

# **Clear Aligner Usage by Orthodontists and General Dentists in South Africa**

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# Declaration

By submitting this thesis, I declare that the entirety of the work contained therein is my own original work, that I have sole authorship thereof (unless otherwise explicitly stated) and that I have not previously, in its entirety nor in part, submitted it for obtaining any qualification.



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Signature of student

Date

## Keywords

Clear Aligners

South African Orthodontist

General Dentist

Fixed Appliance Therapy

Spark

Invisalign

## Abstract

**Background:** Clear aligner therapy (CAT) is an aesthetic appliance considered to be an alternative to conventional fixed orthodontics. Clear aligners are a sequence of preformed thermoplastic splints used by patients which are serially changed as the treatment is planned to move teeth in three dimensions. The usage of clear aligners has increased in recent times and the clinical practices of aligner users have been investigated in Australia, Britain and North America (Meade & Weir, 2022; Meade et al., 2023; Abu-Arquub et al., 2023). However, currently there are no published studies on clear aligner usage in the South African population.

**Aim:** To describe the use of CAT by general dentists and specialist orthodontists in a South African sample.

**Methodology:** A web-based survey was developed for orthodontists and general dentists to respond. The survey was adapted from a validated tool published by Meade et al. (2023). The questionnaire was distributed to members of the South African Society of Orthodontists and the South African Dental Association via the Research Electronic Data Capture (REDCap) platform. The required sample size was 101 respondents.

**Results:** The response rate achieved was 56,83 %. The prevalence of CAT usage among the surveyed respondents was 32.7%, with specialist orthodontists exhibiting a significantly higher likelihood of utilizing this treatment modality compared to general dentists, as evidenced by an odds ratio of 7.7 (95% confidence interval: 2.99 to 19.6;  $p < 0.001$ ). Among the participants, Spark Clear Aligners® (Ormco Corporation, Orange, CA, USA) emerged as the preferred CAT system, chosen by 44.1% of respondents. Notably, the quality of digital treatment planning was identified as the most influential factor in the selection of a particular CAT brand, while case suitability and complexity played critical roles in the decision to offer CAT to patients. Respondents indicated a greater inclination to treat adult patients using CAT and a significant majority expressed comfort in managing mild crowding cases using CAT, although they reported less confidence in addressing severely crowded cases with aligners. Furthermore, a substantial portion of clinicians (56%) indicated that premolar extractions were not considered suitable adjuncts to aligner therapy, stating they never combined these treatments. Opinions regarding aligner change protocols were divided, with 47% favouring a weekly schedule and 50% opting for a fortnightly approach. Additionally, most clinicians reported that fixed appliance therapy (FAT) yielded better treatment outcomes compared to CAT. In terms of retention appliances, a thermoplastic retainer was favoured by 56% of respondents for the

maxilla, while preferences for the mandible were evenly split between thermoplastic (35%) and bonded retainers (35%). The predominant barrier to the adoption of CAT, identified by 67% of clinicians who did not utilize this treatment modality, was patient compliance.

**Conclusion:** CAT practices were somewhat aligned amongst clinicians and the prevalence of CAT usage showed that it is not as widely adopted when compared to international literature.

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## List of Abbreviations

CAT: Clear Aligner Therapy

FAT: Fixed Appliance Therapy

BOS: British Orthodontics Society

ABO: American Board of Orthodontics

AAO: American Association of Orthodontists

SASO: South African Society of Orthodontists

SADA: South African Dental Association

CAD/CAM: Computer assisted design/ Computer assisted manufacturing

DTP: Digital Treatment Plan

DTC: Direct to Consumer

IPR: Interproximal Reduction

ABO-OGS: American Board of Orthodontics Objective Grading System

PAR: Peer Assessment Rating

AOB: Anterior Open Bite

ERR: External Root Resorption

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## 1. Introduction

Clear aligner therapy (CAT) is a constantly evolving treatment modality that is considered to be an alternative to conventional fixed orthodontics. Its popularity has grown amongst adult patients coveting the perfect smile. When introduced in 1999, Invisalign (Align Technology, San Jose, Calif) revolutionized aesthetic orthodontics. CAT is a sequence of preformed thermoplastic splints used by patients which are serially changed as the treatment is designed to move teeth in the three planes of space. (Abu-Arqub et al., 2023).

The history of CAT dates back to the 20th century. Remensnyder's "Flex-O-Tite" appliance served as the starting point and in 1945, Kesling built on it by developing a rubberised positioning appliance. This appliance put forth the idea of utilizing them in succession in order to achieve incremental movements of specific teeth. The first transparent thermoplastic appliance capable of moving teeth orthodontically appeared in the 1960's (Nahoum, 1964). Subsequently, in the early 1970's, Ponitz designed the first "invisible retainer" based on this concept, which was improved on by McNamara in the 1980's. Later in 1993, Sheridan came up with a comparable appliance, the Essix retainer.

The aligners' design and production were manually planned and carried out using time-consuming techniques such successive wax set-ups (Barone et al., 2016). The main drawback of these manually fabricated methods was that they could only produce a tiny subset of aligners, thus preventing them from being used for comprehensive orthodontic treatments. Rapid prototyping and CAD/CAM methods have recently made it possible to plan and manufacture clear thermoplastic aligners using an industrial approach (Martorelli et al., 2013).

In 1999, Align Technology (Align Technology Inc., CA) was established with the goal of modernizing the orthodontic treatment process through the use of CAD/CAM technology. The company secured venture capital to develop a series of incremental cast modifications for the fabrication of clear aligners, branded as Invisalign®. This innovation allowed for the management of more complex orthodontic cases through meticulous planning and the implementation of a greater number of aligners. Initially, clear aligners were primarily designed for adult patients and late adolescents, as this demographic exhibited a significant preference for orthodontic appliances that were either invisible or minimally visible (Proffit et al., 2018).

With the early implementation of Invisalign® treatment, challenges arose related to the staging of treatment, optimal rates of tooth movement and the criteria for using attachments on the

teeth. The initial professional acceptance of this modality was limited. However, as the technique developed, clinical evaluations identified effective treatment sequences and appropriate tooth movement increments. The incorporation of tooth-coloured attachments enhanced the aligners' grip on the teeth, facilitating movement. According to Gu et al. (2017), even complex malocclusions can now be effectively treated with Invisalign® and current practices have shown success in addressing moderate to extremely complex malocclusions. Notable advantages over traditional fixed orthodontic appliances include enhanced aesthetics, improved oral hygiene, reduced discomfort, decreased treatment duration and increased convenience (Proffit et al., 2018).

Meier et al. (2003) identified aesthetics as the primary concern for patients opting for CAT. Additional advantages include the removability of aligners during meals, improved oral hygiene through easier brushing and flossing, and the absence of metal components that may irritate oral tissues. Crosby and Lee (2009) noted that the complexity of pre-treatment cases influences the total number of appointments, refinement percentages and the necessity for fixed appliances. The success of clear aligners has led to the development of auxiliaries, such as “power ridges”, “bite ramps”, “precision cuts” and elastics, which enhance the treatment of more severe malocclusions (Tamer et al., 2019). Currently, clear aligners are suitable for various malocclusions, which include moderate crowding, distalization, deep overbite, narrow arches, rotations and space management (Papadimitriou et al., 2018). With the expiration of patents, competing companies are introducing clear aligners that build upon existing techniques, while orthodontists are increasingly utilizing digital models and 3D printing technologies to produce aligners in-house (Chen et al., 2017).

Although CAT is a relatively new modality when compared traditional fixed appliance, there has been an increase in the amount of literature published on the topic. Besides biomechanical and materials-based studies internationally, there has been a rise in studies of clinicians' aligner practices. Aligner-based research in the South African setting is currently non-existent. The purpose of this study was to investigate CAT practices by South African dental clinicians.

## 2. Literature Review

The commercial market for clear aligners worldwide was worth \$5.2 billion in 2022 (Grandview Research, 2022). According to Align, in 2020, the use of Invisalign® increased by over 30% in both by adults and teenagers (Grandview Research 2022). The Covid pandemic saw the largest adoption of aligners among patients who were teens or younger. According to Grandview Research (2022), the adults market category had the biggest market share in 2022 with 61.2%. Data about Invisalign®, in accordance with the Align Company Fact sheet of 2015, as stated by Wier (2017) is as follows: Worldwide, there were 3.2 million Invisalign® cases supplied, 199 million aligners produced, 98 860 doctors who had received Invisalign® training, and 45 580 active Invisalign® practitioners (Weir, 2017). Hence the adoption of aligners is ever-growing and is becoming an important treatment modality available to orthodontic clinicians.

### 2.1 Prevalence and Case load

According to Meade and Weir (2022), most Australian orthodontists do an average of less than 50 cases a year with clear aligners, which makes up 24.17% ( $\pm$  21.35%) of their mean annual orthodontic treatment caseload. Meade et al. (2023) investigated the clear aligner practices among members of the British Orthodontic Society and found that more than 75% of the 233 respondents made use of clear aligners with the median percentage of yearly caseload treated with CAT to be 10%. According to Miranda e Paulo et al. (2024), Canadian orthodontists on average treat, 29.9% of their annual caseload with CAT, with most performing more than 50 CAT cases per annum. When assessing aligner practices among members of the American Association of Orthodontists, Abu-Arqub et al. (2023) reported that CAT was used by 65% of the respondents. Further analysis revealed that in 47% of the respondents, CAT was the treatment of choice in more than 20% of their cases.

Meade and Weir (2024) reported a greater percentage of Australian general dentists who perform orthodontic treatment, make use of CAT compared to specialist orthodontists. Of 174 general dentists who performed orthodontic treatment, 98.9% indicated that they used CAT. On the contrary, d'Apuzzo et al. (2019) reported that a greater percentage of orthodontists (83%) reported to use CAT as compared to general dentists (65%).

## 2.2 Preferred Aligner System

Invisalign® (1999) pioneered the use of clear thermoplastic materials, conjunction with modern CAD/CAM technology to fabricate orthodontic aligners. Since its inception, Invisalign® has been the most widely used system globally. However, the expiry of its commercial patent in 2017 has resulted several clear aligner systems being introduced (Bichu et al., 2023).

The major role players in the aligner market are displayed in Figure 1 (Hartshorne & Wertheimer, 2022).

Company	Aligner brand	Software	Key features
Align Technology (San Jose, Calif)*	Invisalign	ClinCheck	<ul style="list-style-type: none"> <li>• Global presence</li> <li>• Cloud-based treatment visualization</li> <li>• Global dental CAD/CAM software leader EXOCAD</li> <li>• Addresses simple and complex patients and posttreatment retention</li> <li>• SmartTrack material: yields constant subtle forces to improve tooth movement</li> <li>• SmartStage technology: programs sequential tooth movement to optimize treatment outcome predictability</li> <li>• SmartForce: customized attachments, biteramps, and power ridges</li> </ul>
Institute Straumann AG (Basel, Switzerland)	Clear Correct	Clear Pilot	<ul style="list-style-type: none"> <li>• Clear Pilot: digital treatment planning</li> <li>• ClearQuartz Trilayer high performance aligns the material to ensure consistent accurate pressure</li> <li>• Smooth flat trimline that extends past teeth for greater retention: 2.5 x more retentive than scalloped aligners</li> <li>• Improved comfort</li> <li>• Stain resistant</li> </ul>
Henry Schein (Melville, NY)†	Reveal		<ul style="list-style-type: none"> <li>• Web-based portal for simplified patient submission and treatment planning</li> <li>• ClearWear material</li> <li>• Precision fit, greater tooth contact reducing need for attachments</li> <li>• Accurate capture of interproximal contacts</li> <li>• Flexible and durable</li> <li>• Optimized trim for retention control</li> <li>• Uniquely clear and stain resistant</li> </ul>
Dentsply Sirona (York, Penn)	SureSmile	Open Software and Digital Lab	<ul style="list-style-type: none"> <li>• Esix high-performance material and effective tooth movement</li> <li>• Open Software and Digital Lab to customize treatment planning</li> <li>• 50% fewer refinements</li> <li>• Customize the design of the trimline (scalloped or straight)</li> </ul>
3M (3M ESPE, Maplewood, Minn)¶	Clarity Aligner Flex Clarity Aligner Force		<ul style="list-style-type: none"> <li>• Web-based portal allowing access to treatment planning</li> <li>• Open platform allows use of any leading intraoral scanner</li> <li>• Clarity Aligner Flex: flexible 5-layer material indicated for a wire sequencing approach</li> <li>• Recommended for rotation and proclination</li> <li>• Clarity Aligner force: rigid material, indicated for a sequential mechanics approach</li> <li>• Recommended for torque, expansion, torque, sequential intrusion, and bodily movement</li> </ul>
ORMCO Corp (Envista, Brea, Calif)‡	Spark	Approver	<ul style="list-style-type: none"> <li>• TruGEN and TruGEN Aligner material</li> <li>• Greater sustained force</li> <li>• Better contact surface retention</li> <li>• More control over predictable treatment planning</li> <li>• More efficient and effective tooth movement</li> <li>• Aligners are clearer, more comfortable, and stain resistant</li> <li>• Eruption guides, posterior bite turbos, bite ramps and anatomic bevel attachments</li> </ul>

Figure 1: Six major manufacturers in the worldwide CAT industry

The production of In-house or laboratory CAT appliances has been made possible through advancements in three dimensional treatment planning software with addition of intergrated intra-oral scanners and 3 dimensional printers (Weir, 2017). In-house aligners have been reported be used by 21.63% of Australian orthodontists (Meade & Weir, 2022); 2.9% of British orthodontists (Meade et al., 2023) and 36.88% of American orthodontists (Abu-Arquib et al., 2023).

