Original Article

Invisalign Lite: a cross-sectional investigation of orthodontist treatment-planning practices

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ABSTRACT

Objectives: To survey treatment-planning practices of orthodontists related to the Invisalign Lite clear aligner appliance (Align Technology, San Jose, Calif).

Materials and Methods: Patients satisfying inclusion and exclusion criteria and treated with Invisalign Lite were selected from a database containing more than 17,000 patients. Relevant data regarding treatment-planning practices were obtained from Align Technology's treatment-planning facility, ClinCheck, and evaluated.

Results: Most (n = 135; 79.9%) patients were female and had a median (interquartile range [IQR]) age of 30.5 (23.8, 43.1) years. The median (IQR) number of aligners for the sample was 23.0 (14, 28) for the maxilla and 24 (14, 28) for the mandible. Most (n = 122; 72.2%) patients required at least one additional series of aligners. More locations for interproximal reduction (IPR) were prescribed in the mandible (mean 1.91 [1.78]) than in the maxilla (1.03 [1.78]; $P < .024$) in the initial accepted plan of all patients. More teeth were prescribed composite resin (CR) attachments in the maxilla ($P < .0001$) in the initial accepted plan of all patients. Issues regarding tooth position protocols (n = 50; 53.3%) and requirement for additional IPR (n = 68; 45.3%) were reasons for treatment plan changes before acceptance of the initial treatment plan by orthodontists.

Conclusions: More than 7 of 10 patients required at least one additional series of aligners after the initial series of Invisalign Lite aligners was completed. Prescription of IPR was more common in the mandible, and prescription of CR attachments was more common in the maxilla. (*Angle Orthod*. 2024;94:280–285.)

KEY WORDS: Clear aligner therapy; Invisalign Lite; Treatment protocols

INTRODUCTION

Orthodontic treatment of malocclusion has become commonplace globally.[1] Most orthodontic treatment has been traditionally carried out with the use of fixed appliances. Over the past 20 years, however, clear aligner therapy (CAT), an esthetic alternative to fixed appliances, has increased.[2] The modern iteration of CAT started in the late 1990s with the introduction of the Invisalign (Align Technology, Santa Clara, Calif) appliance, using computer-aided design and computer-aided manufacturing technology.[3] A plethora of CAT appliances have been introduced by other companies in the interim, but Invisalign appears to be the most widely used CAT appliance system wordwide.[4–7]

In general, CAT involves the provision of a series of removable plastic aligners fitted over the teeth, each modified slightly, to incrementally correct an individual's malocclusion.[3] Patients are required to wear their aligners for approximately 22 hours daily with renewal of the aligner every 7 to 14 days as prescribed by the treating clinician, until the wear of all aligners in the series has been completed. The bonding of composite resin (CR) attachments to the

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Accepted: January 2024. Submitted: October 2023.
Published Online: February 22, 2024

teeth is frequently used to optimize the effectiveness of the aligners.[8] In addition, the interproximal reduction (IPR) of enamel is commonly used in conjunction with CAT to aid attainment of treatment objectives.[9,10] Recent studies, however, have indicated that there may be uncertainty surrounding the use of CR attachments and IPR in CAT.[4,6,9–11] Just over 72% of respondents in a 2022 survey of orthodontists indicated that CR attachments were "almost" or "always" a factor in need of change in the initial treatment plan provided by a CAT provider.[4] In addition, recent investigations indicated that the amount of IPR prescribed by the orthodontist as part of the treatment plan is frequently not achieved.[9–11]

CAT requires close communication between the orthodontist and the provider of the aligners.[3] This is usually mediated through a digital interface. The orthodontist can modify the initial digital treatment plan (DTP) provided by the aligner manufacturer via the interface before acceptance of the plan by the orthodontist. The interface can also facilitate the modification of additional DTPs, which are routinely required for the provision of additional sequences of aligners to achieve desired treatment outcomes.[3,8,12] For Invisalign, this interface is called ClinCheck. A feature of ClinCheck is the capacity to provide numerical data regarding aspects of the treatment-planning process such as the number of DTPs required before acceptance by the treating orthodontist and any additional DTPs necessary to achieve planned treatment objectives.[3,13] In addition, it can provide a visual representation with information of the upper and lower teeth regarding the prescription of CR attachments and IPR.

