

Clear aligner therapy procedures and protocols of orthodontists in New Zealand

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Objective: To survey clear aligner therapy (CAT) procedures and protocols of orthodontists in New Zealand.

Methods: One hundred and ten full members of the New Zealand Association of Orthodontists were invited to complete an e-survey. The questions related to respondent demographics, aligner choice and use, CAT planning and treatment protocols, case selection, patient-reported CAT problems and relevant respondent opinions. The reasons for respondents not providing CAT were also surveyed.

Results: The response rate was 70%. Most respondents (88.3%; $N = 68$) reported that they used CAT as a treatment modality with 43.15% ($N = 29$) treating between 1 and 20 patients per year. The predominant CAT system was the Invisalign appliance (70.3%; $N = 45$) with 49.2% ($N = 32$) stating that they used more than one CAT system. The respondents reported the areas which were always or mostly in need of amendment prior to acceptance of the CAT treatment plan were attachments (75.6%; $N = 50$) and final tooth positions (62.1%; $N = 41$). A median of 0% (IQR: 0, 1) of initial digital treatment plans were approved without changes according to the respondents with a median of 90% (IQR: 80, 99) of CAT patients requiring an additional aligner phase. Almost 80% (78.1%; $N = 50$) indicated that they were not comfortable in treating cases with increased overbite and 66.7% ($N = 44$) rarely or never carried out premolar extractions when using CAT. A remote monitoring system was mostly or always used by 32.4% ($N = 21$) of respondents in conjunction with CAT. Concern regarding patient compliance with CAT protocols was expressed by 43.5% ($N = 22$). That fixed appliances provided better treatment outcomes was a moderate or major influence on the decision of all respondents ($N = 8$) who did not provide CAT.

Conclusion: Although CAT provision by orthodontists is commonplace among orthodontists in New Zealand, there is wide variation in its usage and procedures.

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Introduction

Clear aligner therapy (CAT) has become an accepted aesthetic alternative to fixed labial appliances.¹ Since the introduction of the Invisalign appliance (Align Technology, Santa Clara, California, U.S.A.) over 20 years ago, several CAT systems have been developed and presented for the treatment of malocclusion. A more recent phenomenon has been the introduction of clear aligner systems targeted for use by the consumer ('direct-to-consumer' or DTC) without

any direct input or supervision by a clinician.² Initially intended to treat minor tooth malalignment in the adult patient, contemporary CAT systems are commonly used for the management of more complex malocclusions.³

CAT involves the manufacture of a series of plastic aligners that are sequentially changed to move the teeth to a pre-determined or planned position. CAT systems use a digital interface through which the orthodontist can visualise and plan tooth movements,

often prescribing bonded composite resin (CR) attachments and/or interproximal reduction (IPR) to aid treatment planning objectives.^{1,4}

The commonly reported advantages of CAT include acceptable aesthetics, reduced chair time, less discomfort compared with fixed appliances and the ability to remove the appliance for eating and oral hygiene practices.^{1,5,6} The purported disadvantages include the difficulty of some patients in complying with prescribed wear protocols and the environmental effects of the non-biodegradable plastic used in their fabrication.^{1,7,8}

Despite developments in software and plastic material technology, the limited available CAT-related research indicates that CAT may be deficient at managing some malocclusions.^{9–14} Consequently, this may require the manufacture of one or more additional series of aligners to achieve treatment objectives, thus extending treatment time and/or the need to combine CAT with fixed appliances to complete treatment.^{4,15}

Until recently, information regarding CAT practices and protocols among orthodontists was limited to sections of more broad-ranging surveys regarding orthodontic treatment protocols.^{16–18} The findings from three comprehensive surveys, however, investigating CAT procedures of orthodontists in Australia, the United States and Canada (U.S.A./Canada), the United Kingdom and the Republic of Ireland (U.K./ROI) have been recently published and have provided insight into orthodontist CAT-related practices.^{19–21} Similar information is lacking in New Zealand (NZ). The aim of the present cross-sectional investigation was to survey CAT procedures delivered by specialist orthodontists in NZ. An additional aim was to determine the factors that influenced orthodontists in NZ not to provide CAT.

Material and methods

The present study was approved by the University of Adelaide Human Research Ethics Committee (H-2023-166). The survey was adapted from similar surveys carried out in Australia and the U.K./ROI.^{20,21} The questions were modified to ensure applicability for a NZ-based specialist orthodontist population and piloting suggested completion of the survey took approximately 15 min. The survey was developed on the SurveyMonkey (San Mateo, CA, U.S.A.) online platform.

The survey questions were divided into nine sections. The first pertained to the respondent's demographic information. The second section investigated the frequency of CAT use by providers. Those who answered that they did not provide CAT as part of their treatment armamentarium were questioned regarding the reasons that influenced their decision (Section 9). The questions in Section 3 related to the preferred CAT systems used by respondents. Questions pertaining to digital treatment plans, case selection and CAT procedures were asked in Sections 4 to 7. The respondents were surveyed regarding their post-CAT retention protocols and their opinions regarding CAT in Section 8.