More recently, the use of Direct-to-Consumer clear aligner therapy has increased substantially. This is offered by companies with technicians who take impression or scans on their behalf and the user receiving their new set of aligners via mail. This process eliminates the in-person dental supervision and monitoring, thereby allowing companies to decrease the cost compared to that of a similar in-office procedure (Wexler et al., 2020). This form of unsupervised 'DIY orthodontics' comes with inherent risks, such as potentially permanent and costly destruction to the dentition and supporting structures as well as occlusal changes , to mention a few (Behrents, 2014).

Questionnaire-based investigations into aligner practices have confirmed Invisalign® to be the most prescribed CAT system. Meade and Weir (2022) found the Invisalign® (Align Technology Inc) system are prescribed in 60.58% of cases with Spark Clear Aligners® (Ormco Corporation) being the second most prescribed system at 20.67%. This was congruent with the results of a cross-sectional online survey disseminated to members of the British Orthodontic Society in 2023, with the most frequently prescribed CAT system being Invisalign® at 81.2% trailed by Spark Clear Aligners® with 10.6% (Meade et al., 2023). Additionally, in study done by Abu-Arquib et al. (2023), Invisalign® was again found to be the most popular aligner brand amongst member of the American orthodontic association, prescribed by 81.25% of orthodontists. The use of aligner systems used by general dentists mirrored much the same trends, with 61.2 % of general dentists in Australia preferring Invisalign® and Clear Correct® (Straumann Holding) being preferred by almost 20% of respondents (Meade & Weir, 2024). It has been suggested that the popularity of Invisalign® may, in part, be due the manner in which it is being marketed using a Direct-to-consumer (DTC) marketing strategy (Kravitz and Bowman, 2016).

Most clinicians report to use more than one aligner brand in their practices. Weir and Mead (2022) reported that 63% of orthodontist use more than one CAT system. These findings are similar to those by Meade et al. (2023), Miranda e Paulo et al. (2024), and Meade and Weir (2024), who all reported that more than 50% of respondents made use of multiple CAT brands.

A variety of factors have been proposed as influencing the clinicians' decision to use a particular aligner company (Meade et al., 2023). The factors cited most included the ease of digital treatment planning, quality of digital treatment plan (Meade & Weir, 2022) and patient satisfaction (Meade & Weir, 2024); with the factors seen as least influential being brand identity and corporate advertising (Meade & Weir, 2022). Subsequently, Meade & Weir (2024) found 60% of respondents among British orthodontist reported that brand awareness among patients was a "moderate" or "major influence" on their decision to choose a particular clear aligner system, as opposed to one third of Australian respondents (Meade & Weir, 2022). "Cost of appliance" was also viewed as having minor to no influence over aligner brand choice (Meade et al., 2023).

### 2.3 Indications for CAT

According to Joffe (2003), the following types of cases are indicated for CAT:

1. Mildly crowding and malalignment (1mm to 5mm).
2. Treatment that can be performed with minor expansion, interproximal tooth reduction (IPR) or removal of a lower incisor.
3. Spacing issues between 1mm to 5mm.
4. Deep overbite which can be reduced by intrusion and advancement of incisors.
5. Narrow arches that can be expanded without excessive tipping.

### 2.4 Biomechanics and Mechanism of the Actions of CAT

The basic orthodontic principles of diagnosis, treatment planning, biomechanics and anchorage apply to moving teeth with clear aligners and fixed orthodontics. There may be many similarities to moving teeth with aligners and fixed appliances, but significant differences do also exist. It is these differences that would allow certain malocclusions to be treated efficiently with CAT (Graber et al., 2023). An essential difference between tooth movement with CAT compared to fixed appliances, is that CAT tends push on teeth, whereas fixed appliances use archwires to generally pull on teeth (Graber et al., 2023).

CAT involves small-scale tooth movement, which is accomplished by using a series of aligners or trays that move teeth incrementally over time (Upadhyay & Arqub, 2022). Shape moulding and auxiliary components are the two main mechanisms that facilitates this incremental movement. Shape moulding involves moulding the movement of specific teeth in accordance to the aligner contour used. This difference in shape between the aligner and the teeth creates a 3-dimensional force system which acts on all the areas that are in contact (Barone et al.,

2017). The purpose of auxiliaries, such as attachments and “power ridges”, is to improve specific movements of teeth as they target force delivery at specific areas on teeth (Upadhyay & Arqub, 2022).

Tooth movement occurs by the creation of an interaction between the stress created by the aligner and the periodontal ligament-bone complex (Li et al., 2021). The stress/ force level created by shape moulding will, theoretically, be less than that of attachments because the stress acts on a larger surface area when shape moulding is used (Simon et al., 2014). It should be noted that most of the movement that occurs with CAT, is as a result of shape moulding (Tamer, Oztas & Marsan, 2019).

Fixed appliance treatment is divided into three distinct stages based on the sequence of archwires as the treatment progresses (McLaughlin et al., 2001). The first stage of treatment is alignment, the second stage for levelling and space closure in the dental arches, with the final stage of treatment being detailing and finishing, in which the tip and torque of individual teeth and occlusal interdigitation is detailed to complete treatment. In clear aligner treatment, there is no need to progress through a series of archwires with increasing rigidity, because tooth movements may occur simultaneously in several planes of space (Buschang et al., 2014). A significant distinction between fixed appliance and clear aligner treatments is the sequence of correction: with fixed appliances, teeth are initially aligned before correcting the buccal occlusion, whereas clear aligner treatment reverses this process by first addressing the buccal occlusion and then aligning the anterior teeth (Graber et al., 2023).

Clear aligners offer a notable advantage in managing the vertical dimension, allowing for precise control of tooth proclination. Clinicians have the option to restrict the proclination of teeth as part of the planned tooth movements (Graber et al., 2023). Additionally, clear aligners tend to reduce the likelihood of "round-tripping" of teeth, which occurs when teeth revert to their original position (Graber et al., 2023). In fixed appliance systems, all teeth are interconnected through an archwire, causing reciprocal effects on the entire arch when individual teeth are moved. In contrast, clear aligners can facilitate the movement of specific teeth while keeping others stationary during different stages of treatment (Samoto & Vlaskalic, 2014).

## 2.5 Effects of CAT

### 2.5.1 Aesthetics

A key advantage of clear aligner therapy is its superior aesthetics, which results in greater patient acceptance and an overall increased quality of life (Fujiyama et al., 2014). Several authors have tested the perception of aesthetics of clear aligner with the use of tools such as eye-tracking technology to measure eye movement and gaze direction (Maranon-Vasquez et al., 2021; Thai et al., 2020). One such author was Thai et al. (2020), who found that eye-tracking data indicated that subjects tended to spend the least amount of time on the photographs of the minimal attachments, followed by those of the ceramic brackets, posterior attachments, and finally anterior attachments. There was an overall preference for CAT with minimal attachments and ceramic brackets over aligners with several attachments. When comparing CAT, CAT with attachments, lingual appliances, ceramic brackets, with no appliance as the control, Försch et al. (2020) reported that all the appliances, except the lingual appliance, resulted in an increased fixation on the mouth area, leading to the conclusion that only lingual braces did not affect the appearance and perception of the face.

Maranon-Vasquez et al. (2021) evaluated the factors influencing patients' and orthodontists' preferences for various orthodontic appliances. Participants were presented with a chart with images of different orthodontic appliances. These appliances included CAT, lingual and buccal metallic brackets and ceramic brackets. The participants were asked to rate these appliances in terms of preference. The results showed that both the patient and orthodontist groups, clear aligners ranked the highest in terms of aesthetics (Marañón-Vásquez et al., 2021).

### 2.5.2 Root Resorption

External root resorption (ERR) refers to the progressive inflammatory response that may be encountered in orthodontic treatment with complicated causes (Fang et al., 2019). It is an unwanted and unavoidable consequence of orthodontic tooth movement (Gandhi et al., 2021), the severity of which could lead to the treatment being compromised. As result of the mechanical difference between CAT and fixed appliance therapy (FAT), it is expected that differences exist between the amount of root resorption of these two treatment modalities (Fang, Qi & Liu, 2019).

Yi et al., (2018) postulated that the differences in severity and prevalence of ERR between CAT and FAT was the result of:

- i) The forces acting on teeth during aligner therapy are intermittent rather than continuous in FAT, as a result of aligners being removed when eating or during hygiene practices.
- ii) Different levels of moments and forces are generated by FAT and CAT.
- iii) The transmission of forces by FAT to the dentition usually act through the centre of the clinical crown whereas in CAT, the force acts directly by the aligner or via its attachment .

Brandon (2010) compared the frequency and severity of ERR between patients who underwent fixed orthodontic appliances therapy with those who used CAT (Invisalign®). The study focused on the incisors and canines in both the dental arches. The findings revealed that no ERR was found in Invisalign® group. However, in the group of patients who received conventional fixed orthodontics, 2% to 50% of the teeth displayed evidence of ERR, with the maxillary lateral incisors showing a 2.2% incidence of severe resorption (Brandon 2010).

A systematic review by Elhaddaoui et al. (2017) reported the incidence of ERR with CAT to be between 0 and 46%, of which 6% were severe. In patients who underwent fixed non-extraction treatments to treat similar malocclusions, the incidence of ERR was between 2% and 50%, with 22% considered to be severe. These findings are similar to those reported by Fang et al. (2019), who found that the incidence and severity ERR was significantly less with CAT compared with fixed orthodontic appliances therapy. This was especially true for the maxillary incisor region. With regards to the of severity of resorption that occurs in CAT, Krieger et al. (2013) found the reduction of root length to be as follows: >0% to 10% in 27.75% of teeth (mild resorption), >10% to 20% in 12% (moderate resorption) and severe resorption (>20% reduction) in 6.3% of teeth.

### 2.5.3 Pain

Pain is a subjective response and pain complaints are common during orthodontic treatment (Kazancı, Aydoğan & Alkan, 2016). Pain directly influences patients' satisfaction and is a major reason for patients discontinuing orthodontic treatment (Al-Omiri & Abu Alhaija, 2006). Pain is reported to be greatest 24-hours after insertion and decreases to a negligible level after 7 days. Studies regarding pain levels with CAT compared to fixed appliances have found mixed results (Cardoso et al., 2020).

Flores-Mi et al. (2018) compared quality of life and patient satisfaction after treatment with CAT and conventional fixed appliances with the use of a validated questionnaire. They found

that in terms of eating and chewing, the CAT group reported greater levels of satisfaction (Flores-Mir, Brandelli & Pacheco-Pereira, 2018). The perception of pain and oral quality of life between CAT and FAT was highlighted by Gao et al. (2021), who found significantly higher pain levels in FAT patients on day 1, 2, 4, and 5 days after treatment. The increased pain with regards to fixed appliances could be related to the contact of the bracket's edges with soft tissue, thus leading to irritation which induces pain. In contrast, the edges of aligners are located higher up and are less bulky, which reduces mucosal irritation and pain. Additionally, forces produced by FAT may differ between clinicians and patients when compared with the more exact and suitable forces produced by CAT (Gao et al., 2021).

Cardoso et al. (2020) reported on variance in pain levels when comparing CAT with FAT in a systematic review. Seven publications were included in the study, two of which provided strong evidence, three provided moderate evidence and two provided weak evidence of pain variance. During the first few days of therapy, pain levels in individuals receiving CAT were reportedly lower than for those for whom conventional orthodontic appliances therapy was used. However, differences in the pain levels between the 2 appliances vanished after 3 months (Cardoso et al., 2020).

