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Ana Marija Milićević[1†], Luka Šimunović[1†], Tea Popović[2], Tony Weir[3], Maurice J Meade[3], Senka Meštrović[1]

A Survey of Orthodontic Clear Aligner Practices among Orthodontists in Croatia

Anketa o primjeni alignera među ortodontima u Hrvatskoj

[1] Department of Orthodontics, the University of Zagreb School of Dental Medicine, Zagreb, Croatia
Sveučilište u Zagrebu Stomatološki fakultet, Zavod za ortodonciju, Zagreb, Hrvatska
[2] Resident, Department of Orthodontics, University Hospital Centre Zagreb, Zagreb, Croatia
Zavod za ortodonciju, Klinika za stomatologiju, Klinički bolnički centar Zagreb, Hrvatska
[3] Orthodontic Unit, Adelaide Dental School, the University of Adelaide, Adelaide, Australia
Zavod za ortodonciju, Stomatološki fakultet, Sveučilište u Adelaideu, Australija
[†] Joint first authorship
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Abstract

Objectives: The aim of this cross-sectional survey was to investigate clear aligner therapy (CAT) practices and protocols among orthodontic specialists in the Republic of Croatia. **Materials and Methods:** The modified version of a previously published questionnaire s was distributed online to 180 orthodontists. It included 46 open- and closed-ended questions across 11 sections, covering demographics, clinical use of CAT, aligner preferences, digital treatment planning (DTP), indications, protocols, interproximal reduction (IPR), refinements, retention, patient-reported issues, and overall perceptions. Respondents not using CAT were directed to a separate section on non-use. **Results:** The majority of respondents (88%) reported using CAT in clinical practice, although only 10% of their annual cases involved CAT. Adults were more common patient group (57.9%), and the main indication was mild to moderate crowding. Invisalign was the most frequently used aligner system (58.7%), primarily chosen for the quality of digital treatment planning (DTP) and sophistication of product features. Two-thirds of the respondents reported modifying the digital treatment plan, particularly by adjusting the final tooth position. Refinement was performed in 50% of the cases. IPR was included in 80% of the initial treatment plans and only 20% of the refinement phases. Finally, 52.6% of orthodontists considered CAT to be superior to conventional fixed appliance therapy. **Conclusions:** CAT is widely used by orthodontists in Croatia, primarily for mild cases. Nevertheless, aligners are still not perceived as producing superior outcomes compared with fixed appliances.

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Address for correspondence
Ana Marija Milićević, DMD
University of Zagreb School of Dental Medicine
Department of Orthodontics
Gundulićeva 5, 10000 Zagreb, Croatia
Phone: +385 1 4802 117
amilicevic@sfzg.unizg.hr

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Ana Marija Milićević: https://orcid.org/0009-0008-5488-6915
Luka Šimunović: https://orcid.org/0000-0003-2848-6041
Tea Popović: https://orcid.org/0009-0008-2316-723X
Tony Weir: https://orcid.org/0000-0002-3049-2021
Maurice J Meade: https://orcid.org/0000-0001-5688-1079
Senka Meštrović: https://orcid.org/0000-0003-3224-3579

Introduction

Over the past few years, clear aligner therapy (CAT) has gained substantial popularity, driven by increasing esthetic expectations and advancements in dental materials (1). As transparent and removable appliances, aligners provide a purportedly discreet treatment option while also facilitating better oral hygiene compared to fixed orthodontic appliances (2). CAT involves a series of plastic aligners that are changed progressively in accordance with the planned tooth movements. The treatment plan, including the sequencing of these movements, is guided by a digital interface that often incorporates composite attachments and interproximal reduction (IPR) to ensure a successful therapeutic outcome (3). Additionally, chair time may be reduced because of the absence of wire changes during routine checkups. However, for treatment outcomes to be successful, patient compliance

UVOD

Proteklih nekoliko godina terapija prozirnim ortodontskim alignerima (CAT) stekla je znatnu popularnost, potaknuta sve većim estetskim očekivanjima pacijenata te napretkom u razvoju dentalnih materijala (1). Kao prozirne i uklonjive naprave, aligneri omogućuju diskretnu ortodontsku terapiju i ujedno olakšavaju održavanje oralne higijene u usporedbi s fiksnim ortodontskim napravama (2).