Align Technology also provides a treatment modality, Invisalign Lite, which aims to address minor crowding and/or spacing orthodontically within a maximum of 14 aligners.[14] Up to two additional DTP phases, comprising a maximum 14 aligners per phase, are provided "free of charge" if required. However, the additional DTPs must be provided within 2 years of the start of treatment.

Treatment-planning protocols related to the Invisalign appliance have been explored in the literature.[3,8] However, similar data regarding Invisalign Lite are limited. Comparable information about Invisalign Lite is likely to be valuable as it can provide orthodontists and patients with new knowledge about treatment-planning protocols and the potential need for additional aligners and treatment duration.

The aim of the study was to survey the treatment-planning practices of orthodontists regarding the Invisalign Lite clear aligner appliance.

MATERIALS AND METHODS

Ethical approval was provided by the University of Adelaide Human Research Ethics Committee.

Patient data were obtained for evaluation from the Australasian Aligner Research Database, which contains the relevant details of patients treated with aligners provided by Align Technology. The database comprises information related to approximately 17,000 patients treated by 18 orthodontists in three countries and experienced in the use of the company's aligner appliances. All patients treated with appliances provided by Align Technology by the orthodontists are included in the database.

Inclusion Criteria

1. Patients aged $\geq$18 years who received dual-arch Invisalign Lite treatment only between 2018 and 2021
2. Patients with a complete permanent dentition (excluding third molars) or mixed dentition in which no permanent successors were present
3. Wear of the initial prescribed sequence of aligners to the satisfaction of the treating orthodontist
4. Availability of ClinCheck data following the completion of the initial series of aligners

All patients who satisfied the criteria were included in the study. The following information was recorded on a Microsoft (Redmond, Wash) Excel spreadsheet from each included de-identified patient's ClinCheck details: age, gender, number of DTPs prior to acceptance by the orthodontist, number of aligners prescribed in the initial DTP, number of additional DTPs (if any), and number of aligners prescribed in the additional DTPs. Data regarding prescribed CR attachments and IPR protocols were also recorded.

The areas of IPR prescription for each arch were categorized according to whether the IPR location was anterior (from the distal of the canine to its antimere; maximum of seven contacts) or posterior (mesial and distal to the second premolars; maximum of four contacts).[9] Finally, details regarding the changes from the proposed plan by Align Technology to the initial accepted plan by the orthodontist were documented.

Statistics

GraphPad Prism (GraphPad Software Inc., La Jolla, Calif) was used for statistical analysis. Descriptive statistics entailed the use of means, medians, and percentages. The application of the Shapiro-Wilks test determined that the data followed a nonparametric distribution. The Mann-Whitney, Wilcoxon rank-sum,

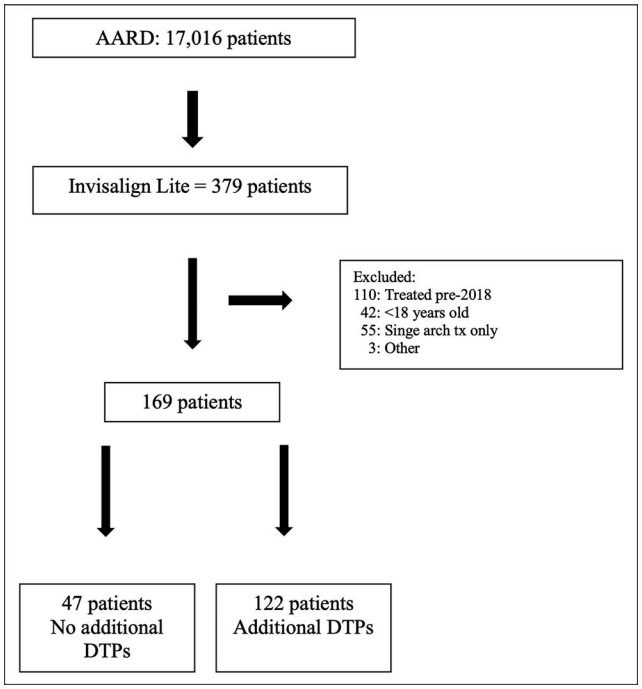

Figure 1. Flow diagram showing patient selection.

and Kruskal-Wallis tests were used to determine whether differences between groups and subgroups were significant. Intra- and inter class correlation (ICC) testing was carried out to determine reliability in data input.