#### 2.5.4 Periodontal Effects and Oral Hygiene Practices

Orthodontic treatment can have a direct or indirect effect on the periodontal status of a patient. In patients wearing fixed appliances, there is a correlation between increased plaque indices and deteriorating general oral health conditions (Rossini et al., 2015a). On the contrary, CAT offers better plaque control and an improvement in oral hygiene practices, which is most likely to be due to the removable nature of CAT (Miller et al., 2007). Additionally, CAT lends itself to the reduction in the incidence of white spot lesions, as supported by Buschang et al. (2019). Only 1.2% of the aligner patients developed white spot lesions when compared with 26% of the patients treated with fixed appliances, which was attributed to by better oral hygiene practices or due to a shorter treatment time with CAT (Buschang et al., 2019).

Karkenechi et al. (2013) compared the periodontal status of adults treated with FAT and CAT over one year of active therapy. It was reported that after 6 months, the FAT group had a significantly greater mean plaque index, gingival index and probing pocket depth scores compared to the CAT group. The fixed orthodontic group were also more than 5 times more likely to have a higher BANA score. The BANA score is a chairside in-vitro test for subgingival plaque, which can detect 3 major anaerobic bacteria responsible for periodontal disease (Karkhanechi et al., 2013).

## 2.6 Treatment Duration and Efficiency

When assessing treatment modalities, an important consideration is that of efficiency and efficacy. According to Buschang et al. (2014), conventional edgewise braces requires significantly more visits, longer treatment time, additional emergency visits, more emergency time and an increased chair time when compared to CAT. Clear aligner therapy however, shows considerably more material cost and requires significantly more clinician-time when compared to edgewise FAT. Zeng et al. (2017) reported that the average treatment duration for CAT was up to 5 months shorter when compared to fixed appliances for matched non-extraction cases. They also reported that chair time was up to 50% less, with 67% fewer appointments compared to FAT treated patients.

Although CAT is seen as a more efficient option to treat mild non-extraction patients, an increased treatment time is required for complex cases than it would when using FAT. In terms of extraction cases however, Baldwin et al. (2008) reported that, for premolar extraction cases, CAT treatment duration was longer than treatment with fixed appliances alone. Li et al. (2015), as cited by Hartshorne and Wertheimer (2022), found that the treatment duration with aligners was 44% longer when compared to FAT.

The measurement of outcomes of orthodontic treatment is vital in determining the efficacy of an orthodontic appliance. The American Board of Orthodontics Objective Grading System (ABO-OGS) (Casko et al., 1998) and Peer Assessment Rating (PAR) (Richmond et al., 1992) are widely accepted tools used to evaluate these outcomes. Using the ABO-OGS, Djeu et al. (2005) reported that the outcomes for Invisalign® were, on average, 13 points lower than that of patients treated with conventional fixed orthodontics, with the passing rate for Invisalign® being close to 30% lower than that for fixed orthodontic appliances cases. Invisalign® scores were consistently lower than fixed orthodontic scores for “buccolingual inclination”, “occlusal contacts”, “occlusal relationships” and “overjet”. Additionally, data from a systematic review and meta-analysis showed that treatment with CAT was associated with lesser treatment outcomes when compared with FAT (Papageorgiou et al., 2020). This can be attributed to the fact that it is significantly more challenging to control the movement of roots with CAT compared to FAT, particularly when no attachments are used (Hennessy & Al-Awadhi, 2016).

When the PAR rating system was used to compare CAT and fixed orthodontics, Lanteri et al. (2018) found no significant difference in PAR scores for both treatment groups. However, Gu et al. (2017) reported that both CAT and FAT reduced PAR scores by over 30%. The difference

between PAR ratings and ABO-OGS ratings can be attributed to the fact that each of these indices have been developed for specific needs. PAR index is thus a less rigorous evaluation of tooth position within the dental arches and a more representative measurement of baseline case severity, whereas the ABO-OGS was developed to evaluate the fine aspects expected to be present in a precisely finished case in 3 spatial planes. Therefore, it can be expected that the post-treatment PAR ratings do not always coincide with the ratings of the post-treatment ABO-OGS evaluation (Papageorgiou et al., 2020).

An important aspect of assessing the efficiency of CAT, is the amount of planned tooth movement that is actually realised. According to Upadhyay and Arqub (2022), the consensus is that about 50% of planned tooth movement is achievable. Clinicians have reported that before ending treatment, up to 80% of patients treated with CAT require either a midcourse correction, refinements or even a change to FAT. Kravitz et al., (2023) showed that this conversion from Invisalign® to FAT was performed in 17,2% of patients. The average amount of refinement scans required to complete Invisalign® treatment was of 2.5 scans and less than 10% of patients could complete their treatment without any refinements. Patients who switched to braces from CAT, on average, used 80.6 aligners and subsequently required an additional 6.9 months of fixed appliance therapy.

## 2.7 Range of Tooth Movements

Due to the biomechanical nature of the CAT system, the treatment of certain malocclusions is more efficiently treated with CAT than others. Therefore, evaluating the effectiveness of CAT therapy is to investigate the performance in a range of different tooth movements. In terms of anterior alignment and bucco-lingual changes, Robertson et al. (2020) found CAT comparable to fixed appliances therapy. However, to achieve successful resolution of anterior crowding, additional aligners and refinements would be required in 37% of patients (Lanteri et al., 2018). Tipping movement with CAT are reported to be 77% as accurate as fixed appliance therapy (Weir, 2017), while bodily movement is 36% as accurate as fixed appliance therapy (Zhou & Guo, 2020).

Clear aligner therapy is an effective technique for expansion of discrepancies in the transverse plane, exhibiting a high level of effectiveness and certainty in both arches. The expansion, however, is predominantly through tipping rather than bodily movement and it has been shown that the efficiency of CAT driven expansion decreases from the canine to the first molar (Zhou & Guo, 2020).

One of the most challenging movements for CAT are rotational movements, especially on cylindrical shaped teeth (Hartshorne & Wertheimer, 2022). Canine and premolar rotations are reported to be the most challenging to correct, with an average accuracy for rotation of 63.2% (Karras et al., 2021). This is especially true if the degree of rotation is greater than 15 degrees (Upadhyay & Arqub, 2022). Simon et al. (2014a) noted that the amount of force that can be directed to premolars for rotational purposes was greater when attachments are used at 8.8N.mm than without at 1.2N.mm. Hence, if derotational movements are planned, attachments are imperative.

Treating complex malocclusions, which includes, severe crowding, tooth-size/ arch-length discrepancies, excessive facial height or bimaxillary protrusion are often treated with the extraction of premolars (Akinci Cansunar & Uysal, 2014). Gaffuri et al. (2020) reported that the use of Invisalign®'s G6 protocol, may effectively treat complex malocclusions requiring first premolar extraction, if combined with a precise diagnosis and the appropriate protocols. These protocols included the use of the appropriate auxiliaries, interarch elastics and optimized attachments. However, the Invisalign® G6 protocol showed an increased treatment time (2.1 years with  $35 \pm 5$  aligners per arch), and required an additional 7 months for refinements, when compared to the 2 years required for FAT.

However, Dai et al. (2019) reported that when treating extraction cases with CAT, first molars were subjected to increased mesial tipping, mesial translation and intrusion than anticipated. Additionally, with regards to central incisor retraction, less was achieved with lingual crown torque and extrusion of the central incisors being more than predicted. Therefore, it was concluded that anchorage control and retraction was not fully realised by CAT in first premolar extraction cases (Dai, Xu & Shu, 2019). Rossini et al. (2015b) found that CAT effectively controlled maxillary molar distalisation of greater than 1.5mm with an 88% accuracy, while Simon et al. (2014b) reported that it was possible to obtain up to 2.6mm molar distalisation without the use of skeletal anchorage.

The correction of an increased overjet and reduction in deep bites are important considerations in the treatment of class II malocclusions. Patterson et al. (2021) reported the amount of overjet reduction (horizontal discrepancy) with CAT to be only 6.8% of the predicted amount. This poor performance in correcting these features are highlighted by Meade and Weir (2024b), who found that approximately half the amount of planned overjet correction was actually achieved with CAT in non-extraction treatment of 2.1mm versus 3mm in patients treated with FAT. Additionally, the study reported that for patients undergoing extraction treatment, the overjet reduction was 1.9mm for CAT versus 3.1mm for FAT. Only one third of

planned deep bite corrections for class II patients can be achieved with CAT (Meade and Weir 2024b).

Extrusive tooth movements are noted to be difficult to achieve with CAT. According to Kravitz et al. (2009), the efficiency of extrusion was 29.6% and this was especially true for the maxillary incisors with an accuracy of only 18.3% (Kravitz et al., 2009). These findings were confirmed by Karras et al. (2021), who reported the mean accuracy for incisors and canine extrusion to be 47.6%. Rossini et al. (2015b) noted that CAT can accurately control anterior intrusion, with a mean accuracy of 47% and 45% for the mandibular and maxillary central incisors respectively and the average intrusion achieved to be 0.72mm (Rossini et al., 2015b).

Correction of an anterior open bite (AOB) is known to be highly unstable (Fleming, 2021). Traditionally, treatment involves intruding molars and avoiding extrusion of the incisors to prevent instability as extrusion is reported to relapse in 40% of cases (Janson et al., 2006). CAT has been shown to be an appropriate modality in the treatment of anterior open bite cases. This is due to its full occlusal coverage which causes intrusion of the molars, leading to a reduction of the vertical dimensions in the posterior segment whilst simultaneously retroclining the maxillary incisors (Garnett et al., 2019). However, Harris et al. (2020) reported that the mechanics of AOB closure is primarily from the drawbridge effect or simple tipping of incisors, which accounts for approximately 60% of the correction observed. Molar intrusion results in mandibular auto-rotation which accounts for 30% of the correction and the final 10% of the correction is due to incisor extrusion. Finkleman et al. (2024) reported that the average overbite change for patients treated with CAT is 3.2mm and the average molar intrusion is 0.71mm greater than patients treated with conventional fixed appliances.

## 2.8 Aligner Change Protocol

Majority of CAT brands are designed to effect tooth movements of 0.25mm to 0.33mm over a 14-day period (Kravitz et al., 2009). Since 2016, the Invisalign® brand have changed their recommended protocol from 14 days to 7 days in order to reduce the treatment time by half. Additionally, Invisalign® advocated that CAT should be worn for 20 to 22 hours per day (Al-Nadawi et al., 2021). According to Bollen et al. (2003), a 14-day wear protocol increased the chance of completing CAT sequence by up to 50% compared to a 1-week protocol. Clements et al. (2003) however, reported there to be no clinically significant difference in outcomes of treatment between a weekly and fortnightly aligner wear protocol.

Al-Nadawi et al. (2021) investigated the efficacy of orthodontic tooth movements with 7-, 10- and 14-day aligner change protocols. No significant difference in the efficiency of tooth

movements between the three protocols was found. It was suggested that a 1-week protocol would be beneficial as it shortens the treatment time and that a 2-week protocol would be advisable for more complex cases (Al-Nadawi et al., 2021). Meade and Weir (2022) reported that the average aligner change protocol advocated by Australian orthodontists was one week. Abu-Arquib et al. (2023) found that more than half of respondents (58.12%) advocated a 1-week aligner change protocol. Furthermore, over half of general dentist respondents reported to advocate a 2-week change protocol (Meade & Weir, 2024a). Additionally, it was reported that 5.7% of all respondents adopted a change protocol that was determined by a remote dental monitoring system. Other protocols advised changing aligners at periods ranging from 5 days to 4–5 weeks, with a suggested aligner change every 10 days being reported by 12.7% of respondents (Meade et al., 2023).

## 2.9 Case Selection

There is general agreement that CAT is not the treatment of choice for all types of malocclusions (Christensen, 2002). However, with the improvement of the efficacy of CAT, controversy exists as to which malocclusions are suitable for this treatment modality. Some clinicians indicate that CAT should be used in patients with mild crowding (Joffe, 2003), whilst others suggest that it can be used in more complex orthodontic cases (Vlaskalic & Boyd, 2002).

As detailed previously, there are extensive studies from the literature regarding which types of tooth movements can occur efficiently and effectively with CAT, whilst clinical case selection does not always match up. When comparing the confidence displayed by general dentists and orthodontists in treating various malocclusions with CAT, Best et al. (2017) found that general dentists were more assured treating deep bites, severe crowding and Class II malocclusions with CAT, while orthodontists displayed more confidence in treating cases of mild crowding with CAT. Both groups displayed equal confidence in treating crossbite and anterior open bite cases with CAT. The use of CAT for the treatment AOB was echoed by Abu-Arquib et al. (2023), who reported that 85% of orthodontists were confident in this regard. However, only 10% of orthodontists reported the use of aligners for the treatment of impactions, 22.5% for addressing facial asymmetry and 30.6% for managing severe skeletal discrepancies.