There were 147 individuals registered as orthodontic specialists with the Dental Council of New Zealand including 32 who had a practising status of "Not practising in the Orthodontic Specialist Scope of Practice" on September 9th, 2023.²² The New Zealand Association of Orthodontists (NZAO) is the representative body for orthodontic specialists in NZ. Full member orthodontists attending a NZAO clinic day on July 28th, 2023, were invited to participate in the survey via a "quick response" (QR) code. An email invitation for participation, with a link to the survey, was sent to all 110 full members on August 1st, 2023 and an email reminder was sent on August 21st to invite members to participate who had not already responded. Student and associate members were excluded. The survey was closed on August 30th, 2023. Cookies on the platform's web browsers were used to reduce the risk of repeat submissions of the survey by the same respondents.

The survey responses were recorded on a Microsoft Excel spreadsheet (version 16.0, Microsoft, Redmond, WA, U.S.A.) which was exported from the SurveyMonkey platform. Following data cleaning, statistical analyses were carried out through the GraphPad Prism (GraphPad Software Inc., La Jolla, California, U.S.A.) software program. The results were presented in frequencies and percentages. The content of respondent comments regarding CAT-related problems and improvements that respondents would like addressed were categorised, using a coding guide, under themes. Some comments were categorised under more than one theme.

Results

A response rate of 70% ($N = 77$) was recorded. Not all respondents answered every question. Percentages

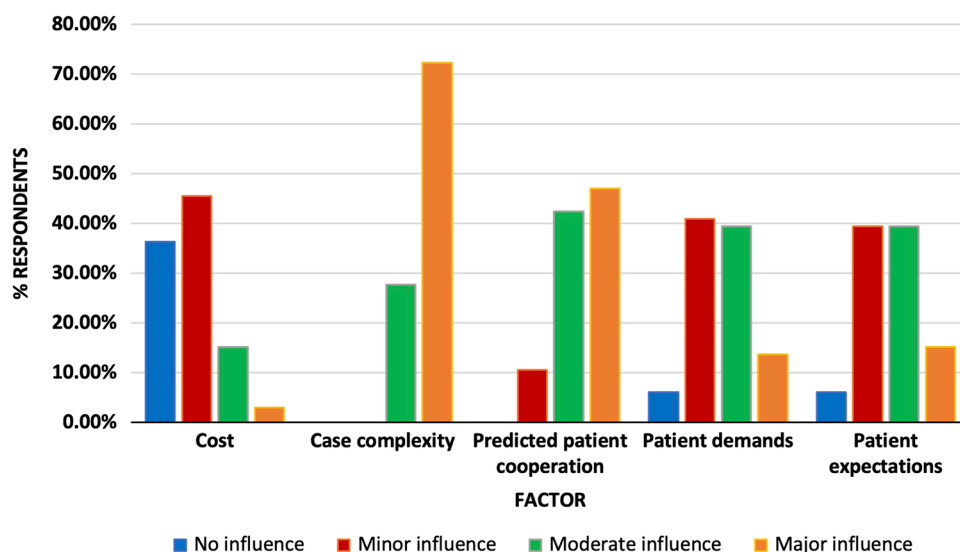


Figure 1. Factors that influence respondents' decision to offer CAT ($N = 66$).

provided in the present survey, therefore, related to the number of respondents who answered the pertinent questions.

The majority of those who responded were male (55.3%; $N = 42$). The median number of years in practice was 16.0 (interquartile range [IQR]: 6.5, 26.0). Most respondents reported that they acquired their specialist orthodontic qualification in NZ (61.0%; $N = 47$) followed by Australia (13.0%; $N = 10$), U.K. ($N = 10.4$ %; $N = 8$), U.S.A. (3.9%; $N = 3$) and other countries (11.7%; $N = 9$). Private practice was the clinical setting for the majority (89.7%; $N = 69$) with 7.8% ($N = 6$) reporting their practice to be a combination of a community/hospital/university and private settings. Almost 90% (88.3%; $N = 68$) reported that they used CAT as a treatment modality. The median percentage number of cases from the overall case load reportedly treated with CAT by the respondents each year was 15 (IQR: 10, 30). Figure 1 shows case complexity was a major influence of 72.3% ($N = 47$) in the decision to offer CAT.

More than 28% (28.8%; $N = 19$) reported that they treated between 11 and 20 patients per year, followed by 22.7% ($N = 15$) who treated between 51 and 100 and 15.15% ($N = 10$) who treated between 1 and 10. One in six (16.7%; $N = 11$) respondents reported that they treated more than 100 patients with aligners each year.

Figure 2 indicates that patients presenting in the mixed dentition were infrequently treated with CAT by the respondents.

The most commonly used CAT system by the respondents was the Invisalign appliance (70.3%; $N = 45$) followed by the uLab system [uLab Systems Inc., San Mateo, CA, U.S.A.] (9.4%; $N = 6$), Spark Clear Aligners [Ormco Corporation, Orange, CA, U.S.A.] (7.8%; $N = 5$), SureSmile [Dentsply-Sirona, Charlotte, NC, U.S.A.] (6.3%; $N = 4$), Clarity aligners [3M, St Paul, MN, U.S.A.] (4.7%; $N = 3$) and Angel Align [Wuxi Angel Align Biotechnology Co Ltd, Wuxi, China] (1.6%; $N = 1$).

