term orthodontic treatment options like Invisalign or Six Month Smiles rather than further training on IOT (Jauhar *et al.*, 2016).

The second question posed to the participants was whether the money paid by medical aids affected their decision to perform IOT in the practice. In total, 15 out of the 24 said yes, money did indeed impact their decision while nine said no; it did not influence their decision to apply IOT.

The reasons for answering yes to the monetary rewards associated with IOT included the following: time is money (25%) and medical aids pay poorly for orthodontics done in general practices (33%).

Those that said the monetary rewards did not influence their decision to apply IOT offered the following reasons: if it benefits the patient, they will perform treatment despite monetary remuneration (4%), the parents need to pay privately for these types of treatment (8%), they did not in any way perform orthodontic treatment in their practices (17%), and they worked in the public sector (13%).

The main reasons why the money paid by the medical aids influenced their choice to treat were that medical aids pay poorly for treatment done in general practices. Where money did not bother the practitioners, the main reason was that they did not perform interceptive treatments in their practices in any case.

Based on this study, money played a role in the non-implementation of IO. This confirms the findings of other studies that found that financial income played a significant role in the long-

term plans of newly qualified dentists and the types of clinical work on which they chose to focus (Gallagher *et al.*, 2009; Brocklehurst *et al.*, 2013).

The third question posed to the participants was whether the infrastructure of their practices supported the implementation of IO. In total, 15 participants answered yes while nine said no.

Those that said yes cited the following reason: they had the support of good laboratory services, tools and radiographic machines to treat interceptive orthodontic cases (63%).

Those that said yes cited the following reasons: their practices did not have the infrastructure to support IOT and not did they have proper equipment to implement IOT (27%).

Therefore, the practitioners felt that they would more readily implement IOT given the right infrastructure and support.

Lastly, the participants were given the opportunity to state any other reasons why they did or did not implement IO in their practices. The following reasons were provided: Monetary remuneration (8%), patient fatigue (4%), patient compliance (17%), patient finances (4%), the dental IQ of the patients (8%), the availability of specialists in the practitioner's area (4%), a colleague that is already treating such cases in the practice (4%), most patients requiring fixed braces in any way (4%), the long period of time over which income is generated (8%), only willing to treat easy cases (4%), no interest in the field (4%) and lack of knowledge (4%). Six general practitioners did not add any comments at the end of the interview (25%).

Based on this study, the main other reason why the general practitioners did not implement interceptive orthodontic services was patient compliance.

Some studies noted that patient compliance influenced orthodontic treatment and that the main reason that patients terminated treatment was the lack of motivation (Brattström *et al.*, 1991). In this study, patient compliance also influenced the willingness to implement orthodontic treatment. Another study stated that socio-emotional matters influenced patient compliance significantly (Müssig *et al.*, 2008).

6.8 CONCLUSION

This chapter summarised the reasons cited by the 24 general dental practitioners as to why they were willing, or not, to offer interceptive orthodontic treatment to patients. Their ability to offer IOT were impacted by, among others, knowledge of IOT, affordability of the treatment, their confidence of self-efficacy and their attitude towards interceptive orthodontics.

The conclusions that can be drawn from this will be discussed in the following chapter.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

Feedback from the 24 general dental practitioners on their willingness to use interceptive orthodontic treatment provided insight into the range of reasons for their decisions. Going forward, what can be learned from these insights?

7.2 CONCLUSIONS

The following conclusions can be drawn from the present study:

- General dental practitioners do not implement IO as a routine treatment in their practices for various reasons.
- The 24 general dental practitioners from the metropolitan area of Tshwane had good knowledge about the need for orthodontic treatment. Also, the average knowledge scores of the dentists in the public and private sectors did not differ significantly.
- The average percentage knowledge score for the dentists practising in the middle socio-economic class was significantly lower than the percentage for those practising in the higher and lower socio-economic classes.
- The average percentage knowledge score for the dentists with 11 to 15 years of experience was significantly lower than the percentage for those with 16 to 20 years of experience.
- Confidence of self-efficacy indicated that a third of the dentists were not confident or were unsure about their ability to implement IO in their practices. This is probably the main reason these dentists did not routinely implement IO as part of their normal scope of practice.
- The majority of dentists have a good attitude towards the implementation of IOT.
- Half of the dentists had a keen interest in orthodontics.
- Most of the dentists felt that the monetary amount paid by medical aids for orthodontic treatment played a role in their decision to implement IOT.
- Patient compliance with orthodontic treatment was another factor that influenced the dentists' decision whether to offer interceptive orthodontics or not.

7.3 RECOMMENDATIONS

The following recommendations are made based on the results of the study:

- A larger sample size is recommended as the sample size was small.
- A greater geographical area in South Africa is suggested for follow-up studies in order to obtain a sample that represents the views of dentists in South Africa and not only the views of dentists in Tshwane.
- Investigate the potential of short-term orthodontic training courses for general dental practitioners to increase the uptake of IOT services at their practices.