CAT terapija uključuje niz plastičnih alignera koji se postupno mijenjaju u skladu s planiranim pomacima zuba. Plan terapije, a on obuhvaća i redoslijed tih pomaka, izrađuje se putem digitalnog sučelja koje često uključuje kompozitne pričvrstke i interproksimalnu redukciju (IPR) kako bi se postigao uspješan terapijski ishod (3). Uz to, vrijeme provedeno u stomatološkome stolcu tijekom kontrolnih pregleda može biti skraćeno zato što nema promjena žica. No za uspješan te-is crucial—specifically, the consistent and regular wear of the aligners, which often presents a challenge. Another potential concern regarding CAT is its environmental impact, as aligners are non-biodegradable and therefore pose a potential ecological threat (4,5).

Despite advancements in software systems and plastic material technology, aligners appear to have limited efficacy in the treatment of certain malocclusions, particularly in cases involving deep bites and tooth rotations (6-10). Data on CAT practices and protocols among orthodontic specialists are limited. Recent studies have shown that the majority of general dentists and orthodontists incorporate aligners into their daily clinical practices in countries such as France, Canada, Australia, the United States, and New Zealand (11-15). However, to date, no such data are available for the Republic of Croatia.

The aim of this cross-sectional survey was to investigate CAT practices and protocols among orthodontic specialists in the Republic of Croatia.

Materials and Methods

The study was conducted in the Republic of Croatia using a revised version of a previously published survey (13). The questionnaire was created using Google Forms and sent to all 180 orthodontists currently in practice in Croatia, of whom 83 participated in the study. The survey was divided into 11 sections and included 46 open and closed questions. Section A covered the general demographic information of the respondents, with adaptations for the principal Croatian regions. Section B assessed whether respondents incorporated CAT into their practice and the frequency of use. Respondents who indicated that they did not use CAT were redirected to Section L. Section C explored the aligners most commonly used by respondents in their practice and the reasons for their preference. Section D was related to digital treatment planning (DTP) protocols. Section E examined the cases in which respondents chose to treat with aligners. Section F focused on treatment protocols. Section G investigated the presence and implementation of interproximal reduction (IPR) in the treatment plan. Section H covered refinements and the finalization of aligner therapy. Section I included questions regarding retention after treatment completion. Section J focused on issues reported by patients. Section K examined the respondents' overall views on aligners. At the end of this section, participants had the option to leave comments about CAT. Section L explored the reasons why respondents decided not to use aligners in their practice.

The study was approved by the Ethics Committee of the School of Dental Medicine, University of Zagreb (approval number 02/013AG).

Statistical analysis

All analyses were performed in IBM SPSS Statistics (version 29.0; IBM, Armonk, NY). Categorical variables are presented as counts and percentages, whereas continuous or ordinal variables that did not meet the assumption of Gaussian distribution using the Shapiro-Wilk test are summarized by their medians and inter-quartile ranges (IQR).

rapijski ishod ključna je suradnja pacijenta, osobito dosljedno i redovito nošenje alignera, što je često izazov. Još jedna moguća zabrinutost povezana s terapijom CAT odnosi se na njezin utjecaj na okoliš, zato što ti prozirni aparatići nisu biorazgradivi pa su potencijalna ekološka opasnost (4, 5). Unatoč napretku u razvoju softverskih sustava i tehnologiji plastičnih materijala, čini se da su aligneri ograničeno učinkoviti u liječenju određenih malokluzija, osobito u slučaju dubokoga zagriza i rotacija zuba (6 – 10). Podatci o praksi i protokolima primjene CAT terapije među specijalistima ortodoncije još su uvijek ograničeni. Nedavna istraživanja pokazala su da većina doktora dentalne medicine i ortodonata u zemljama poput Francuske, Kanade, Australije, Sjedinjenih Američkih Država i Novog Zelanda uključuje alignere u svoju svakodnevnu kliničku praksu (11 – 15). No do danas nema takvih podataka za Republiku Hrvatsku.