Majority of orthodontist are comfortable to treat spaced dentitions with CAT and least comfortable treating severely crowded dentitions with aligners (Meade et al., 2023). General dentists are less likely to prescribe extractions in severely crowded cases when using CAT compared with their orthodontic colleagues (Best et al., 2017). It is evident that if patients with severe crowding were treated without extractions, it would necessitates considerable arch

expansion and proclination of the teeth, exceeding levels typically regarded as stable and periodontally healthy (Best et al., 2017). When extractions are prescribed in crowded lower dentitions, a lower incisor extraction is preferred as opposed four premolar extractions (Meade et al., 2023).

The use of CAT for the treatment of increased overjet shows relative variation among practitioners. D 'Apuzzo et al. (2019) showed that 57% of orthodontist and 46% of general dentists prescribed CAT for the treatment of an increased overjet, with 63.6% of British orthodontists being confident in treating the malocclusion with CAT (Meade et al., 2023). Abu-Arquab et al. (2023) showed that only 38.8% of orthodontist in their study sample were comfortable treating an increased overjet in this manner.

## 2.10 Stability, Relapse and Retention Protocol

Horowitz and Hixon (1969) defined relapse as changes in tooth position after orthodontic treatment. The prevention of this phenomenon is a critical aspect of orthodontic treatment and is ensured through one's retention protocol. Moyers (1973) defined retention as "the holding of teeth in the treated position following orthodontic treatment for the period necessary for the maintenance of the result".

According to Kuncio et al. (2007), patients treated with Invisalign® displayed a greater total and mandibular anterior alignment post-retention relapse than patients treated with FAT. It was hypothesized that the reduction of treatment stability and increased post-retention relapse could be ascribed to increased tipping movements with CAT. Ke and coworkers (2019) suggested that a 7 to 14-day aligner wear period is insufficient to allow for proper alveolar bone repair and periodontal regeneration, which could lead to more relapse occurring (Ke, Zhu & Zhu, 2019). In addition, it is problematic to guarantee the preferred treatment stability as a result of the removable nature of CAT. Clinicians therefore would have to trust their patients to comply with the post-treatment retention protocols.

A variety of retention protocols exist for both removable and fixed appliances (Fleming, 2021). Removable retainers offer the potential advantages of being easier for oral hygiene, as they can be removed to allow cleaning of both the retainer and the dentition, and can be worn part-time if required (Graber et al., 2023). Fixed retention does not require the patient to remember to wear them, making them particularly useful in cases in which the result is potentially unpredictable (Graber et al., 2023). Randomised control trial studies by Bellini-Pereira et al.

(2024) and O'Rourke et al. (2016) have shown no difference in clinical efficacy between fixed and removable retainers.

Post CAT treatment retention protocols have shown that clinicians prefer using an Essix<sup>®</sup> vacuum formed retainer with 83% choosing this option, while 43% make use of bonded retainers and 21% preferring a Hawley type appliance (Abu-Arquub et al., 2023). Meade and Weir (2022) reported that most orthodontists preferred to combine bonded retainers with vacuum formed retainers in both the maxilla and the mandible. The same trend can be seen with general dentist where close to 60% report to use thermoformed retainers, with bonded retainers being used by 20% of respondents (Meade & Weir, 2024b).

## 2.10 Factors why Clinicians Choose not to use CAT

Despite the growing clear aligner market and perceived increase in demand for clear aligner therapy, certain practitioners still do not use the CAT treatment modality. D'Apuzzo et al. (2019) reported that most orthodontists who do not offer CAT, as it is considered to provide limited treatment outcomes compared to FAT. The second most cited reason was the high cost of the CAT system. This was supported by Mead and Weir (2022), who also found perceived patient compliance as a significant barrier in providing CAT. However, 69% of respondents who did not make use of the CAT system indicated that they would use this treatment modality in the future (d'Apuzzo et al., 2019). Having insufficient experience and knowledge of CAT was seen by general dentist as a major barrier in providing CAT in their practices (d'Apuzzo et al., 2019), with over 60% of general dentists reporting that they would refer those patients requesting the CAT system to specialist orthodontists (Meade & Weir, 2024b).

CAT has been shown to be an effective treatment modality for mild and moderate types of malocclusions. These include anterior crowding and anterior open bites. However, the treatment outcomes, when compared to fixed appliances for more complex types of malocclusions, appear to be inferior. Hence, appropriate case selection of patients for CAT therapy is of paramount importance for successful treatment outcomes.

The availability of literature for the usage of clear aligners in the South African setting is non-existent. Investigation into the current state of clear aligner usage could provide a valuable insight into CAT usage based on sound and contextually relevant evidence.

### 3. Methodology

#### 3.1 Research Hypothesis

The null hypothesis was that there is no difference in case selection, treatment management and aligner choice among aligner users in South Africa.

#### 3.2 Aim

To describe the use of clear aligners by general dentists and specialist orthodontists in a South African sample.

#### 3.3 Objectives

- 1) Determine the prevalence of clear aligner usage within a South Africa sample.
- 2) To determine the demographics of clinicians using clear aligners.
- 3) To describe the factors related to the choice of clear aligner usage.
- 4) To identify the perceived differences of treatment outcomes between CAT and fixed orthodontics (FAT).
- 5) To determine the reasons why clinicians choose not to use clear aligners.
- 6) To determine the type of retention used post CAT.

#### 3.4 Rationale for the study

The usage of aligners has been extensively studied internationally, where aspects such as usage, biomechanics and efficacy have been explored. However, literature regarding clear aligner usage is lacking within our local context. The purpose of this mini thesis is to elucidate clear aligners usage by both specialist orthodontist and general dentists within the South African dental setting and to ascertain how it compares with practices internationally.

#### 3.5 Study Design

A cross-sectional descriptive study methodology was used. In a cross-sectional study, both exposure and outcome are assessed simultaneously for each participant. This type of study displays one of the simplest forms of individual-level observational studies and is typically less costly and simpler to implement than cohort or case-control study types. Cross-sectional studies can be either descriptive or analytical. Descriptive studies focus on detailing the prevalence of outcomes, making them useful for evaluating the burden of diseases or conditions and for planning healthcare services. Analytical cross-sectional studies, on the other hand, attempt to identify associations between exposures and outcomes. However, they

provide only weak evidence of causal relationships due to the challenge of distinguishing between cause and effect (Pandis, 2014).

### 3.6 Study Population

All general dentists and specialist orthodontists working within the South African setting.

#### 3.6.1 Inclusion Criteria

- General Dentists
- Specialist Orthodontist

#### 3.6.2 Exclusion Criteria

- General dentists and specialist orthodontists working outside the South African borders.

#### 3.6.3 Study Site

- South Africa

### 3.7 Sample Size Determination

For the difference between two proportions, it can be hypothesized that CAT usage in orthodontists is 45% and CAT usage in general dentists is 64% (Best et al., 2017), with a 5% level of confidence and a power of 0.8. The proposed sample size is 101, with a finite population correction of 3434 participants.

$$m = \frac{[(Z\alpha/2 + Z\beta)^2 * (p_1(1-p_1) + p_2(1-p_2))]}{(p_1 - p_2)^2}$$
$$= \frac{[(1.96 + 0.84)^2 * (0.45(1-0.45) + 0.64(1-0.64))]}{(0.45 - 0.64)^2}$$
$$= 104$$

With finite population correction

$$n = \frac{m}{1 + \left(\frac{m-1}{N}\right)}$$
$$= 101.1$$

### 3.8 Data Collection Tool

A web-based survey was developed for both general dentists and orthodontists to respond to statements regarding their perceptions and experiences with clear aligner therapy. The survey was a modification of a validated instrument published by Meade et al., (2023).

#### 3.8.1 Validity

The validity of a questionnaire is determined by its ability to measure what is intended to be measured. In essence, are the “inferences and conclusions made based on the results of the questionnaire” (Murphy & Davidshofer, 2001). Two main types of validity are important in questionnaire-based research, namely content validity and construct validity (Tsang, Royse & Terkawi, 2017).

Content validity refers to the way the elements of the questionnaire represent the theoretical construct that the questionnaire is aimed to assess (Shultz et al., 2020). A panel of experts, with a thorough understanding of the construct that the questionnaire aims to measure, should be responsible for evaluating content validity. The panel is tasked to assess whether the questionnaire items effectively measure the intended construct and whether they sufficiently cover the domain of interest (Tsang, Royse & Terkawi, 2017). Items that are assessed with regards to content validity include (Anthoine et al., 2014):

- The clarity and ease
- Has the questions covered all problematic areas within your plan
- Could the questionnaire be used in assessments in the future
- Are there any important questions that are lacking
- Does any of the questions transgress privacy issues.

A concept related to content validity is face validity. Face validity pertains to the extent to which respondents or laypersons perceive the questionnaire items as valid. This decision is not based on the technical aspects of the items, but rather on whether the items seem to measure a construct that is important to the respondents. While face validity represents a relatively weak method for establishing overall validity, it may enhance respondent motivation to provide more accurate and truthful answers (Tsang et al., 2017).

The validity of the survey published by Meade et al. (2023) was assessed by distributing the pilot survey and information sheet to four orthodontists, comprising two hospital-based orthodontists and two orthodontists in specialist practice within the United Kingdom or the Republic of Ireland. Feedback was consolidated from these orthodontists concerning the

relevance and clarity of the questions, the length of the survey as well as the time needed to complete the survey.

### 3.8.2 Content of the Finalised Questionnaire

The modified version of the questionnaire (Addendum 1) used in this study was comprised of five parts. Part 1 contained a digital consent form (Addendum 2), which required participants to digitally accept and sign the informed consent. Part 2 was related to the demographics of the respondents and Part 3 investigated the frequency of the use of aligners within practice. Respondents who specified that they did not use aligners were asked a series of questions regarding the factors that influenced their decision not to use the appliance (Part 5). Part 4 was completed only by those reported regular use of CAT, which explored favoured systems, case selection, treatment protocols and retainer selection post CAT treatment (see Addendum 1). The data collected in the survey was ordinal using a Likert scale. No qualitative data was collected. A Likert scale is widely utilized to assess attitudes, knowledge, perceptions, values and behavioral changes. This type of scale consists of a series of statements, allowing respondents to select from predefined response options to rate their agreement or disagreement when evaluative questions are asked (Vogt, 1999).

The modified version was piloted with four clinicians, two specialist orthodontists and two general dentists, with varying experience with CAT. The clinicians found the questionnaire to be clear and easy to complete. The total time to complete the survey was 10 minutes. The results of the pilot were excluded from the study.

### 3.8.3 Reliability

The reliability of a questionnaire pertains to the consistency of the collected results. Specifically, internal consistency measures the degree to which items within the questionnaire are inter-correlated, reflecting their ability to consistently assess the same construct. This is commonly evaluated using Cronbach's alpha, a statistical coefficient that ranges from 0 to 1, where higher values denote a stronger inter-relationship among items (Cronbach, 1951). A Cronbach's alpha score of 0.70 or above is generally considered to be indicative of adequate internal consistency (Nunnally, 1978). The Cronbach alpha score for the modified questionnaire used in the study was 0.711, indicating an adequate internal consistency.

### 3.9 Questionnaire Dissemination

Requests were made to both the South African Dental Association (SADA) and the South African Society for Orthodontists (SASO) to distribute the survey among their members, which totaled 3 290 and 144 respectively. SADA agreed to distribute the questionnaire through its online newsletter (Addendum 3). In contrast, SASO declined to assist without providing an official explanation.

Specialist orthodontist listings were obtained from the official SASO website and contact information was gathered using the Google™ search engine. When email addresses were not available, calls were made to orthodontic practices to request this information. The collected details were organised into an Excel spreadsheet (Microsoft™) and added to the Research Electronic Data Capture (REDCap) mailing list. Specialist orthodontists' offices were contacted telephonically prior to the survey launch to inform them of the study. In total, 117 orthodontists were invited to participate in the survey.

Data collection was conducted using the online surveying software REDCap, hosted by the University of the Western Cape (UWC), Cape Town, South Africa. This electronic tool was configured to ensure anonymous collection of survey responses. An information sheet (Addendum 4), along with the electronic survey link, was distributed via REDCap.