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APPENDIX 1: ETHICS APPROVAL



OFFICE OF THE DIRECTOR: RESEARCH
RESEARCH AND INNOVATION DIVISION

Private Bag X17, Bellville 7535
South Africa
T: +27 21 959 4111/2948
F: +27 21 959 3170
E: research-ethics@uwc.ac.za
www.uwc.ac.za

14 October 2019

Dr L Joubert
Faculty of Dentistry

Ethics Reference Number: BM19/4/2

Project Title: Factors influencing the implementation of interceptive orthodontic treatment at the level of the general dentist: 24 case studies of the metropolitan area of Tswane, South Africa.

Approval Period: 17 May 2019 – 17 May 2020

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

A handwritten signature in black ink, appearing to read 'Josias'.

*Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape*

BMREC REGISTRATION NUMBER -130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE.



APPENDIX 2: INFORMATION SHEET

FACULTY OF DENTISTRY

Private Bag X1 Tygerberg 7505
TEL: +27 21 937 3105/6/3030 * FAX: +27 21 931 2287
www.uwc.ac.za

Date: March 2019

INFORMATION SHEET TO PARTICIPATE IN A RESEARCH PROJECT

Project Title: Factors influencing the implementation of interceptive orthodontic treatment at the level of the general dentist: 24 case studies from the metropolitan area of Tshwane, South Africa.

Dear participant,

This is a research project being conducted by me, Dr Leorika Joubert, at the University of the Western Cape. I am inviting you to participate in this research project because you as you are a general dentist practicing in South Africa. The purpose of this research project is to determine what influences the decision of general dentist to perform interceptive orthodontics in their practices or to rather refer the patient to an orthodontist.

What will I be asked to do if I agree to participate?

You will be asked to:

- Participate in a 30-minute one-on-one interview at your workplace or a public location and answer questions based on the treatment plan option(s) for 5 orthodontic paper patient cases.
- Answer questions on your thoughts regarding confidence of self-efficacy in implementing interceptive orthodontics on a personal level.
- Answer questions regarding your views on attitude and other factors towards the implementation of interceptive orthodontics on a personal level.

Would my participation in this study be kept confidential?

The researchers undertake to protect your identity and the nature of your contribution. To ensure your anonymity, we do not require any personal information or information on your practice. Your questionnaire will be identified via a numbering system; thus, your participation is completely anonymous. To protect your anonymity, the questionnaires will be stored online in a secure location.

APPENDIX 3: CONSENT FORM



FACULTY OF DENTISTRY

Private Bag X1 Tygerberg 7505
TEL: +27 21 937 3105/6/3030 * FAX: +27 21 931 2287
www.uwc.ac.za

CONSENT FORM TO PARTICIPATE IN RESEARCH

Title of Research Project: Factors influencing the implementation of interceptive orthodontic treatment at the level of the general dentist: 24 case studies from the metropolitan area of Tshwane, South Africa.

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve, and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone and that the answers given during my interview, will be kept confidential and will be stored online in a secure location. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name.....

Participant's signature.....

Date.....

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

APPENDIX 4: QUESTIONNAIRE

Date _____

Interview no _____

Section A:

Paper patient 1

During a routine dental check-up of a 9-year-old patient you notice an anterior crossbite of the 12 and 42. The patient and her parents are unaware of the crossbite.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		
2. Plan and perform treatment self?		
3. Refer to a specialist for treatment?		
4. Treat with functional appliance?		
5. Treat with removable appliance?		
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment)?		
8. Restore carious teeth?		
9. Extract primary or permanent teeth?		
10. Check for mobility of the primary tooth?		

Paper patient 2

A 10-year-old scholar presents to you with an increased overjet and class II molar relationship. He is also complaining of cold sensitivity on the mesial aspect of all the first primary molars.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		
2. Plan and perform treatment self?		
3. Refer to a specialist for treatment?		
4. Treat with functional appliance?		
5. Treat with removable appliance?		
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment)?		
8. Restore carious teeth?		
9. Extract primary or permanent teeth?		
10. Check for mobility of the primary tooth?		

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Paper patient 3

A 10-year-old patient presents to the practice with an anterior open bite and a thumb sucking habit.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		
2. Plan and perform treatment self?		
3. Refer to a specialist for treatment?		
4. Treat with functional appliance?		
5. Treat with removable appliance?		
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment)?		
8. Restore carious teeth?		
9. Extract primary or permanent teeth?		
10. Check for mobility of the primary tooth?		