Cilj ovoga presječnog istraživanja bio je ispitati praksu i protokole primjene CAT terapije među specijalistima ortodoncije u Republici Hrvatskoj.

Materijali i metode

Istraživanje je provedeno u Republici Hrvatskoj na temelju revidirane verzije ranije objavljenoga upitnika (13). Upitnik je izrađen na platformi *Google Forms* i poslan na adrese 180 ortodonata koji trenutačno obavljaju praksu u Hrvatskoj, od kojih je 83 sudjelovalo u istraživanju. Upitnik je bio podijeljen u 11 cjelina i sadržavao je ukupno 46 otvorenih i zatvorenih pitanja.

Odjeljak A obuhvaćao je opće demografske podatke ispitanika, s prilagodbama za glavne hrvatske regije. Odjeljak B procjenjivao je uključuju li ispitanici CAT terapiju u svoju kliničku praksu te učestalost njezine primjene. Ispitanici koji su naveli da se ne koriste CAT-om bili su preusmjereni na odjeljak L. Odjeljak C istraživao je kojim se vrstama alignera ispitanici najčešće koriste u praksi te razloge njihova odabira. Odjeljak D odnosio se na protokole digitalnog planiranja terapije (DTP). Odjeljak E ispitivao je slučajeve u kojima su se ispitanici odlučili na terapiju alignerima. Odjeljak F bio je usmjeren na protokole liječenja. Odjeljak G istraživao je prisutnost i primjenu interproksimalne redukcije (IPR) u terapijskome planu. Odjeljak H obuhvaćao je postupke dorade i završne faze terapije alignerima. Odjeljak I sadržavao je pitanja o retenciji poslije završetka terapije. Odjeljak J bio je usmjeren na probleme koje su prijavljivali pacijenti. Odjeljak K ispitivao je opća stajališta ispitanika o alignerima. Na kraju toga odjeljka sudionici mogli napisati komentar o CAT terapiji. Odjeljak L istraživao je razloge zbog kojih se ispitanici nisu odlučili koristiti alignerima u svojoj praksi.

Istraživanje je odobrilo Etičko povjerenstvo Kliničkoga bolničkoga centra Zagreb (broj odobrenja: 02/013AG).

Statistička analiza

Sve analize provedene su u programu *IBM SPSS Statistics* (verzija 29.0; IBM, Armonk, NY). Kategorijske varijable prikazane su kao apsolutni i relativni udjeli (brojevi i postotci), a kontinuirane ili ordinalne varijable koje nisu zadovoljavale pretpostavku normalne (Gaussove) distribucije prema Shapiro-Wilkovu testu sažete su s pomoću medijana i interkvartilnog raspona (IQR).

Results

A total of 83 orthodontic specialists from various regions of Croatia participated in the survey (46.1%). Regarding gender distribution, 72.3% of the respondents were female and 27.7% were male. The median number of years of experience as a specialist orthodontist was 15 (IQR: 8–20).

The vast majority of respondents (88.0%) reported using clear orthodontic aligners in their clinical practice, while 12.0% of them stated that they did not currently utilize it. When asked to estimate the proportion of their annual orthodontic cases treated with aligners, the median response was 10% (IQR: 5–20%). The number and percentage of CAT per year per orthodontist is shown in Figure 1.

To better understand clinical decision-making, the respondents were asked to rate the extent to which various factors influenced their decision to offer CAT. The distribution of responses for each factor is presented in Table 1.

Aligners were reported to be used more frequently in adult patients than in adolescent patients. Among adolescents, most orthodontists indicated rare or occasional use—36.1% reported using aligners "sometimes," 26.5% "rarely," and 26.5% "never." Only 10.8% reported using them "frequently" or "always." In contrast, aligner therapy was much more common in adults, with 57.9% of respondents using aligners "frequently" or "always," and only 10.8% reporting rare or no use.