The survey was launched on 22 January 2024 and sent to 117 specialist orthodontists, with 9 emails returned as undeliverable. These participants were subsequently contacted through standard email channels. Reminder emails were sent weekly via REDCap and additional efforts were made to reach non-respondents by telephone. Additionally, the survey was disseminated through a link posted on an informal WhatsApp™ (Meta) group associated with SASO. The survey was also distributed at two SADA meetings in Port Elizabeth and the Southern Cape, as well as to the Postgraduate Diploma (Orthodontics) program at the University of the Western Cape. The survey concluded on 12 April 2024.

### 3.10 Statistical Analysis

Categorical data were presented as frequencies and percentages to provide a comprehensive summary of the distribution of variables within the dataset. To examine associations between categorical variables, bivariate analysis was conducted using the Chi-squared test or Fisher's exact test, depending on the sample size, and expected frequency of observations. The Chi-squared test was appropriate for larger sample sizes where expected frequencies met the test's assumptions, while Fisher's exact test was employed in cases where sample sizes were

small or where the assumptions of the Chi-squared test were not satisfied. Statistical significance for all analyses was established at a threshold of  $p < 0.05$ , indicating that results were unlikely to be due to chance alone. The Cronbachs Alpha coefficient was used to determine the reliability of the tool. Data analysis was performed using STATA 18 software (Stata, College Station, Texas, USA 2023), which provided robust tools for statistical evaluation and ensured accuracy in the analytical process.

### 3.14 Data Management

Data collected on REDCap was stored on the electronic system, where any data exported into a statistical software programme (eg. Microsoft Excel or Stata) was transferred to the UWC institutional research data repository.

### 3.15 Ethical Considerations

Ethics approval (reference number BM23/6/17) was granted by the Biomedical Research Ethics Committee (BMREC) at the University of the Western Cape (Addendum 5). An information sheet, encompassing the title and all relevant details of the research, was attached to the survey. A digital consent form was integrated into the online survey, informing participants that their participation was voluntary and anonymous. Participants had the option to withdraw from the study at any time without facing any consequences.

Each participant was assigned a number (i.e. 1, 2) and names were not recorded to ensure anonymity. All information was securely stored on the password-protected computer of the primary researcher. Access to the REDCap survey login credentials was granted to the primary researcher, the supervisor and the statistician, who affirmed that meticulous precautions were implemented to ensure the strict confidentiality of all collected data.

## 4. Results

### 4.1 Response Rate

The overall response rate of 56.83% (n=104) was recorded from 183 clinicians who accessed the survey. The data from four respondents was excluded as only the e-consent and not the questionnaire component was completed. Not all respondents provided responses to every question and the percentages given related to the proportion of respondents who answered the relevant questions.

### 4.2 Demographics

Majority of respondents resided in the Western Cape Province in South Africa (n=35; 33.7%). Other respondents practiced in Gauteng (n=33; 31.7%), North West (n=2; 1.9%) and no respondents were from the Northern Cape. Majority of participants had 10 to 20 years of experience (n=28; 26.9%), and the least number of participants were from the 5 to 10 years (n=28; 26.9%) of experience category. The majority of the participants were general dentists (n=73; 70.2%), compared to 29.8% (n=31) orthodontists (Table 1).

The majority of orthodontist respondents were from the Western Cape (n=14; 40%) followed by Gauteng (n=11; 33%). No orthodontists from Mpumalanga and the North West responded. The majority of general dentist respondents resided in Gauteng (n=22; 30.1%) with the Western Cape representing 28,7% of general dentist respondents (n=21). The North West and Mpumalanga had the fewest respondents among general dentists, with only 2 participants (1.9%) each.

There was a notable, but not statistically significant difference, in experience levels between the orthodontists and general dentists ( $p$  0.052). Among respondents with 10 to 20 years of experience, 86% (n=24) were general dentists, while 14% (n=4) were orthodontists. For those respondents with 5 to 10 years of experience, 74% (n=17) were general dentists and 26% (n=6) were orthodontists. Respondents who were new graduates (less than 5 years) included 69% (n=18) general dentists and 31% (n=8) orthodontists. In the "Very Experienced" category (20 years or more), 52% (n=14) were general dentists and 48% (n=13) were orthodontists.

Table 1: Demographics of participants

Variable	n	Overall (n = 104 <sup>1</sup> )	General Dentist (n = 73 <sup>1</sup> )	Orthodontist (n = 31 <sup>1</sup> )	p-value <sup>2</sup>
<b>Caseload of CAT</b>	34				0.643
<5%		13 (38%)	6 (46%)	7 (54%)	
≥5%		21 (62%)	8 (38%)	13 (62%)	
<b>Years of experience</b>	104				0.052
Experienced (10 -20 yrs)		28 (27%)	24 (86%)	4 (14%)	
Intermediate (5-10 yrs)		23 (22%)	17 (74%)	6 (26%)	
New Graduate (<5 yrs)		26 (25%)	18 (69%)	8 (31%)	
Very Experienced (≥20 yrs)		27 (26%)	14 (52%)	13 (48%)	
<b>Province</b>	104				0.740
Eastern Cape		9 (8.7%)	7 (78%)	2 (22%)	
Free State		6 (5.8%)	5 (83%)	1 (17%)	
Gauteng		33 (32%)	22 (67%)	11 (33%)	
KwaZulu-Natal		9 (8.7%)	7 (78%)	2 (22%)	
Limpopo		8 (7.7%)	7 (88%)	1 (13%)	
Mpumalanga		2 (1.9%)	2 (100%)	0 (0%)	
North West		2 (1.9%)	2 (100%)	0 (0%)	
Western Cape		35 (34%)	21 (60%)	14 (40%)	
<b>Aligners</b>	104	34 (33%)	14 (41%)	20 (59%)	<0.001
<sup>1</sup> n (%)			<sup>2</sup> Pearson's Chi-squared test; Fisher's exact test		

### 4.3 Frequency of CAT usage

Seventy participants did not use CAT (67.3%), whereas thirty-four participants used CAT (32.7%). CAT was mostly used in Gauteng (n=13; 39%) and in the Western Cape (n=11; 31%) (Table 2). There was no association between CAT usage and location of practice (p=0.12) (Table 2). Participants who were classified as very experienced (≥20 years) reported to use CAT more frequently (n=12; 44.0%). However, there was no association between participant experience and CAT usage (p=0.333). Sixty-five percent of orthodontists reported to use CAT (n=20). There was a statistically significant difference between CAT usage and qualification (p<0.001), with orthodontists reporting an increase in odds for using CAT compared to general dentists (OR=7.7; 95% CI=2.99 to 19.6). The distribution of caseloads involving CAT did not show statistically significant differences between general dentists and orthodontists (p=0.643)

(Table 1). Specifically, 46% (n=6) of general dentists and 54% (n=7) of orthodontists reported managing less than 5% of their cases with CAT. In contrast, 38% (n=8) of general dentists and 62% (n=13) of orthodontists managed 5% or more of their caseload with clear aligners.

Table 2: Aligner usage and demographics

Variable	n	Overall (n = 104 <sup>1</sup> )	No (n = 70 <sup>1</sup> )	Yes (n = 34 <sup>1</sup> )	p-value <sup>2</sup>
<b>Years of experience</b>	104				0.333
Experienced (10 -20 yrs)		28 (27%)	22 (79%)	6 (21%)	
Intermediate (5-10 yrs)		23 (22%)	16 (70%)	7 (30%)	
New Graduate(<5 yrs)		26 (25%)	17 (65%)	9 (35%)	
Very Experienced (≥20 yrs)		27 (26%)	15 (56%)	12 (44%)	
<b>Province</b>	104				0.120
Eastern Cape		9 (8.7%)	7 (78%)	2 (22%)	
Free State		6 (5.8%)	6 (100%)	0 (0%)	
Gauteng		33 (32%)	20 (61%)	13 (39%)	
KwaZulu-Natal		9 (8.7%)	3 (33%)	6 (67%)	
Limpopo		8 (7.7%)	7 (88%)	1 (13%)	
Mpumalanga		2 (1.9%)	1 (50%)	1 (50%)	
North West		2 (1.9%)	2 (100%)	0 (0%)	
Western Cape		35 (34%)	24 (69%)	11 (31%)	
<b>Qualification</b>	104				<0.001
General Dentist		73 (70%)	59 (81%)	14 (19%)	
Orthodontist		31 (30%)	11 (35%)	20 (65%)	
<sup>1</sup> n (%)	<sup>2</sup> Pearson's Chi-squared test; Fisher's exact test				

#### 4.5 Preferred CAT Systems

The most frequently prescribed CAT system reported by the respondents was Spark Clear Aligners® (Ormco Corporation, Orange, CA, USA) (n=15; 44.1%), followed by Active Clear Aligners® (n=4; 12%). Krsti® and Invisalign® (Align Technology Inc., CA, CA) were used in 8.8% of the cases for both aligner type. Reveal® was the least frequently reported CAT used (n=1; 3%). In-house aligners were reported to have been used by 12% (n=4) of participants (Table 3).

Table 3: Preferred CAT system

Question	Brand	n (%)
Which of the following aligner system do you use in your practice?	Active Aligners	4 (12%)
	Clearcorrect	1 (3%)
	In-House	4 (12%)
	Invisalign	3 (9%)
	Krstl	3 (9%)
	Reveal	1 (3%)
	Spark <sup>t</sup>	15 (44%)
	Other	3 (9%)

Most participants considered the quality of digital treatment planning (50%; n=17) to be an extremely influential factor in choosing a particular aligner brand. The cost of the appliance (59%; n=20), ease of digital treatment (59%; n= 20), sophistication of appliance design (47%; n=16), the aesthetics of the appliance (50%; n=17), patient satisfaction (62%; n=21), brand identity (47%; n=16), ongoing education by the provider (47%; n=16) and assistance in troubleshooting (44%; n=15) were found to be 'very influential' factors when choosing an aligner brand. Corporate support advertising was reported by some (41%; n=14) to be slightly influential for the choice of an aligner (Table 4).

Table 4: Factors that influence decisions in choosing to use a particular aligner company/ brand

Factor	Level	Value
<b>n</b>		34
<b>Cost of appliance</b>	Slightly influential	4 (12%)
	Very influential	20 (59%)
	Extremely influential	10 (29%)
<b>Ease of digital treatment</b>	Not at all influential	1 (3%)
	Slightly influential	2 (6%)
	Very influential	20 (59%)
	Extremely influential	11 (32%)
<b>Quality of digital treatment plan</b>	Slightly influential	2 (6%)
	Very influential	15 (44%)
	Extremely influential	17 (50%)
<b>Sophistication of appliance design</b>	Slightly influential	3 (9%)
	Very influential	16 (47%)
	Extremely influential	15 (44%)
<b>Aesthetics of appliances</b>	Not at all influential	3 (9%)
	Slightly influential	3 (9%)
	Very influential	17 (50%)

	Extremely influential	11 (32%)
<b>Patient satisfaction</b>	Not at all influential	1 (3%)
	Slightly influential	1 (3%)
	Very influential	21 (62%)
	Extremely influential	11 (32%)
<b>Brand identity</b>	Not at all influential	8 (24%)
	Slightly influential	6 (18%)
	Very influential	16 (47%)
	Extremely influential	4 (12%)
<b>Ongoing education by provider</b>	Not at all influential	4 (12%)
	Slightly influential	5 (15%)
	Very influential	16 (47%)
	Extremely influential	9 (26%)
<b>Assistance in troubleshooting</b>	Not at all influential	1 (3%)
	Slightly influential	4 (12%)
	Very influential	15 (44%)
	Extremely influential	14 (41%)
<b>Corporate support advertising</b>	Not at all influential	4 (12%)
	Slightly influential	14 (41%)
	Very influential	11 (32%)
	Extremely influential	5 (15%)

#### 4.6 Factors that influence the decision to offer CAT

Cost (50%; n=17), predicted patient co-operation (62%; n=21), patient demands (44%; n=15) and patient expectations (62%; n=21) were reported to be 'very influential' factors when prescribing CAT for patients. Case complexity (62%; n=21) and case suitability (79%; n=27) were reported to be 'extremely influential' when choosing a CAT to use (Table 5).