RESULTS

Figure 1 shows that 169 patients satisfied the inclusion criteria. Table 1 shows that most (n = 135; 79.9%) were female and that the median (interquartile range [IQR]) age was 30.5 years (23.8, 43.1 years). There was no difference in gender ($P > .05$) or age ($P > .05$) between those who required additional aligners and those who did not. Most (n = 122; 72.2%) patients required at least one additional DTP and series of aligners. An overall median of four initial and refinement DTPs was required in those who were prescribed additional aligners.

The initial DTP for 19 (11.24%) patients required no change before acceptance by the orthodontists. The median (IQR) number of initial DTPs before acceptance by orthodontists was 2.0 (2.0, 3.0). The median number of aligners for the overall sample was 23 (14, 28) for the maxilla and 24 (14, 28) for the mandible. The number of aligners prescribed in the initial DTP was 4626, and the total number of aligners prescribed in the initial and additional DTPs was 8203.

Table 2 outlines the details regarding the nature of the required changes from the proposed plan by Align Technology to the initially accepted plan by the orthodontists.

Table 3 shows that a maximum of five additional DTPs were required in those patients who required additional aligners. Most (n = 64; 52.5%) completed treatment after one additional DTP. The maximum number of aligners prescribed per patient was 56 in each of the maxilla and mandible.

Table 4 shows the breakdown of the number of prescribed locations of IPR in the initial accepted DTP according to whether patients were prescribed additional aligners. It indicates that 103 patients (60.9%) of the overall sample had IPR in their initial DTP. More interproximal locations for IPR were prescribed in the mandible (mean 1.92 [1.78]) than in the maxilla (1.03 [1.78]; $P < .024$) in the initial accepted plan of all patients.

Most (n = 158; 93.5%) patients had CR attachments prescribed on teeth in the maxilla and mandible, with one patient (0.6%) having attachments prescribed in the maxilla only. Ten (5.9%) patients were not prescribed any attachments. The median (IQR) number of CR attachments prescribed in the maxilla was 8 (6, 10; maximum: 15, minimum 0) in the initial accepted DTP and was greater than the 7 (6, 8;

Table 1. Demographic Statistics ($N = 169$)[a]

	Overall		No Additional DTPs		Additional DTPs	
N	169		47		122	
Gender	F: 135 (79.9%)		F: 38 (80.85%)		F: 97 (79.5%)	
	M: 34 (20.1%)		M: 9 (19.15%)		M: 25 (20.5%)	
	Median (IQR)		Median (IQR)		Median (IQR)	
Age, y	30.5 (23.8, 43.1)		29.92 (23.7, 45.8)		30.5 (24.3, 43)	
IDTPs	2.0 (2.0, 3.0)		2.0 (2,3)		2.0 (2.0, 3.0)	
Additional DTPs			–		2.0 (2.0, 4.0)	
Total DTPs (Initial and additional)			–		4.0 (4.0, 7.0)	
Initial aligners	Maxilla	Mandible	Maxilla	Mandible	Maxilla	Mandible
	14 (14, 14)	14 (14, 14)	14 (14, 14)	14 (14, 14)	14 (14, 14)	14 (14, 14)
Initial + additional aligners					26 (22, 28).	26 (22.5, 28)

[a] ADTP indicates additional digital treatment plan; DTP, initial digital treatment plan; F, female; M, male.

Table 2. Details of Changes From the Proposed Plan to the Initial Accepted Plan by Orthodontist (N = 150)[a]

Change[b]	n	%
Tooth position protocols	80	53.33
Additional IPR	68	45.33
Less IPR	11	7.33
Additional CR attachments	71	47.33
Fewer CR attachments	51	34
CR attachment changes	24	16
TP changes	2	1.33

[a] CR indicates composite resin. IPR, interproximal reduction; TP, treatment plan.

[b] There may be more than one reason for changing from the proposed plan to the initial accepted plan.

maximum: 14, minimum 0) prescribed for the mandible ($P < .00001$).