A majority of orthodontists (58.7%) reported using *Invisalign (Align Technology, Inc., 2820 Orchard Parkway, San Jose, 95134, United States)* making it the most commonly used aligner system. This was followed by *ClearCorrect (ClearCorrect, LLC, 21 Cypress Blvd, Suite 1010, Round Rock, TX 78665, United States)* used by 38.7% of respondents, *Spark (Ormco Corporation, 200 S. Kraemer Blvd, Brea, California 92821, United States)* by 20.0%, and *SimplySmile (SimplySmile, Prilaz Ivana Visina 5, 10000 Zagreb)* by 18.7%. A smaller proportion (9.3%) of orthodontists reported using in-house fabricated aligners. In contrast, all other aligner systems were used by fewer than 3% of respondents.

To further understand brand preferences, participants were asked to indicate which aligner system they use most frequently in their practice. Invisalign remained the dominant brand, selected by 38.7% of users as their primary aligner system. This was followed by ClearCorrect (28.0%) and SimplySmile (14.7%). All other brands, including Spark (6.7%), in-house aligners (5.3%), and niche systems such as F22, Graphy, and ClearX, were selected by fewer than 7% of respondents each.

Rezultati

Ukupno su u istraživanju sudjelovala 83 specijalista ortodoncije iz različitih regija Hrvatske (46,1 %). S obzirom na spolnu raspodjelu, 72,3 % ispitanika bile su žene, a 27,7 % muškarci. Medijan broja godina stručnog iskustva kao specijalista ortodoncije iznosio je 15 (IQR: 8 – 20).

Velika većina ispitanika (88,0 %) navela je da se u svojoj kliničkoj praksi koristi prozirnim ortodontskim alignerima, a 12,0 % izjavilo je da ih trenutačno ne primjenjuje. Kada su bili zamoljeni da procijene udio svojih godišnjih ortodontskih slučajeva liječenih alignerima, medijan odgovora iznosio je 10 % (IQR: 5 – 20 %). Broj i postotak slučajeva CAT terapije na godinu po ortodontu nalazi se na slici 1.

Kako bi se bolje razumio proces kliničkog odlučivanja, ispitanici su zamoljeni da ocijene koliko različiti čimbenici utječu na njihovu odluku o uključivanju CAT terapije u kliničku praksu. Raspodjela odgovora za svaki čimbenik nalazi se u tablici 1.

Prema rezultatima, aligneri se puno češće upotrebljavaju za odrasle pacijente nego za adolescente. Među adolescentima većina ortodonata navela je rijetku ili povremenu uporabu – 36,1 % izjavilo je da alignerie koriste *katkad*, 26,5 % *rijetko* a 26,5 % *nikada*. Samo je 10,8 % ispitanika navelo da se njima koristi *često* ili *uvijek*. Suprotno tomu, terapija alignerima bila je znatno češća kod odraslih pacijenata: 57,9 % ispitanika koristi se alignerima *često* ili *uvijek*, a samo 10,8 % navelo je rijetku ili nikakvu primjenu.