Table 5: Factors influencing the decision to offer clear aligner therapy

Factor	Level	Value
<b>n</b>		104
<b>Cost</b>	Not at all influential	4 (12%)
	Slightly influential	4 (12%)
	Very influential	17 (50%)
	Extremely influential	9 (26%)
<b>Case complexity</b>	Slightly influential	1 (3%)
	Very influential	12 (35%)
	Extremely influential	21 (62%)
<b>Predicted patient cooperation</b>	Slightly influential	1 (3%)
	Very influential	19 (56%)
	Extremely influential	14 (41%)
<b>Patient demands</b>	Not at all influential	3 (9%)
	Slightly influential	4 (12%)
	Very influential	15 (44%)
	Extremely influential	12 (35%)
<b>Patient expectations</b>	Not at all influential	1 (3%)
	Slightly influential	1 (3%)
	Very influential	21 (62%)
	Extremely influential	11 (32%)
<b>Case suitability</b>	Very influential	7 (21%)
	Extremely influential	27 (79%)

#### 4.7 Case Selection and Treatment Protocols

The majority of clinicians reported to mostly treat (32%; n= 11) and sometimes treat (38%; n= 13) adult patients with CAT. Adolescent patients were reported to either never being treated (44%, n=15) or sometimes treated (35%; n=12) using CAT. A large proportion of participants (76%; n=26) reported to never treating patients in the mixed dentition with clear aligners (Table 6).

Table 6: Patient Cohort treated with CAT.

Factor	Level	Value
<b>n</b>		34
<b>Patients in the mixed dentition</b>	Sometimes	3 (9%)
	Rarely	5 (15%)
	Never	26 (76%)
<b>Adolescent/ teenage patients</b>	Mostly	3 (9%)
	Sometimes	12 (35%)
	Rarely	4 (12%)

	Never	15 (44%)
<b>Adult patients</b>	Always	4 (12%)
	Mostly	11 (32%)
	Sometimes	13 (38%)
	Rarely	5 (15%)
	Never	1 (3%)

#### 4.8 Practitioner Comfort or Discomfort in treating patients with CAT according to different case types

Mild crowding was selected as a case type that the overwhelming majority of respondents were comfortable treating with CAT, at 88% (n=30). Half of the practitioners noted confidence in treating moderate crowding with CAT (50%; n=17), with 65% (n=22) being confident in treating spaced dentitions with CAT.

Interestingly, only 9 participants (26%) were comfortable treating reduced overbites or anterior open bites with CAT. Deep bites (71%; n=24) and bilateral cross bites (65%; n=22) were malocclusions that most clinicians were not comfortable treating with clear aligners. Majority of clinicians (59%; n=20) would not treat an increased overjet with CAT, nor severe crowding (85%; n=29) (Table 7).

Table 7: Comfort and *non*-Comfort treating different case types

Factor	Comfortable (n=34)	Not Comfortable (n=34)
Spaced dentition	22 (65%)	6 (18%)
Mild crowding (0–4 mm crowding)	30 (88%)	1 (%)
Moderate crowding (4.1–8 mm crowding)	17 (50%)	4 (11%)
Severe crowding (>8 mm crowding)	4 (12%)	29 (85%)
Increased Overbite (Deep Bite)	8 (24%)	24 (71%)
Reduced Overbite (Anterior Open Bite)	9 (26%)	13 (38%)
Increased Overjet	8 (24%)	20 (59%)
Reduced Overjet	9 (26%)	12 (35%)
Posterior crossbite (Unilateral)	11 (32%)	15 (44%)
Posterior crossbite (Bilateral)	7 (21%)	22 (65%)

#### 4.9 Types of Complex cases that are treated with CAT

In terms of more advanced treatments, most providers never combine CAT with premolar extractions (56%; n=19). When extractions are warranted, respondents were more likely to perform lower incisor extractions, with 30% (n=10) indicating that they sometimes perform this treatment. CAT was seldom used alongside orthognathic surgery, with the majority of participants (76%; n=25) reporting that they never combined these treatment modalities (Table 8).

Table 8: Complex Cases Treated with CAT

Factor	Level	Value
<b>n</b>		34
<b>Premolar extractions</b>	Never	19 (56%)
	Rarely	13 (38%)
	Sometimes	1 (3%)
	Mostly	1 (3%)
<b>Lower incisor extractions</b>	Never	16 (48%)
	Rarely	6 (18%)
	Sometimes	10 (30%)
	Mostly	1 (3%)
<b>Orthognathic surgery</b>	Never	25 (76%)
	Rarely	4 (12%)
	Sometimes	2 (6%)
	Mostly	2 (6%)
<b>Deep bite cases with bite ramps</b>	Never	13 (38%)
	Rarely	7 (21%)
	Sometimes	12 (35%)
	Mostly	1 (3%)
	Always	1 (3%)

#### 4.10 CAT change-protocols

With regards to CAT change-protocols, 76% (n=26) of practitioners did not feel it was necessary to change the clear aligner trays for patients in the mixed dentition. The majority of respondents (n=13; 38%) felt it was not indicated to change aligners in adolescent patients. However, of those participants who choose to use aligners for adolescent patients, the preferred change protocol was fortnightly (n=10; 29%). For the adult aligner change protocol, the response was similar, with 50% (n=17) opting for a fortnightly change and 47% (n=16) of participants preferring a weekly change (Figure 2).

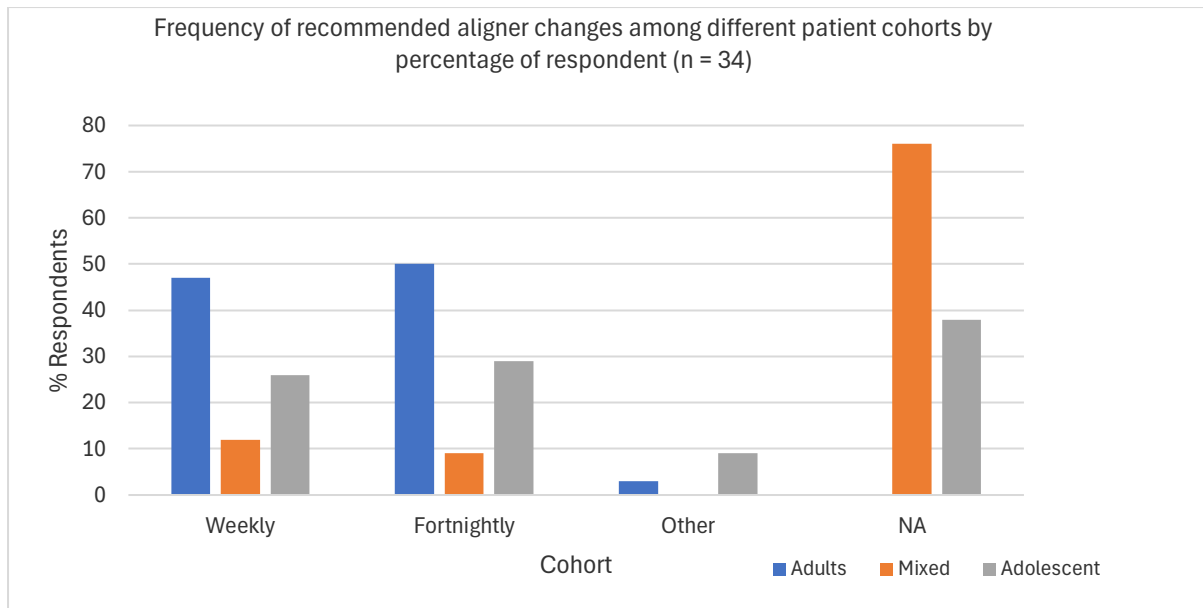


Figure 2: Aligner Change protocol amongst different patient cohorts

#### 4.11 Combination of CAT and Fixed Appliances

The majority of practitioners (44%; n=15) sometimes combined CAT with fixed appliances in their initial treatment plan. Almost as many (38%; n=13) responded to rarely combining CAT with fixed appliances. A minority of respondents (3%; n=1) always combine fixed appliances with CAT, while and 6% (n=2) never combine the therapies (Table 9).

Table 9: Combined Fixed Appliance and CAT

Factor	Level	Value
<b>n</b>		34
<b>Do you combine aligners with fixed appliances in your initial treatment plan?</b>	Always	1 (3%)
	Mostly	3 (9%)
	Sometimes	15 (44%)
	Rarely	13 (38%)
	Never	2 (6%)

#### 4.12 Comparison between CAT and FAT

Most practitioners reported that they somewhat disagree (24%; n=8) and strongly disagree (35%; n=12) that the outcomes are similar between CAT and fixed orthodontic cases. A substantial number of respondents (29%; n=10) considered the two modalities to provide the same outcomes. Only 3% (n=1) reported that CAT provided superior outcomes when compared to fixed appliances (Table 10).

Table 10: Does CAT provide superior results to Fixed Appliances

Factor	Level	Value
<b>n</b>		34
<b>In matched cases with identical treatment outcomes do you agree or disagree that patients prescribed aligners produce superior treatment outcomes overall when compared with fixed appliances?</b>	Agree strongly	1 (3%)
	Agree somewhat	3 (9%)
	Neither agree nor disagree. both provide the same outcomes.	10 (29%)
	Disagree somewhat	8 (24%)
	Disagree strongly	12 (35%)

#### 4.13 Perception of required treatment time for CAT therapy as compared to FAT.

The results showed that the majority of respondents either agree somewhat (29%; n=10), neither agree nor disagree (24%; n=9) or disagree somewhat (26%; n=9) that aligners require a longer time period to treat to similar outcomes when compared to fixed appliances (Table 11).

Table 11: Does CAT require more treatment time

Factor	Level	Value
<b>n</b>		34
<b>In matched cases with identical treatment outcomes do you agree or disagree that patients prescribed aligners take more time to treat compared with fixed appliances?</b>	Agree strongly	6 (18%)
	Agree somewhat	10 (29%)
	Neither agree nor disagree. both take the same time.	8 (24%)
	Disagree somewhat	9 (26%)
	Disagree strongly	1 (3%)

The mean treatment time per dual arch non-extraction cases was reported to 14.5 months (n=28). The maximum treatment time was reported as 35 months and the minimum was 4 months.

#### 4.14 Retention Protocol

##### 4.14.1 Maxillary Retention

The most commonly used retention appliance in the maxilla was the thermoplastic retainer with 56% (n=19). A combination of a thermoplastic retainer and bonded retainers were reported to be used by 24% (n=8) of respondents for the maxilla. The least used retention

appliance was a Hawley type retainer (3%; n=1), while only 1 (3%) respondent reported not making use of any retention device (Table 12).

Table 12: Maxillary and Mandibular Retainer choice

Factor	Level	Value
<b>n</b>		34
<b>What maxillary retainer do you most commonly use following orthodontic aligner</b>	Bonded retainer	4 (12%)
	Thermoplastic (tr) only	19 (56%)
	Hawley retainer only	1 (3%)
	Bonded and tr	8 (24%)
	Bonded and hawley	1 (3%)
	None	1 (3%)
<b>What mandibular retainer do you most commonly use following orthodontic aligner</b>	Bonded retainer	12 (35%)
	Thermoplastic (tr) only	12 (35%)
	Hawley retainer only	1 (3%)
	Bonded and tr	8 (24%)
	None	1 (3%)

#### 4.14.2 Mandibular Retention

For the mandible, most clinicians preferred the use of a bonded retainer only (35%; n=12) and equally a thermoplastic retainer only (35%; n=12), with a combination of a bonded retainer and a thermoplastic retainer being used by 24% (n=8) of clinicians. Only 1 (3%) respondent made use of a Hawley type retainer in the mandible and 1 (3%) respondent did not make use of any retention device (Table 12).

#### 4.15 Factors that influence respondent decisions not to use CAT

Patient compliance with treatment protocols was seen as the foremost barrier preventing clinicians from adopting CAT modality, with 34% (n=24) of respondents rating it as very influential and 33% (n=23) as extremely influential. Most clinicians also viewed the fact that fixed appliances provided better treatment outcomes compared to CAT as a major barrier, with 33% (n=23) of participants considering it very influential and 30% (n=21) extremely influential. Costs to patients were considered by clinicians to be a significant barrier, with 40% (n=28) of respondents finding it very influential and 23% (n=16) extremely influential. Patients expectations were seen as another crucial factor. A substantial portion of respondents (37%; n=26) thought that their patients' expectations were very influential and 24% (n=17) deeming it extremely influential (Table 13).

A significant factor in the decision not to provide CAT, is the perceived insufficiency of postgraduate education on clear aligners, with 33% (n=23) of respondents considering it to be very influential and 17% (n=12) reporting this as an extremely influential factor. Dependency on third parties for treatment provision is moderately influential, with 30% (n=21) finding it very influential and 21% (n=15) extremely influential for decision making (Table 13).

The ongoing costs to the practice were perceived by clinicians as somewhat influential, with 26% (n=18) reporting this as not at all influential and 19% (n=13) reporting it as somewhat influential. Initial costs to the practice was also seen as not having a great influence on the clinician's decision not to provide CAT, with 27% finding practice costs very influential, but 51% (n=36) of respondents reported this as either as not at all, slightly or somewhat influential in their practice. The potential disruption to practice function caused by the introduction of a new technology was seen as the least critical barrier for CAT, as 37% (n=26) of respondents reported this as not at all influential, 20% (n=14) as slightly influential and 20% (n=14) as somewhat influential (Table 13).