Just less than half (49.2%; $N = 32$) of the respondents stated that they used more than one CAT system. More than four out of five (81.5%; $N = 53$) responded that they used the Invisalign appliance, 20% ($N = 13$) reported that they used Spark Clear Aligners and 20% ($N = 13$) also indicated that they used uLab appliances. Angelalign (15.4%; $N = 10$), SureSmile (13.4%; $N = 9$) and 'inhouse' appliances (10.8%; $N = 7$) were also reportedly used by the respondents.

Table I shows that the ease and quality of the digital treatment plan was a moderate or major factor for most respondents regarding the decision to use a specific CAT provider.

The respondents reported that a median of 0% (IQR: 0, 1) of their initial DTPs were approved without changes. Forty-seven (75.3%) respondents indicated that the initial DTPs of all their CAT patients required changes before approval. Almost half (48.5%; $N = 32$) considered that one-to-three changes were made to the initial DTP while

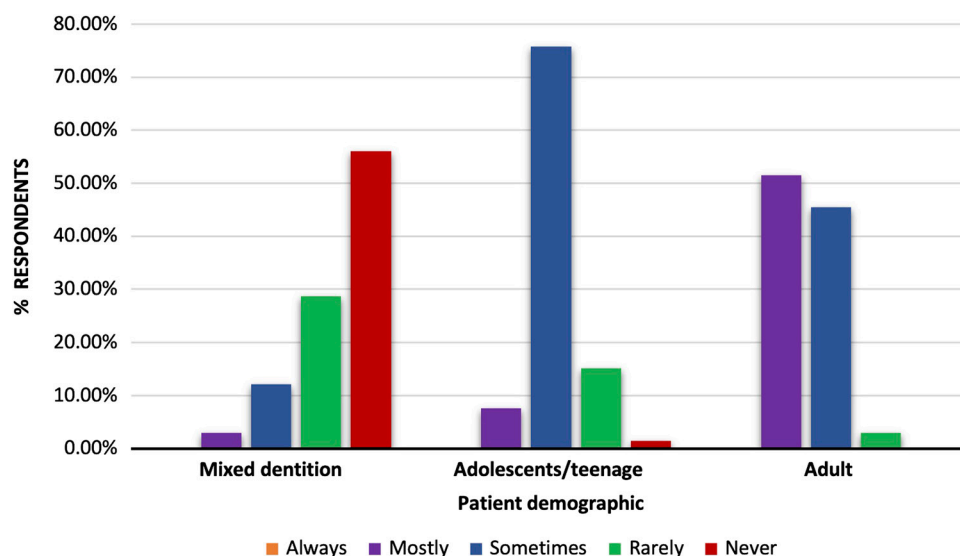


Figure 2. Patient cohorts treated by respondents (N = 66).

37.9% ($N = 25$) made four-to-six changes and 12.1% ($N = 8$) made more than six changes before acceptance of the plan.

A median of 90% (IQR: 80, 99) of CAT patients were reported by the respondents to require an additional aligner phase. The reported median number of additional aligner plans per patient was two (IQR: 1, 2)

Figure 3 indicates that the areas that respondents reported were always or mostly in need of amendment prior to acceptance of the CAT treatment plan were applied attachments (75.6%; $N = 50$) and final tooth positions (62.1%; $N = 41$). Other areas reported to

need change included the timing and staging of IPR (4.5%; $N = 3$).

Table II shows that all respondents were comfortable in treating mild crowding using CAT. Respondents indicated that they were also comfortable in treating a 'scissors bite' (1.5%; $N = 1$) and 'minor retreatments' (1.5%; $N = 1$). Additionally, respondents reported that they were not comfortable treating patients with ectopic or impacted canine teeth (7.8%; $N = 5$).

Figure 4 shows that the respondents were always or mostly more likely to treat 'lower incisor extraction' cases (40.9%; $N = 27$).

Table I. Factors that influence decisions in choosing to use a specific aligner provider

Factor level of influence	No		Minor		Moderate		Major		Total
	%	N	%	N	%	N	%	N	N
Cost	22.7	15	40.9	27	28.8	19	7.6	5	66
Ease of digital treatment planning	3.1	2	6.2	4	47.7	31	43.1	28	65
Quality of digital treatment plan	3.0	2	16.7	11	42.4	28	37.9	25	66
Sophistication of appliance features	9.2	6	40.0	26	33.9	22	16.9	11	65
Aesthetics of appliances	21.2	14	47.0	31	22.7	15	9.1	6	66
Patient satisfaction	16.7	11	33.3	22	31.8	21	18.2	12	66
Brand awareness (among patients)	30.3	20	39.4	26	21.2	14	9.1	6	66
Ongoing education by provider	31.8	21	30.3	20	28.8	19	9.1	6	66
Assistance in 'troubleshooting'	10.8	7	29.2	19	43.1	28	16.9	11	65
Corporate support - advertising	54.6	36	36.4	24	7.6	5	1.5	1	66