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Paper patient 4

A 13-year-old girl presents to the practice with the 75 still present and not mobile. The 35 is unerupted and the 45 fully erupted. The 75 is not mobile and is in infra-occlusion.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		
2. Plan and perform treatment self?		
3. Refer to a specialist for treatment?		
4. Treat with functional appliance?		
5. Treat with removable appliance?		
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment)?		
8. Restore carious teeth?		
9. Extract primary or permanent teeth?		
10. Check for mobility of the primary tooth?		



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Paper patient 5

A 10-year-old girl presents with early loss of the second upper primary molar on the right-hand side. No space maintenance was done for the child.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		
2. Plan and perform treatment self?		
3. Refer to a specialist for treatment?		
4. Treat with functional appliance?		
5. Treat with removable appliance?		
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment) ?		
8. Restore carious teeth?		
9. Extract primary or permanent teeth?		
10. Check for mobility of the primary tooth?		



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Section B: Thinking of all the paper patient cases, please answer the following:

Factor	Question			
		Not confident	Unsure	Very confident
Confidence of self-efficacy	How confident are you that you have designed the correct treatment plan for the patients?			
	How confident are you that you can carry out the treatment plan for the patients?			
	How confident are you that the chosen treatment option(s) is the correct one?			
	How confident are you that your undergraduate training is sufficient?			
		Yes	No	Why?
Attitude	Would you have treated any of the paper patient cases in your practice?			
	Would you consider it important to carry out IOT in the general dental practice?			
	Do you think the patients will be worse off if no IOT is done?			
		Yes	No	Why?
Other	Do you have a keen interest in orthodontics?			
	Does the monetary amount paid by medical aids affect your decision to perform IOT?			
	Does the practice's infrastructure support the implementation of interceptive orthodontics?			
	Is there any other concerns or reasons that influence your choice to perform IOT in your practice?	Please specify:		

APPENDIX 5: ANSWER SHEET FOR PAPER PATIENTS

Paper patient 1

During a routine dental check-up of a 9-year-old patient you notice an anterior crossbite of the 12 and 42. The patient and her parents are unaware of the crossbite.

Would you:

	<u>Y</u>	<u>N</u>
1. Do nothing, but follow up to monitor the malocclusion?		X
2. Plan and perform treatment self?	X	
3. Refer to a specialist for treatment?		X
4. Treat with functional appliance?		X
5. Treat with removable appliance?	X	
6. Treat with fixed appliance?		X
7. Place a space maintainer (preventative treatment)?		X
8. Restore carious teeth?		X
9. Extract primary or permanent teeth?		X
10. Check for mobility of the primary tooth?		X

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Paper patient 2

A 10-year-old scholar presents to you with an increased overjet and class II molar relationship. He is also complaining of complaining of cold sensitivity on the mesial aspect of all the primary first molars.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		X
2. Plan and perform treatment self?		X
3. Refer to a specialist for treatment?	X	
4. Treat with functional appliance?		X
5. Treat with removable appliance?		X
6. Treat with fixed appliance?	X	
7. Place a space maintainer (preventative treatment)?		X
8. Restore carious teeth?	X	
9. Extract primary or permanent teeth?		X
10. Check for mobility of the primary tooth?		X

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Paper patient 3

A 10-year-old patient presents to the practice with an anterior open bite and a thumb sucking habit.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		X
2. Plan and perform treatment self?	X	
3. Refer to a specialist for treatment?		X
4. Treat with functional appliance?		X
5. Treat with removable appliance?		X
6. Treat with fixed appliance?	X	
7. Place a space maintainer (preventative treatment)?		X
8. Restore carious teeth?		X
9. Extract primary or permanent teeth?		X
10. Check for mobility of the primary tooth?		X



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Paper patient 4

A 13-year-old girl presents to the practice with the 75 still present and not mobile. The 35 is unerupted and the 45 fully erupted. The 75 is not mobile and is in infra-occlusion.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		X
2. Plan and perform treatment self?	X	
3. Refer to a specialist for treatment?		X
4. Treat with functional appliance?		X
5. Treat with removable appliance?		X
6. Treat with fixed appliance?		X
7. Place a space maintainer (preventative treatment)?	X	
8. Restore carious teeth?		X
9. Extract primary or permanent teeth?	X	
10. Check for mobility of the primary tooth?	X	

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Paper patient 5

A 10-year-old girl presents with early loss of the second upper primary molar on the right-hand side. No space maintenance was done for the child.

Would you:

	Y	N
1. Do nothing, but follow up to monitor the malocclusion?		X
2. Plan and perform treatment self?	X	
3. Refer to a specialist for treatment?		X
4. Treat with functional appliance?		X
5. Treat with removable appliance?	X	
6. Treat with fixed appliance?		
7. Place a space maintainer (preventative treatment)?	X	
8. Restore carious teeth?		X
9. Extract primary or permanent teeth?		X
10. Check for mobility of the primary tooth?		X

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