Table 13: Factors that influence respondent decisions to not use CAT

Factor	Level	Value
<b>n</b>		70
<b>Insufficient postgraduate education</b>	Not at all influential	10 (14%)
	Slightly influential	6 (9%)
	Somewhat influential	19 (27%)
	Very influential	23 (33%)
	Extremely influential	12 (17%)
<b>Concerns over ongoing aligner education</b>	Not at all influential	15 (21%)
	Slightly influential	10 (14%)
	Somewhat influential	23 (33%)
	Very influential	14 (20%)
	Extremely influential	8 (11%)
<b>Concerns over patient compliance with treatment protocols</b>	Not at all influential	7 (10%)
	Slightly influential	5 (7%)
	Somewhat influential	11 (16%)
	Very influential	24 (34%)
	Extremely influential	23 (33%)
<b>Patients expectations</b>	Not at all influential	5 (7%)
	Slightly influential	4 (6%)
	Somewhat influential	18 (26%)
	Very influential	26 (37%)
	Extremely influential	17 (24%)
	Not at all influential	7 (10%)

<b>Fixed appliances provide better treatment outcomes</b>	Slightly influential	6 (9%)
	Somewhat influential	13 (19%)
	Very influential	23 (33%)
	Extremely influential	21 (30%)
<b>Dependency on a third party for treatment provision</b>	Not at all influential	13 (19%)
	Slightly influential	10 (14%)
	Somewhat influential	11 (16%)
	Very influential	21 (30%)
	Extremely influential	15 (21%)
<b>Disruption to practice with the introduction of new technology</b>	Not at all influential	26 (37%)
	Slightly influential	14 (20%)
	Somewhat influential	14 (20%)
	Very influential	13 (19%)
	Extremely influential	3 (4%)
<b>Costs to the patient</b>	Not at all influential	9 (13%)
	Slightly influential	5 (7%)
	Somewhat influential	12 (17%)
	Very influential	28 (40%)
	Extremely influential	16 (23%)
<b>Ongoing costs to the practice</b>	Not at all influential	18 (26%)
	Slightly influential	10 (14%)
	Somewhat influential	13 (19%)
	Very influential	16 (23%)
	Extremely influential	13 (19%)
<b>Initial costs to the practice</b>	Not at all influential	17 (24%)
	Slightly influential	9 (13%)
	Somewhat influential	10 (14%)
	Very influential	19 (27%)
	Extremely influential	15(21%)

## 5. Discussion

This web-survey based study is the first to describe the clear aligner practices amongst specialist orthodontists and general dentists in South Africa. Currently, it is the only research on clear aligner usage in the country. To improve responses, it was decided to get the assistance of both SASO and SADA to distribute the survey amongst its members. The survey was completed by 104 participants, which included 73 general dentists and 31 specialist orthodontists. The overall response rate was 56,83% (n=104) which is greater than recent surveys involving the responses of 15%–20.1% amongst the British Orthodontic Society (Meade et al., 2023) and internationally between 1.6%–18.1% regarding orthodontic practice protocols (Keim, Vogels lii & Vogels, 2020; Balteau et al., 2021; Abu-Arquib et al., 2023; Meade & Weir, 2024b; Miranda e Paulo et al., 2024).

The majority of respondents resided in the Western Cape (33.7%) and Gauteng (31.7%), with majority of specialist orthodontist respondents residing in the Western Cape (40%) and Gauteng (33%). This could reflect a greater concentration of orthodontists in these provinces as they are regarded as wealthier provinces as well as having orthodontic training institutions located in their boarders. The majority of respondents were classified as being experienced (27%; n=28) or very experienced (26%; n=27).

CAT usage is reported as 32.7% in the current study, which is relatively low compared to findings from Meade et al. (2023), where 77.3% of respondents indicated that CAT was included in their treatment arsenal. This figure is also lower than the 92%–93% observed in Australia and the United States, as reported by Meade and Weir (2022) and Keim et al. (2020) respectively. This indicates that CAT, as a treatment modality, is less accepted with in the South African setting when compared to first word counterparts.

CAT was more widely accepted by orthodontists, with an increased odds ratio of 7.7 (95% CI:2.99 to 19.6) ( $p<0.001$ ) when compared to general dentists. Generally, orthodontist also handle higher caseloads with CAT, with the 62% of practitioners who report to manage more than 5% with CAT being orthodontists. This could be due to orthodontists, in general, treating more orthodontic cases and hence have more confidence treating cases with the modality. Studies by Meade and Weir (2022) and Meade et al. (2023) reported that the average case load with CAT is between 10-25%, compared to  $\geq 5\%$  in the current study, which could indicate that South African practitioners could be late adopters of the modality when compared to their British and Australian counterparts.

The most prescribed CAT system in this study was found to be Spark Clear Aligners® (Ormco Corporation, Orange, CA, USA), with 44.1% of practitioners reporting to use this system. Interestingly, this is not on-trend with other studies on the topic. Abu-Arquub et al. (2023) and Meade et al. (2023) reported that Invisalign® (Align Technology Inc., CA, CA) was prescribed by more than 80% of American and British respondents. A possible contributing factor to this disparity could be due to market factors such as cost of the appliance or the greater brand association that Ormco has with orthodontics within in the South African market. However, the majority of respondents in this study found the quality of the digital treatment plan as being the most influential factor in choosing an aligner brand, with cost of the appliance being regarded as a very influential factor. This aligns with the findings of Meade et al. (2023) and Mead and Weir (2022), who found that more than 90% of respondents felt that quality of the digital treatment plan to be the most influential factor in choosing an aligner brand.

For the respondents who utilise CAT, the patient cohort to whom it was most frequently prescribed were adults. For this particular group of patients, 70% of respondents reported to use CAT either mostly or sometimes. This was more than the reported 60% (Meade et al., 2023) amongst British respondents and 67% (Meade & Wier, 2022) amongst Australian respondents. This coincides with the findings of Fenton et al. (2022), who stated that there is an increase in demand for more aesthetic appliances amongst adult patients.

Clinicians were most comfortable treating cases of mild crowding with CAT, with over 80% responding in this manner. This is similar to the findings of Meade and Wier (2022) as well as Meade and Weir (2024), which is reasonable as the modern iteration of CAT was originally purposed on addressing mild malalignment (Vlaskalic & Boyd, 2002). Most providers (85%) in this study were uncomfortable treating severe crowding with CAT. According to Proffit (2018), severe crowding of  $\geq 10\text{mm}$  is almost always associated with extraction treatment. Hence nearly 60% of respondents never combine premolar extractions with CAT. This correlated well with the findings of Dai et al. (2019) and Gaffuri et al. (2020), who reported that CAT, when combined with premolar extractions, results in increased treatment time, anchorage loss and insufficient incisor retraction. When extractions were deemed necessary, the majority of participants (30%), chose to perform a lower incisor extraction. This preference aligns with the findings of Meade and Weir (2022), who reported that 35.83% of respondents preferred lower incisor extractions over premolar extractions when using CAT.

Interestingly, only 26% of respondents were comfortable treating patients with an anterior open bite with CAT. Finkleman et al. (2024) reported that CAT is an effective modality in

treating AOB through the bite block effect, by achieving an average of 0.71mm more molar intrusion than FAT.

The vast majority of participants in this study followed either a weekly or fortnightly aligner change protocol. These findings are aligned with the work of Al-Nadawi et al. (2021), who found that there is no difference in accuracy of tooth movement between weekly or fortnightly change protocols. This highlights that the clinicians in this study followed an evidence-based and widely accepted approach with regards to aligner change protocol selection.

In the current survey, nearly 50% of respondents indicated that they occasionally combine CAT with FAT. In contrast, a higher proportion, between 50% to 60%, reported routinely employing this combined approach in Australia and the United States (Keim et al., 2020; Meade & Weir, 2022). This suggests a global trend among clinicians to integrate their understanding of the benefits and shortcomings of each system, by adopting a hybrid methodology. Such a practice may become more prevalent as the comparative advantages of each system become increasingly acknowledged (Kravitz et al., 2023).

The mean treatment time with CAT for a non-extraction cases was reported to be 14.5 months, which was less than the 16 months reported by Meade and Weir (2022). The evidence regarding CAT duration is uncertain, with authors such as Zeng et al. (2017) showing that mild CAT cases finish in shorter time periods when compared to fixed appliances. However, a Randomised Clinical Trial by Lin et al. (2022), comparing the efficacy and efficiency of CAT and FAT, indicated that mild cases treated with FAT finished on average 4.8 months shorter than CAT. The respondents in this study were uncertain as to which modality delivers faster results.

More than half of the respondents either strongly disagreed or somewhat disagreed with the assertion that CAT yields superior outcomes when compared to FAT. These results were consistent with systematic review by Papageorgiou et al. (2020), which reported CAT was associated with inferior outcomes when compared to FAT. However, Miranda e Paulo et al. (2024) suggested that there is difficulty in making a direct comparison between CAT and FAT due to CAT often being indicated based on the complexity of the case. As a result, such comparisons may be inherently subjective.

Participants reported that they mostly prescribe a thermoplastic retainer for the maxilla and were divided between a bonded or thermoplastic retainer for the mandible. These findings are

in agreement with data from Australia (Meade and Weir, 2022) and Britain (Meade et al., 2023), where a thermoform retainer was most prescribed in the maxilla. However, our results differed in the mandible as the most prescribed retention device was reported by the aforementioned authors as a combination of a thermoplastic and a fixed retainer.

Respondents who did not use CAT, reported patient compliance as major barrier in the adoption of the modality. This aligned with the work of Meade and Weir (2022), who also reported patient compliance as the most significant barrier for the use of CAT. Inferior outcomes, when compared to FAT, was the second most reported barrier to CAT adoption, which corresponds with the results of d'Apuzzo et al. (2019).

## 6. Limitations

The response rate of 56,83% is a potential limitation of the study. Survey response rates significantly influence two critical aspects of survey quality: bias and statistical precision. The foundational assumption is that higher response rates enhance the likelihood that the sample will accurately represent the population. This in turn yields results that closely align with those of the entire population (Groves et al., 2009). Moreover, elevated response rates increase the probability of capturing all relevant subgroups, which may differ systematically in their attitudes, opinions or other measured variables (Meterko et al., 2015).

Another potential limitation of this study is recall bias. Specifically, responses to certain questions necessitated that clinicians supply answers that may not coincide with quantitative evaluations of their aligner practices. Additionally, the answers to all questions were close ended, which prevents exact quantification of the answers to those questions (McMorrow & Millett, 2017). The lack of open-ended, qualitative sections in the tool could have resulted in the possible omission of more in-depth knowledge on aligner practices. However, this was done in favour of streamlining the survey to increase the potential response rate. Answering a lengthy questionnaire could affect practitioner compliance, leading to incomplete responses (Miranda e Paulo et al., 2024).

A possible final limitation pertains to the potential of individuals who use CAT to be more inclined to respond to the survey, thereby introducing recruitment bias. This bias may have led to an overestimation of CAT usage among the respondents.

## 7. Conclusions

The research hypothesis that is no difference in case selection, treatment management and aligner choice among aligner users in South Africa, was in large part accepted. The majority of clinicians agreed on the suitability of case type, patient type, aligner change protocol and retention type.

CAT usage has grown in recent times, with the modality being marketed not only at a specialist orthodontist level, but also to general dentists. It has been shown to be an effective modality in the treatment of mild crowding, especially in adult cases where aesthetic appliances are important. A yardstick to gain knowledge on how and why South African clinicians use (or not use) CAT is important in order gauge the CAT practices within our country against international practices.

Drawing from the findings of this survey completed by both specialist orthodontists and general dentists, the following overarching conclusions can be drawn:

- 1) The prevalence of CAT usage amongst respondents was 32.7%, with specialist orthodontists more likely to use the modality, at an odds ratio of 7.7 (95% C.I. 2.99 to 19.6) ( $p < 0.001$ ) when compared to general dentists.
- 2) The preferred CAT system reported amongst participants was Spark Clear Aligners® (Ormco Corporation, Orange, CA, USA) at 44.1%.
- 3) The quality of the digital treating planning was the most influential factor in choosing a particular CAT brand.
- 4) Case suitability and case complexity were the most influential factors when deciding to offer CAT to a patient.
- 5) Respondents were more likely to treat adult patients with CAT.
- 6) The vast majority of respondents were comfortable treating mild crowded cases and least comfortable treating severely crowded cases with aligners.
- 7) Premolar extractions were not deemed as a suitable adjunct to aligner therapy with 56% of clinicians reporting that they never combined the two treatments.
- 8) Respondents were split between weekly (47%) and fortnightly (50%) aligner change protocol.
- 9) Most clinicians felt that FAT provided better treatment outcomes when compared to CAT.
- 10) The preferred retention appliance in the maxilla was reported to be a thermoplastic retainer (56%) and in the mandible the preference was split between a thermoplastic (35%) and bonded retainer (35%).