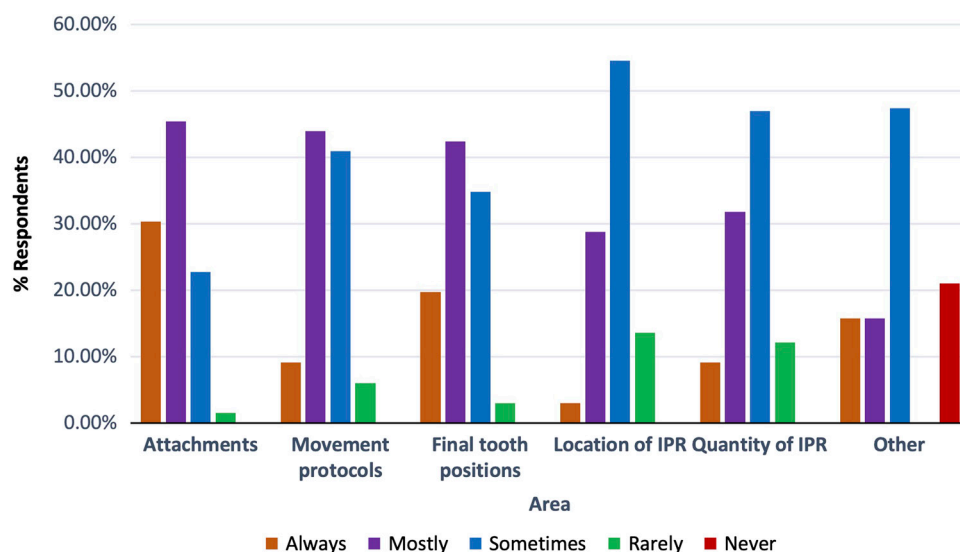


Figure 3. Areas that respondents reported in need of amendment prior to acceptance of the CAT treatment plan ($N = 66$). IPR, interproximal reduction.

Almost three-quarters (71.2%; $N = 47$) stated that they combined fixed appliances with CAT as part of the initial treatment plan in contrast to 18.2% ($N = 12$) who rarely or 10.6% ($N = 7$) who did not. More than half (53.9%; $N = 35$) reported that they did not routinely use Dental Monitoring (Paris, France) or other remote monitoring systems for patients undergoing CAT whereas 13.9% ($N = 9$) always and 18.5% ($N = 12$) mostly did.

Figure 5 shows that respondents most commonly recommended fortnightly changes of aligners for adolescent/teenage (40.9%; $N = 27$) and for adult (57.6%; $N = 38$) patients. Changes every 10 days (6.1%; $N = 4$) and every 10 to 14 days (4.5%; $N = 3$) were other protocols reported by respondents, with overall recommended aligner changes ranging from 4 days to 3 weeks.

Table III shows that the respondents most commonly recommended that patients attended their clinic for progress checks every 8 weeks. Attendance at the surgery for progress checks every 10 weeks (6.1%; $N = 4$) and every 12 to 14 weeks (4.5%; $N = 3$) were 'Other' recommendations made by the respondents.

The respondents reported that a median of 70% (IQR: 50, 80) of CAT patients had IPR prescribed in the initial accepted plan whereas a median of 30% (IQR: 13.75, 50) of CAT patients had IPR prescribed in the additional/refinement plan. Six (9.2%) respondents indicated that they did not prescribe

IPR as part of the initial DTP and 8 (12.3%) did not prescribe IPR in the additional/refinement phases.

Figure 6 indicates that the respondents reported that they always or mostly carried out IPR for the relief of crowding (54.6%; $N = 36$) and for the reduction of black triangles (64%; $N = 42$).

Table II. Respondent 'comfort' with treating different case types (+/- extractions)

	Comfortable		Uncomfortable	
	$N = 66$		$N = 64$	
Case type	%	N	%	N
Spaced dentition	89.4	59	0	0
0 to 4mm crowding (mild)	100	66	0	0
4.1-8mm crowding (moderate)	68.2	45	23.4	15
>8mm crowding (severe)	24.2	16	70.3	45
↓ OB	90.9	60	1.6	1
↑ OB	16.7	11	78.1	50
↓ OJ	45.5	30	10.9	7
↑ OJ	56.1	37	21.9	14
Unilateral posterior x-bite	39.4	26	35.9	23
Bilateral posterior x-bite	15.2	10	79.7	51
Other	7.6	5	23.4	15

+/-, Plus or minus; >, Greater than; ↓, Reduced; ↑, Increased;
%, Percentage; mm, millimetre; N, number; OB: overbite; OJ, Overjet;
x-bite, Crossbite.