Table 5 outlines the mean number of IPR locations and the median number of teeth with CR attachments that were prescribed in each additional DTP. Table 6 shows that the anterior of each arch was the location where IPR was most commonly prescribed in the initial DTP. There were more locations in the anterior teeth of the mandibular arch ($P < .00001$) with prescribed IPR than elsewhere.

ICC scores for data input were very high, with an intrarater range between 0.98 and 1.0 and an interrater range of 0.97 and 1.0 recorded.

DISCUSSION

The current study appears to be the first to investigate orthodontist treatment-planning practices regarding the Invisalign Lite appliance. The increasing demand for esthetic treatment of short duration and the popularity of the Invisalign brand highlight the relevance of the study. Of additional relevance is that the objective of the Invisalign Lite appliance appears to be to address those minor malocclusion traits for which the Invisalign appliance was originally introduced to manage in the late 1990s.[14,15] The findings indicated

Table 3. TP and Aligner Details of Patients According to the Required Number of Additional DTPs

	Patients		Aligners per DTP	
	Location		Location	
	n		Median (IQR)	
DTP	Maxilla	Mandible	Maxilla	Mandible
Initial DTP	122	122	14 (14, 14)	14 (14, 14)
Additional DTP 1	122	122	10 (7, 14)	10 (8, 14)
Additional DTP 2	46	46	10 (6,14)	10 (6, 14)
Additional DTP 3	10	10	11 (7.5, 14)	10.5 (5.75, 14)
Additional DTP 4	1	1	5 (5, 5)	5 (5, 5)
Additional DTP 5	1	1	14 (14, 14)	14 (14, 14)

[a] DTP indicates digital treatment plan; IQR, interquartile range.

Table 4. Prescribed Locations of IPR in the Initial Accepted Digital Treatment Plan According to Whether Patients Were Prescribed Additional Aligners[a]

Location of IPR	No Additional Aligners (n = 47)	Additional Aligners (n = 122)
No IPR	16	50
Maxilla only	10	21
Mandible only	10	30
Maxilla and mandible	11	21

[a] IPR indicates interproximal reduction.

that most patients required at least one additional series of aligners and that almost as many aligners were prescribed in the additional DTPs as in the initial. In addition, the most common reason for orthodontists to make changes to the initial DTP before acceptance was related to tooth position protocols.

Care is required when comparing the findings from other corresponding investigations as the number of published studies investigating the Invisalign Lite appliance is limited.[14] However, some similarities with studies reporting Invisalign treatment-planning protocols were apparent. The median age of patients in the current study was 30.5 years. This compared to a mean of 28.5 to 33.0 years in investigations related to Invisalign and 33.4 years in a study regarding occlusal contact outcomes with the Invisalign Lite appliance and was indicative of the age at which patients frequently undergo CAT.[3,8,14,16] The relatively high percentage of females, however, was greater than that recorded generally in Invisalign studies. This may suggest a tendency for females to undertake orthodontic retreatment more readily or reflects the higher esthetic demands of females.[1,17,18]

A median of two initial DTPs were necessary before acceptance of the initial DTP. This compared to a mean of 0.79 to 2.5 in studies investigating Invisalign and Invisalign Teen appliances.[3,19–21] Almost three-quarters (72.2%) of patients required an additional series of aligners, which was slightly more than the

Table 5. Mean (SD) Number of IPR Locations and Median (IQR) Number of Teeth With CR Attachments per Additional DTP

	IPR		CR Attachment	
	Mean (SD) (IPR Locations)		Median (IQR) (n Teeth)	
	Maxilla	Mandible	Maxilla	Mandible
Initial DTP	0.93	1.8	8 (6, 10)	7 (6, 8)
Additional DTP 1	0.53 (1.27)	0.75 (1.5)	3 (0, 7)	3 (1, 5)
Additional DTP 2	0.32 (0.68)	0.44 (1.28)	1 (0, 4)	0 (0, 3)
Additional DTP 3	0.20 (0.42)	0.4 (1.27)	0.50 (0, 3)	0.0 (0, 1.5)
Additional DTP 4	0	0	2 (2, 2)	2 (2, 2)
Additional DTP 5	0	0	0 (0, 0)	0 (0, 0)

[a] CR indicates composite resin; DTP, digital treatment plan; IPR, interproximal reduction; IQR, interquartile range.