11) The most prevalent barrier in CAT usage was patient compliance, with 67% of clinicians who did not use CAT citing this as the reason for them not adopting the modality.

## 8. Recommendations

To enhance the reliability and generalisability of conclusions, future studies should be conducted with survey data collected from a larger cohort of clinicians. A larger sample size will provide the opportunity to assess the differences in case selection and treatment protocols between specialist orthodontists and general dentists. Further investigations, which should ideally be qualitative in nature, should be undertaken in order to determine why clinicians choose certain treatment modalities, such as combining FAT and CAT, in certain clinical situations. Finally, investigations into digital treatment planning, refinements and well as interproximal reduction usage would provide further insights into the use of CAT in the South African setting.

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# Addendum 1: Clear Aligner Survey

## Clear Aligner Survey

Please complete the survey below.

Thank you!

---

Which province do you practice in?  Eastern Cape  
 Free State  
 Gauteng  
 KwaZulu-Natal  
 Limpopo  
 Mpumalanga  
 Northern Cape  
 North West  
 Western Cape

---

How many years have you been in practice ? \_\_\_\_\_

---

Do you use orthodontic clear aligners (Aligners) in your practice?  Yes  
 No

---

Please tick the one that best describes you?  Orthodontist  
 General Dentist

---

What approximate % of your annual orthodontic case load do you treat with aligners? \_\_\_\_\_

**To what degree do the following factors influence your decision in choosing to offer aligner treatment? (Please tick all that is appropriate)**

	Not at all influential	Slightly influential	Somewhat influential	Very influential	Extremely influential
cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
case complexity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
predicted patient cooperation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
patient demands	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
patient expectations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
case suitability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**How often do you treat the following with aligners?**

	always	mostly	sometimes	rarely	never
patients in the mixed dentition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
adolescent /teenage patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
adult patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Which of the following aligner system do you use in your practice?

- ACTIVE ALIGNERS
- ACCUSMILE
- CLEARCORRECT
- 'INHOUSE'
- INVISALIGN
- KRSTL
- REVEAL
- SLX
- SPARK
- SURESMLE
- OTHER

**To what degree do the following factors influence your decision to use a particular company/provider?**

	Not at all influential	Slightly influential	Somewhat influential	Very influential	Extremely influential
cost of appliance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ease of digital treatment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
quality of digital treatment plan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
sophisticaton of appliance design	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
aesthetics of appliances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
patient satisfaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
brand identity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ongoing education by provider	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
assistance in troubleshooting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
corporate support advertising	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**How often do you use the following aligner treatment modalities?**

	ALWAYS	MOSTLY	SOMETIMES	RARELY	NEVER
Single arch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dual arch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Which type of cases are you comfortable treating with aligners?

- Spaced dentition
- Mild crowding (0 to 4MM crowding )
- Moderate crowding (4.1 to 8MM crowding )
- Severe crowding (>8MM crowding )
- Deep overbite
- Reduced overbite
- Increased overjet
- Reduced overjet
- Posterior crossbite (unilateral)
- Posterior crossbite (Bilateral)

Which type of cases are you not comfortable treating with aligners?

- Spaced dentition
- Mild crowding (0 to 4MM crowding )
- Moderate crowding (4.1 to 8MM crowding )
- Severe crowding (>8MM crowding )
- Deep overbite
- Reduced overbite
- Increased overjet
- Reduced overjet
- Posterior crossbite (unilateral)
- Posterior crossbite (Bilateral)

**How often do you treat the following with aligners?**

	Always	Mostly	Sometimes	Rarely	Never
Premolar extraction cases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lower incisor extraction cases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Combined orthodontic/orthognathic surgery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Deep bite cases with bite ramps	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Do you combine aligners with fixed appliances in your initial treatment plan?

- Always
- Mostly
- Sometimes
- Rarely
- Never

**How frequently do you routinely change aligners for the following?**

	Weekly	Fortnightly	Other	Not applicable
Mixed dentition	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adolescent/teenager	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adults	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

What is the average treatment time, in months, per dual arch non-extraction case in your practice?

\_\_\_\_\_

What maxillary retainer do you most commonly use following orthodontic aligner treatment?

- Bonded retainer
- Thermoplastic (tr) only
- Hawley retainer only
- Bonded and tr
- Bonded and hawley
- None

What mandibular retainer do you most commonly use following orthodontic aligner treatment?

- Bonded retainer
- Thermoplastic (tr) only
- Hawley retainer only
- Bonded and tr
- Bonded and hawley
- None

In matched cases with identical treatment outcomes do you agree or disagree that patients prescribed aligners take more time to treat compared with fixed appliances?

- Agree strongly
- Agree somewhat
- Neither agree nor disagree. both take the same time.
- Disagree somewhat
- Disagree strongly

In matched cases with identical treatment outcomes do you agree or disagree that patients prescribed aligners produce superior treatment outcomes overall when compared with fixed appliances?

- Agree strongly
- Agree somewhat
- Neither agree nor disagree. both take the same time.
- Disagree somewhat
- Disagree strongly

**To what degree do the following factors influence your decision to not provide aligner treatment in your practice?**

	Not at all influential	Slightly influential	Somewhat influential	Very influential	Extremely influential
Insufficient postgraduate education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Concerns over ongoing aligner education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Initial costs to the practice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ongoing costs to the practice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Costs to the patient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disruption to practice with the introduction of new technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dependency on a third party for treatment provision	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fixed appliances provide better treatment outcomes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patients expectations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Concerns over patient compliance with treatment protocols	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Addendum 2: Electronic Consent Form

### consent

Please complete the survey below.

Thank you!

- 
- 1) I hereby confirm that I have been informed by the researcher, Yaseen Fakir, about the nature, conduct, benefits and risks of the proposed research. I have also received, read and understood the above written information (informed consent) regarding the study. I am aware that the results of the study, including personal details regarding sex, age and research results of myself will be anonymously processed into the research report. (See in particular the definition of "personal information" in the Promotion of Access to Information Act 2 of 2000.)  
I may, at any stage, without prejudice, withdraw my consent and participation in the study. I have had sufficient opportunity to ask questions and declare myself prepared to participate in the study.
- Yes  
 No

## Addendum 3: SADA Survey Distribution E-Link



**Circulation date: 2 February 2024**

**Please participate in this study -  
Prevalence of clear aligner usage in South Africa by dentists and orthodontists**

I, Yaseen Fakir, am pursuing my Master of Dental Science degree in the Department of Orthodontics at the University of the Western Cape, South Africa. I would like to invite you to take part in my research project. Please take time to read the following information carefully, and please feel free to ask questions if anything you read is not clear to you or if you'd like more information.

**What is the study about?**

The prevalence of clear usage in South Africa.

**Why are you being invited to participate in this study?**

To describe the use of clear aligners both by general dentists and orthodontists

**What will you be expected to do in this study?**

Complete an e-survey related to clear aligner usage. [Link to e-survey](#)

**What are the potential benefits involved in this study?**

Currently, there isn't any literature on the topic in a South African setting. This will provide useful insight into how the treatment modality is used locally.

**Will my details be kept confidential?**

Yes

**In terms of the requirements of the Protection of Personal Information Act (Act 4 of 2013), please note additional information: Who at UWC is responsible for collecting and storing my personal information?**

I will personally be responsible for collecting and storing the data.

**Who will have access to my personal information outside of the UWC?**

Only the researcher, supervisor, and statistician will have access to the data.

**How long will my personal information be stored?**

Electronic data will be kept on the researcher's or supervisor's password-protected computer for five years and deleted thereafter. Hard copies will be kept in a locked drawer for five years and deleted thereafter.

**How will my personal information be processed?**

No personal information will be processed.

**Who do I contact for further information?**

Dr Y Fakir

Should you require any further information, please do not hesitate to contact me, Yaseen Fakir, on my cell phone (0731571628) or via email (2521908@myuwc.ac.za). Alternatively, you may also contact my supervisor, Prof A Shaikh in the Department of Orthodontics at the University of the Western Cape (UWC), at [ashaikh@uwc.ac.za](mailto:ashaikh@uwc.ac.za).

To report any adverse or unexpected effects emerging from this research, please contact the ethics committee below:

Biomedical Research Ethics Committee  
Research and Postgraduate Division  
University of the Western Cape  
Private Bag X17  
Bellville 7535  
Tel: 021 959 4111  
Email: [research-ethics@uwc.ac.za](mailto:research-ethics@uwc.ac.za)

## Addendum 4: Information Sheet



### Department of Orthodontics

Tel: +2721 937 3106/3105  
Clinic: +2721 937 3172



#### **Information Sheet:**

#### **Topic Clear Aligner Usage by Orthodontists and General Dentists in South Africa**

Dear Colleague,

I, Yaseen Fakir, am pursuing my Master of Dental Science degree in the Department of Orthodontics at the University of the Western Cape, South Africa. I would like to invite you to take part in my research project. Please take time to read the following information carefully, and please feel free to ask questions if anything you read is not clear to you or if you'd like more information.

#### **What is the study about?**

The prevalence of clear usage in South Africa.

#### **Why are you being invited to participate in this study?**

To describe the use of clear aligners both by general dentists and orthodontists

#### **What will you be expected to do in this study?**

Complete a e-survey related to clear aligner usage.

#### **What are the potential benefits involved in this study?**

Currently, there isn't any literature on the topic within the South African setting. This will provide useful insight into how the treatment modality is used locally.

#### **Will my details be kept confidential?**

University of the Western Cape. Private Bag X1. Tygerberg 7505. South Africa.



## Department of Orthodontics

Tel: +2721 937 3106/3105  
Clinic: +2721 937 3172



Yes

In terms of the requirements of the Protection of Personal Information Act (Act 4 of 2013), please note additional information:

**Who at UWC is responsible for collecting and storing my personal information?**

I will personally be responsible to collect and store data.

**Who will have access to my personal information outside of UWC?**

Only the researcher, supervisor and the statistician will have access to the data.

**How long will my personal information be stored?**

Electronic data will be kept on the researcher's/supervisors password protected computer for five years and deleted thereafter. Hard copies will be kept in a locked drawer for five years and deleted thereafter.

**How will my personal information be processed?**

No personal information will be processed.

**Who do I contact for further information?**

**Dr Y Fakir**

Should you require any further information, please do not hesitate to contact me Yaseen Fakir on my cell phone (0731571628) or via email (2521908@[myuwc.ac.za](mailto:myuwc.ac.za)). Alternatively, you may also contact my supervisor Prof A Shaikh in the Department of Orthodontics, University of the Western Cape (UWC), [ashaikh@uwc.ac.za](mailto:ashaikh@uwc.ac.za).

**To report any adverse or unexpected effects emergent from this research, please contact the ethics committee below:**

Biomedical Research Ethics Committee

University of the Western Cape. Private Bag X1. Tygerberg 7505. South Africa.

## Addendum 5: BMREC Ethical Clearance



UNIVERSITY of the  
WESTERN CAPE

Directorate: DVC: Research and Innovation  
Research and Postgraduate Support  
Tel: +27 21 959 4111  
Email: [research-ethics@uwc.ac.za](mailto:research-ethics@uwc.ac.za)

24 August 2023

Dr Y Fakir  
Orthodontics  
Faculty of Dentistry

**BMREC Reference Number:** BM23/6/17

**Project Title:** Clear Aligner Usage among Orthodontists and General Dentist in South Africa.

**Approval Period:** 17 August 2023 – 17 August 2024

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

*Please remember to submit an annual progress report at least two months before expiry date. Failure to submit your annual progress report on time will result in the immediate lapse of your ethics approval and you will have to resubmit an entirely new ethics application.*

For permission to conduct research using student and/or staff data or to distribute research surveys/questionnaires please apply via: <https://sites.google.com/uwc.ac.za/permissionresearch/home>

*The permission letter must then be submitted to BMREC for record keeping purposes.*

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

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

Ms Patricia Josias  
Coordinator: Research Ethics  
University of the Western Cape

NHREC Registration Number: BMREC-130416-050

University of the Western Cape, Robert Sobukwe Road, Bellville 7535, Republic of South Africa