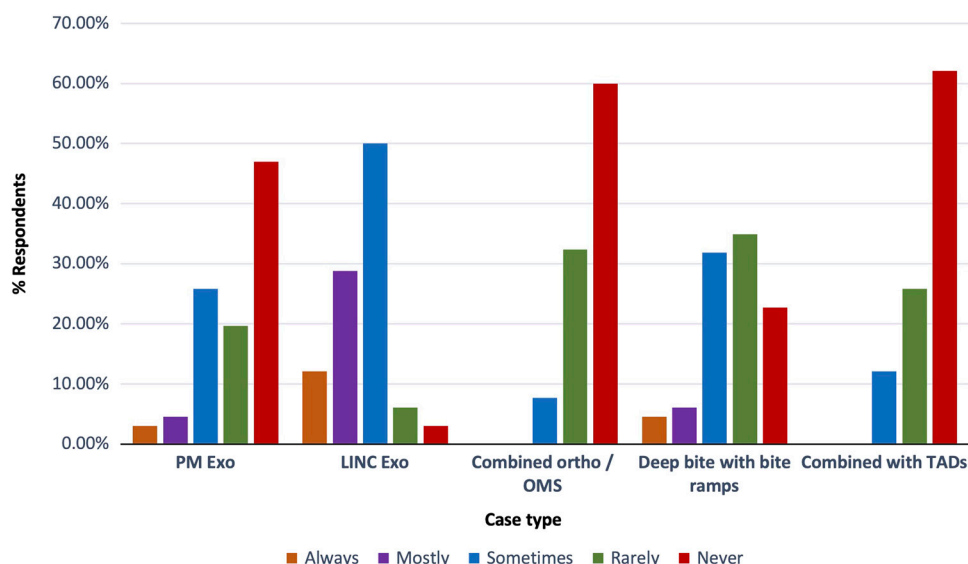


Figure 4. Treatment modalities used CAT ($N = 66$). %, percentage; Exo, extraction; LINC, lower incisor; Ortho, orthodontic treatment; OMS, orthognathic maxillofacial surgery; PM, premolar; TADs, temporary anchorage devices.

A median of 3.8% (IQR: 0, 5) of CAT patients reportedly required completion of their CAT using fixed appliances. More than 40% of respondents (44%; $N = 29$) indicated that they did not start treatment with fixed appliances and changed to CAT. However, one third of the respondents (33.3%; $N = 22$) stated that they started using fixed appliances in 1 to 2% of patients and 10 (15.2%) respondents considered that they started with fixed appliances before changing to CAT. Five respondents (7.6%) indicated that they commenced treatment

with fixed appliances in more than 5% of cases before changing to CAT.

The reported median number of months to complete non-extraction dual arch treatment according to the respondents was 15 (IQR: 14.75, 18.38). Table IV shows that just over 20% of the respondents did not prescribe the clear plastic retainer provided by the aligner company at the end of CAT.

Almost 75% (73.8%; $N = 48$) of the respondents considered that patients mostly or sometimes

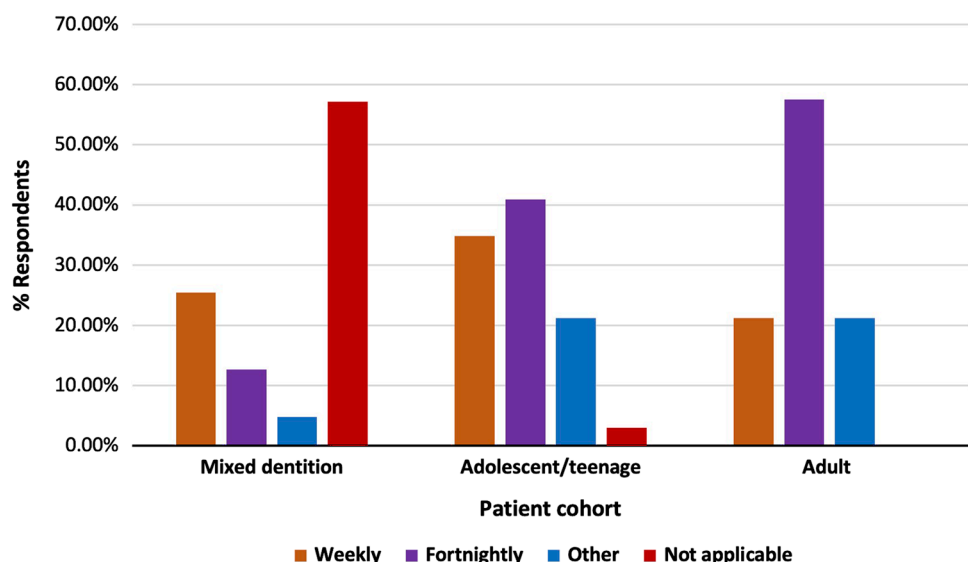


Figure 5. Frequency of aligner changes among different patient cohorts ($N = 66$).

Table III. Frequency of CAT progress checks by respondents ($N = 66$)

Answer Choices	Responses	
	%	N
Every 12 weeks	15.2	10
Every 8 weeks	40.9	27
Every 6 weeks	15.2	10
Every 4 weeks	1.5	1
Only if the patient has a problem - otherwise provide the aligners and check at completion of treatment	0.0	0
When remote monitoring system indicates	7.6	5
'Other'	19.7	13

CAT, clear aligner therapy; N, number; %, percentage.

reported difficulties regarding compliance with their CAT wear protocols (Table V).

Over 40% (42.2%; $N = 27$) reported that they neither agreed nor disagreed that it took longer to obtain identical results in patients with matched initial malocclusions using CAT compared to fixed appliances. However, 40.6% ($N = 26$) reported that they agreed/strongly agreed that it took longer to obtain identical results in patients with matched initial malocclusions using CAT compared to fixed

appliances contrary to 17.2% ($N = 11$) who reported that they disagreed. Two (3.1%) respondents reported that they agreed/strongly agreed with the statement that CAT produces superior outcomes in matched cases when compared with fixed appliances while 37 (57.8%) reported that they disagreed and 25 (39.1%) neither agreed nor disagreed.

Table VI shows that 'fixed appliances provide better treatment outcomes' was a moderate or major influence on the decision of all respondents who did not provide CAT to their patients.

Table VII indicates the themes categorised according to the respondent comments about the most important problems experienced during CAT that respondents would like to see addressed.