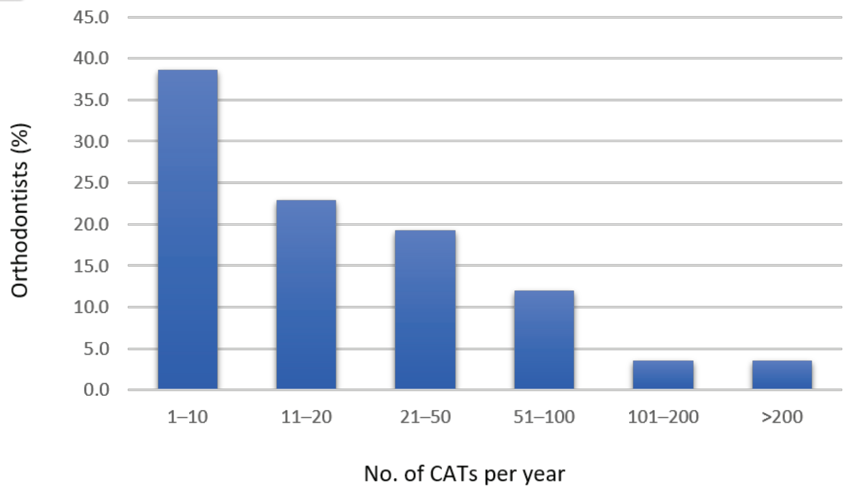
Većina ortodonata (58,7 %) navela je da se koristi sustavom *Invisalign (Align Technology, Inc., 2820 Orchard Parkway, San Jose, California 95134, Sjedinjene Američke Države)*, što ga čini najčešće primjenjivanim sustavom prozirnih alignera. Slijede *ClearCorrect (ClearCorrect, LLC, 21 Cypress Blvd, Suite 1010, Round Rock, TX 78665, Sjedinjene Američke Države)* koji odabire 38,7 % ispitanika, *Spark (Ormco Corporation, 200 S. Kraemer Blvd, Brea, California 92821, Sjedinjene Američke Države)* preferira 20,0 %, te *SimplySmile (SimplySmile, Prilaz Ivana Višina 5, 10 000 Zagreb*, kojim se koristi 18,7 % ispitanika. Manji broj ortodonata (9,3 %) izvijestio je o korištenju vlastitih (in-house) alignera. Nasuprot tomu, svim ostalim sustavima alignera koristi se manje od 3 % ispitanika.

Kako bi se dodatno razumjele preferencije prema pojedinim markama, ispitanici su bili zamoljeni da navedu koji sustav alignera najčešće upotrebljavaju u svojoj praksi. *Invisalign* je ostao dominantan – 38,7 % korisnika odabralo ga je kao svoj primarni sustav alignera. Slijede *ClearCorrect* (28,0 %) i *SimplySmile* (14,7 %). Sve ostale brendove, uključujući

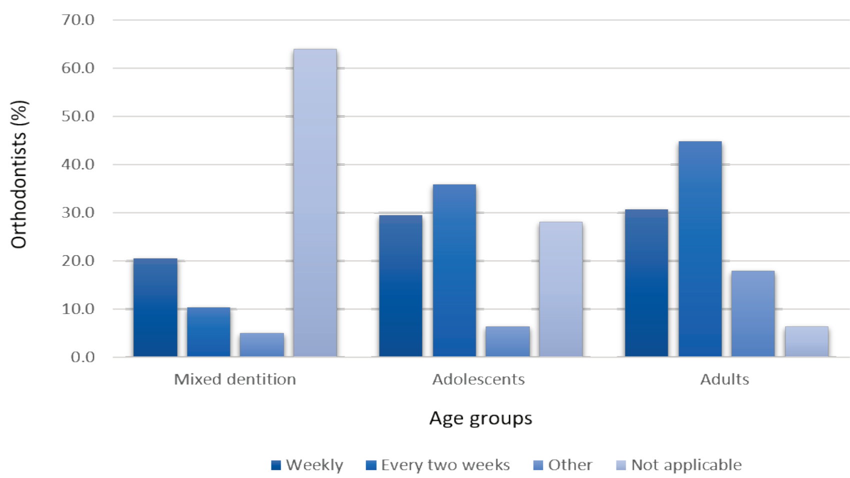
Table 1. Factors that influence decisions in choosing to offer CAT
Tablica 1. Čimbenici koji utječu na odluku o ponudi terapije prozirnim alignerima (CAT)

Factor • Čimbenik	No influence • Bez utjecaja	Slight influence • Blagi utjecaj	Moderate influence • Umjereni utjecaj	Strong influence • Snažni utjecaj
Cost • Trošak	14 (16.9%)	18 (21.7%)	30 (36.1%)	21 (25.3%)
Case complexity • Složenost slučaja	6 (7.2%)	7 (8.4%)	22 (26.5%)	48 (57.8%)
Anticipated patient compliance • Očekivana suradnja pacijenta	5 (6.0%)	8 (9.6%)	37 (44.6%)	33 (39.8%)
Patient requests • Zahtjevi pacijenata	7 (8.4%)	15 (18.1%)	35 (42.2%)	26 (31.3%)
Patient expectations • Očekivanja pacijenata	7 (8.4%)	10 (12.0%)	39 (47.0%)	27 (32.5%)

1.