Table 6. Location of IPR in the Initial DTP

Arch Location	Patients Prescribed IPR	Median (IQR) Location	Range
Maxilla			
Anterior	61	2 (1, 3)	1, 7
Posterior	6	2 (1, 1.5)	1, 4
Mandible			
Anterior	72	5 (3.5)	3, 7
Posterior	4	3.5 (1, 4)	1, 4

Key: IPR: interproximal reduction. DTP: digital treatment plan. N: number. IQR: interquartile range. Note: Patients may have had prescribed IPR in more than one arch location.

68.2% recorded in the 2023 study related to Invisalign Lite.[14] Although less than the 87% to 99.4% reported in a wide range of investigations, the number of patients in the present study requiring additional aligners suggested that achieving a satisfactory occlusal outcome for a mild malocclusion was more challenging than anticipated.[8,12,21]

Just more than 60% of the patients in the present study required IPR as part of their initial DTP. This compared with 61.3% to 90% of patients who were prescribed IPR in three recent studies related to nonextraction treatment with the Invisalign appliance.[8–10] More IPR was carried out in the mandible (particularly in the lower anterior teeth) than in the maxilla, and this was in agreement with the findings in similar studies regarding the Invisalign appliance.[10,22] This may have reflected the choice of IPR as the preferred approach to address lower incisor overlap related to tertiary crowding in adulthood and/or orthodontic treatment relapse.[4,23]

Ten (5.9%) patients were not prescribed CR attachments. This compared with just 1.5% of patients undergoing nonextraction treatment with the Invisalign appliance in a 2023 study.[8] Research regarding the efficacy of CR attachments in CAT is limited.[2] However, recent studies have indicated that attachments may not be successful in effectively achieving some types of tooth movement.[24,25] This, in addition to the fact that the amount of IPR undertaken is apparently less than that prescribed by orthodontists, suggested satisfactory outcomes for the correction of some malocclusion traits may be difficult to achieve with the appliance and may contribute to outcomes that do not correspond to those planned by the orthodontist.[9–11]

Issues regarding CR attachments were among the reasons why 16% to 47.33% of the orthodontists required changes from the initial DTP to the accepted DTP in the present investigation. This contrasted with the 35% to 72.5% of orthodontists who reported that "CR attachments" was the factor that "always" or "mostly" required change from the initial plan received from the CAT provider in recent surveys of orthodontists.[1,3] This may indicate that CR attachments are less of an issue for orthodontists in the treatment planning for milder malocclusions.

Poor patient compliance with aligner wear protocols, aligner material deficiencies, and suboptimal CAT software systems have been suggested as reasons why additional aligners are necessary for most patients undergoing comprehensive CAT.[2,3,8] Research is required to determine the extent that these factors play in the provision of additional aligners in Invisalign Lite therapy. Research is also needed to determine the processes by which a decision is made to treat a patient with the Invisalign appliance rather than Invisalign Lite. In addition, more detailed analysis of the presenting malocclusion and the planned and achieved treatment outcomes in the current cohort is warranted to enable the identification of those aspects of CAT with the Invisalign Lite appliance where improved efficacy may be required.

The authors acknowledge the limitations of the present study. There was a high risk of selection bias as the investigation was retrospective. The application of strict inclusion criteria, however, to a large database aimed to reduce this. Also, the findings related to adult patients are not relevant to other CAT appliances and nonadult patients.

Nevertheless, as the available evidence regarding Invisalign Lite is limited, the findings of the present study provide information for the orthodontist and the patient in shared decision-making processes. Patients were more often likely to require at least one additional series of aligners in their treatment with the appliance, and more than 60% of patients were prescribed IPR and more than 90% were prescribed CR attachments. Further investigation is urgently required to determine the efficacy of Invisalign Lite appliance treatment-planning practices in achieving desired treatment outcomes.

CONCLUSIONS

- More than 7 of 10 patients in the present investigation required at least one additional series of aligners after the initial series of Invisalign Lite aligners was completed.
- Almost as many aligners were prescribed in the additional DTPs as in the initial DTP.
- Prescription of IPR was more common in the mandible and prescription of CR attachments was more common in the maxilla.
- Tooth position protocols and the requirement for additional IPR were common reasons for treatment plan changes before the acceptance of the initial treatment plan.

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