Table VIII outlines the themes according to the respondent comments regarding improvements to CAT that respondents would like to see addressed.

Discussion

The present investigation is the first to study CAT protocols and procedures provided by orthodontists in NZ. Most respondents reported that they used CAT and that it was prescribed for more than one in seven of their patients. The Invisalign appliance was the most prescribed CAT system although almost half of the respondents reported using more than one supplier.

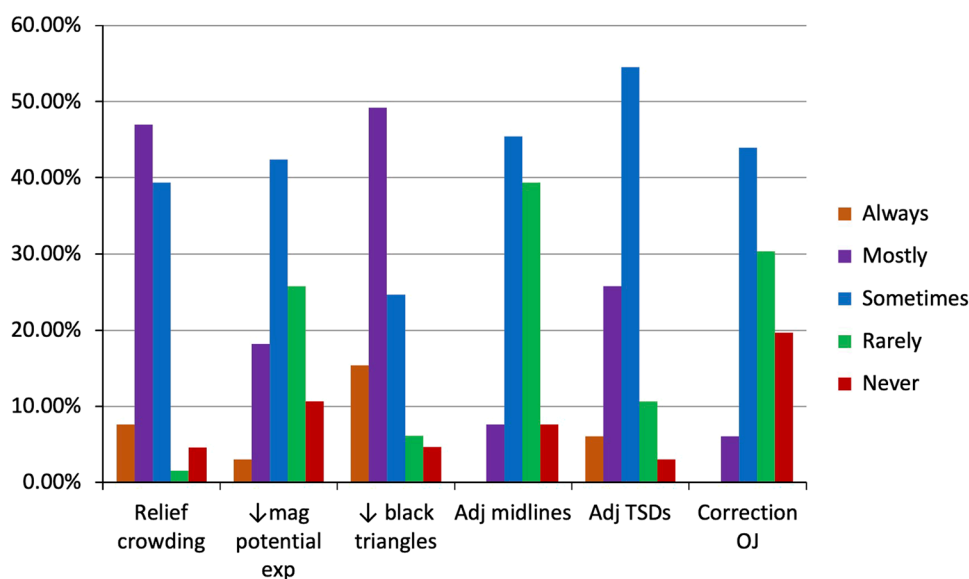


Figure 6. Frequency of interproximal reduction prescription of IPR to address treatment objectives ($N = 66$). ↓, reduction; Adj, adjustment; Exp, expansion; OJ, overjet; TSD, tooth size discrepancy.

Table IV. Frequency of prescription of a clear plastic retainer provided by aligner company at the end of CAT (N = 66)

Answer Choices	Responses	
	%	N
Always	21.2	14
Mostly	6.1	4
Sometimes	30.3	20
Rarely	19.7	13
Never	21.2	14
Other	1.5	1

CAT, clear aligner therapy; N, number; %, percentage.

A strength of the current survey was the high response rate of 70%. It was greater than the 3.8% to 54% recorded in recent similar international investigations and equalled the minimum response rate of 70% suggested for external validity.^{19–21,23} Additionally, the

adaption of the questionnaire from similar surveys carried out in Australia, U.K./ROI allowed close comparison of the findings from those countries.^{20,21}

The median number of time in orthodontic practice was 16.0 years which compared with a mean of 15.8 to 21.9 years in a 2019 cross-sectional survey on orthodontic retention procedures in NZ.²⁴ Furthermore, 55.3% of the respondents were male which corresponded to 56.8% in the NZ orthodontic retention survey. Almost 89% of the respondents indicated that they provided CAT as a treatment modality. This was greater than the 73% recorded in the U.K./ROI investigation but was lower than the 92% documented in Australia and the 99.4% in a 2023 study of orthodontists in the U.S.A and Canada.^{19–21} The response rate, however, in the U.S.A./Canada survey was only 3.8% so the findings from that study should be interpreted with caution.

The respondents indicated that a median of 15% of their overall annual orthodontic treatment case

Table V. Patient-reported CAT issues by respondent

Issue	Always		Mostly		Sometimes		Rarely		Never		Total
	%	N	%	N	%	N	%	N	%	N	N
Discomfort	1.54	1	10.8	7	53.9	35	29.2	19	4.6	3	65
Speech/lisping	0.0	0	9.2	6	38.5	25	46.2	30	6.2	4	65
Smell of aligner	0.0	0	7.8	5	23.4	15	51.6	33	17.2	11	64
Difficulty in compliance with wear protocol	0.0	0	4.6	3	69.2	45	24.6	16	1.5	1	65
Wear/breakage of aligner	0.0	0	3.1	2	58.5	38	33.9	22	4.6	3	65
Loss of aligner(s)	0.0	0	3.1	2	55.4	36	36.9	24	4.6	3	65
Poor fit of aligner(s)	0.0	0	4.6	3	52.3	34	41.5	27	1.5	1	65
Appearance of aligner(s)	0.0	0	1.5	1	7.7	5	63.1	41	27.7	18	65
Appearance/ discomfort of attachments	0.0	0	3.1	2	55.4	36	33.9	22	7.7	5	65
Staining of teeth around attachments	0.0	0	3.1	2	60.0	39	32.3	21	4.6	3	65
Dissatisfaction with treatment length	3.1	2	6.2	4	44.6	29	38.5	25	7.7	5	65
Dissatisfaction with treatment outcome	0.0	0	0.0	0	12.3	8	76.9	50	10.8	7	65
Dissatisfaction with need for refinement	0.0	0	3.1	2	38.5	25	40.0	26	18.5	12	65

CAT, clear aligner therapy; N, number; %, percentage.

Table VI. Factors that influence the decision not to provide CAT (N = 8)

	No Influence		Minor Influence		Moderate Influence		Major Influence		Total
	%	N	%	N	%	N	%	N	
Insufficient post-graduate education	37.5	3	25.0	2	37.5	3	0.0	0	8
Concerns over ongoing aligner treatment education	50.0	4	50.0	4	0.0	0	0.0	0	8
My practice (e.g.- University or public orthodontic service) does not provide it	75.0	6	0.0	0	0.0	0	25.0	2	8
Other clinicians in my practice provide aligner treatment	37.5	3	12.5	1	25.0	2	25.0	2	8
Initial costs to the practice	75.0	6	25.0	2	0.0	0	0.0	0	8
Ongoing costs to the practice	62.5	5	25.0	2	0.0	0	12.5	1	8
Costs to the patient	37.5	3	50.0	4	12.5	1	0.0	0	8
Disruption to practice with the introduction of new technology	37.5	3	50.0	4	0.0	0	12.5	1	8
Dependency on a 'third party' for treatment provision	25.0	2	12.5	1	37.5	3	25.0	2	8
'Fixed appliances provide better treatment outcomes'	0.0	0	0.0	0	62.5	5	37.5	3	8
Patient expectations	0.0	0	62.5	5	12.5	1	25.0	2	8
Concerns over patient compliance with treatment protocols	25.0	2	12.5	1	37.5	3	25.0	2	8
Other									1

CAT, clear aligner therapy; Eg, for example; N, number.

load was treated using CAT. This was greater than the 10% reported in the U.K./ROI survey in which some clinical environments may have limited the use of CAT as a treatment modality.²¹ However, it was less than the mean of 25% reportedly treated by orthodontists in Australia and compared with the 0-20% of the practice patient load treated by 52.5% of respondents in the U.S.A./Canada.²⁰

Just less than half of the respondents reported that they used more than one CAT system in their practice. This compared with 31.8% of respondents in the U.K./ROI and 60% in Australia who indicated that they used more than one CAT system.^{20,21} The most used CAT system by the respondents was the Invisalign appliance which corresponded to previous findings.^{19-21,25} The 70.3% who most commonly reported that they used Invisalign in the present

survey was greater than the 60.6% recorded in Australia but was less than the 81.2% of the U.K./ROI and U.S.A./Canada respondents.^{20,21} A curious finding, however, was that the recently introduced uLab appliance was the second most prescribed CAT system used in NZ. This may illustrate the dynamic nature of the CAT landscape in which aligner manufacturers appear to be launching new clinician-supervised and direct to consumer aligner systems on a regular basis.^{2,26}

The ease of digital treatment planning was a major or moderate influence for over 90% of respondents in the choice of CAT provider among respondents in NZ and was comparable to findings in the U.K./ROI and Australia.^{20,21} However, almost all respondents in the present survey reported that they still made changes to the initial digital treatment plan (DTP)

before acceptance. This corresponded with the findings in the U.K./ROI and Australian surveys and retrospective studies investigating orthodontist DTP processes in which changes to the initial plan are routine.^{1,4,20,21} The respondents also considered that they prescribed one or more additional series of aligners for 90% of their patients which compared with approximately 80-90% documented in the U.K./ROI, Australia and the U.S.A./Canada.¹⁹⁻²¹ The reported median number of additional aligner plans per patient was two which was similar to the numbers recorded in the earlier surveys and retrospective investigations.^{1,15,20,21,27} The requirement for changes to the initial and additional DTPs is testimony to the critical role the orthodontist plays in CAT planning.⁴

All respondents who used CAT in their practice reported that they were comfortable using the modality for the treatment of mild crowding. This was similar to findings from other countries and is perhaps unsurprising as the Invisalign appliance was originally introduced to manage this malocclusion type.^{3,20} Over 40% (40.9%; $N = 27$) of respondents were always or mostly likely to treat 'lower incisor extraction' cases. This compared with 16.9% of respondents in the U.K./ROI who always or mostly extracted a lower incisor with CAT and 58.8% of respondents in the U.S.A./Canada who 'commonly' extracted a single tooth/mandibular incisor as part of aligner treatment.^{19,21} Just 7.6% ($N = 5$) of respondents were always or mostly likely to treat premolar extraction cases which was similar to the 4.3 to 6% recorded in Australia and the U.K./ROI, and which suggests a wariness among orthodontists in undertaking CAT combined with premolar extraction.^{20,21}

A fortnightly change of aligner protocol for adolescent/teenage patients was most recommended by the respondents in the present survey. This contrasted with the U.K./ROI and U.S.A./Canada studies in which weekly changes were most recommended.^{19,21} The wide variation in responses, however, indicated that respondents may be adopting patient/malocclusion-specific aligner change protocols.

The respondents most commonly recommended that patients attend their clinic for progress checks every 8 weeks. This was similar to the recommendation in Australia.²⁰ However, the emergence of remote monitoring systems, as observed in the present

Table VII. Most significant problems with CAT by respondent ($N = 62$)

Theme	%	N
Concerns over patient compliance with CAT wear protocols	43.5	22
Tooth movements	16.1	10
Detailing/finishing	16.1	10
Overbite	16.1	10
Torque	14.5	9
Lateral incisors	12.9	8
Tracking	9.7	6
Commercialisation:	6.5	4
Case selection	6.5	4
Costs	4.8	3

CAT, clear aligner therapy; N, number.

survey, onto the orthodontic treatment landscape is likely to impact on the intervals at which patients attend clinics for progress checks in the future.^{28,29}

More than half of the respondents reported using fixed appliance therapy with CAT which corresponded to the findings in the Australian survey and is indicative of the trend towards a combined fixed appliance/CAT approach for many patients observed in a 2022 retrospective investigation.^{15,20}

Table VIII. Improvements respondents would like to see with CAT ($N = 51$)

Theme	%	N
Actual outcomes closer to planned/predicted by software	31.4	16
Tooth movement	27.5	14
Costs	17.6	9
Aligner material	11.8	6
Software	11.8	6
Environmental	9.8	5
CAT and GDPs	7.8	4
Need for further research	5.9	3
Acceptance of shortcomings	5.9	3

CAT, clear aligner therapy; GDP, general dental; N, number.

Between 9.2 and 12.3% of the respondents in the present survey indicated that they did not use IPR in combination with CAT. This contrasted with the U.S.A./Canada study in which 100% of the respondents indicated that they used IPR in conjunction with CAT.¹⁹ Respondents reported that IPR was prescribed for 70% of their patients in the initial DTP which was greater than the 55.3% recorded in the Australia study.²⁰ However, the median of 30% of patients who had IPR in their additional/refinement plans in the current study was almost identical to the 30.6% recorded in Australia.²⁰ In addition, respondents in NZ and Australia reported similar reasons for using IPR and noted as the relief of crowding or the reduction of black triangles.²⁰ Moreover, the respondents reported that the quantity, location, staging and timing of IPR were the areas frequently in need of amendment prior to acceptance of the CAT treatment plan. The role of IPR in CAT requires further investigation, particularly as previous research has indicated that prescribed IPR is rarely matched by the actual amount carried out by clinicians.^{30,31}

The majority of respondents disagreed with the statement that CAT resulted in superior outcomes compared to fixed appliance treatment which was in alignment with the findings from the respondents in the U.K./ROI and Australian surveys, and the conclusions of a recent systematic review.^{20,21,32} Additionally, that fixed appliances provide better treatment outcomes was a moderate or major influence on the decision of all respondents in the present survey who did not provide CAT. This corresponded with the finding in the Australian study in which almost 80% of the respondents similarly reported.²⁰

Just over 70% of the respondents reported that patients sometimes indicated that there was difficulty in complying with CAT wear protocols. This compared with 66% in the Australian survey, and a recent retrospective study in which 64% of adult patients self-reported that they were fairly or poorly compliant with prescribed daily CAT wear of at least 22 hr.^{7,20} Furthermore, concern regarding patient compliance with CAT wear protocols was the most frequently coded comment theme provided by the respondents regarding their opinions related to the problems associated with CAT. An additional finding in the present survey was that respondents reported that they would like to see improvement in the

potentially deleteriously environmental impact from the production of the non-biodegradable plastic used in aligner manufacture.^{1,8,33}

A limitation of the present survey was response bias whereby those orthodontists who used CAT were more inclined to participate in the survey and, as a result, exaggerate the use of CAT in NZ. However, the survey recorded the responses from two-thirds of the orthodontists in clinical practice in NZ, and so the results were likely to be reasonably representative. Furthermore, a balance between survey length and content was required. Although additional questioning would have yielded further valuable data, it may have risked lowering the response rate.³⁴

The findings of the present survey mirror the increasing use of CAT observed internationally and provides baseline data for future CAT-related investigations. The surveys provide information that can enable clinicians to compare their CAT protocols and procedures with other orthodontists in the absence of relevant clinical guidelines. The findings also suggest that NZ orthodontists may be more conservative in their use of CAT compared to their Australian counterparts. The wide variation in responses, however, emphasises the need for further urgent research regarding CAT protocols and procedures.

Conclusions

- Most respondents reported the use of CAT with just over 40% treating between 1 and 20 patients per year.
- The Invisalign appliance was the most prescribed CAT system, but half of the respondents indicated that they used more than one aligner system.
- Virtually no initial digital treatment plan was approved without changes and the majority of patients were required to have an additional phase of aligner treatment.
- Areas which were most in need of amendment prior to acceptance of the CAT treatment plan were the attachments and final tooth positions.
- Almost 80% indicated that they were not comfortable in treating cases of increased overbite and the majority rarely or never carried out premolar extraction treatment with CAT.
- A remote monitoring system was mostly or always used by one third of respondents in conjunction with CAT.

- More than half of the respondents reported using fixed appliance therapy with CAT and up to 90% reported that they used IPR combined with CAT.
- That fixed appliances provided better treatment outcomes was a moderate or major influence on the decision of all respondents who did not provide CAT.

Conflict of interest

T.W. is on the editorial board of the Australasian Orthodontic Journal. The remaining author declares that there is no other conflict of interest.

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