2.



3.

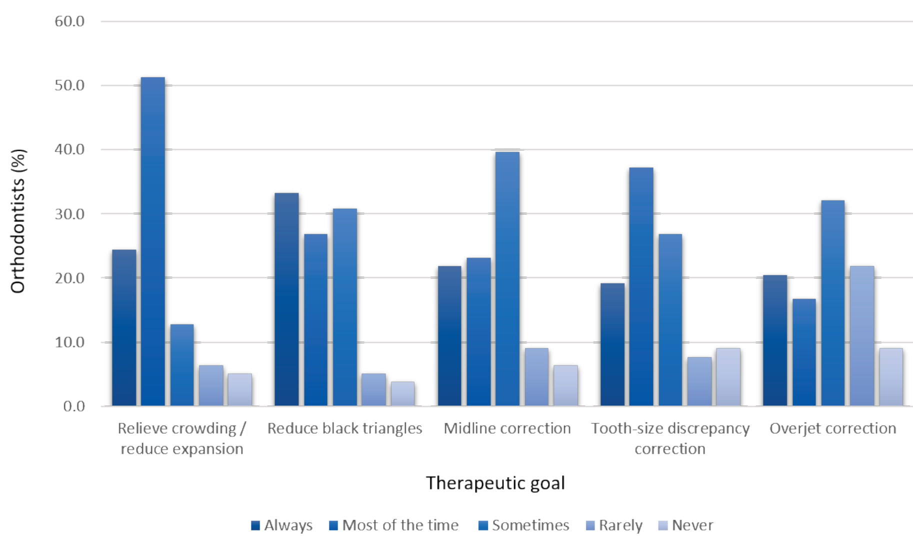


Figure 1 Percentage of CATs per year per othodontist
Slika 1. Postotak CAT terapija na godinu po ortodontu
Figure 2 Frequency of aligner change in different scenarios
Slika 2. Učestalost promjene alignera u različitim okolnostima
Figure 3 Frequency of prescription of IPR to address treatment objectives
Slika 3. Učestalost propisivanja interproksimalne redukcije (IPR) u svrhu postizanja terapijskih ciljeva

The factors that influenced orthodontists' choice of a specific aligner provider were the quality of the digital treatment plan and the sophistication of product features, which were rated as having a strong influence by 71.8% and 60.3% of respondents, respectively. Other highly influential factors such as patient satisfaction (57.7%), troubleshooting support (57.7%), and the simplicity of treatment planning (47.4%) are indicated in Table 2.

When asked about their treatment preferences, the majority of orthodontists reported a clear preference for dual-arch aligner therapy. Over 88% of them indicated that they "always" or "most of the time" treat both arches simultaneously, while only a small fraction of orthodontists reported using this approach occasionally or rarely.

Regarding the digital treatment plan (DTP), nearly two-thirds of orthodontists reported modifying the final tooth positions either "always" (23.1%) or "most of the time" (41.0%). Similarly, over half of them reported making frequent adjustments to the tooth movement protocols. Attachments were also commonly revised, with 44.9% of respondents requesting changes "sometimes" and an additional 23.1% of them doing so "often" or "always." In contrast, other elements of the digital setup were rarely modified, as 65.4% of respondents stated that they "never" altered these aspects. These findings are presented in Table 3.

While reviewing DTP, a vast majority of orthodontists reported doing so themselves. Specifically, 89.7% of them stated they "always" review treatment plans personally, while an additional 5.1% of orthodontists reported doing so "most of the time." Only a small proportion delegated this task regularly: 84.6% of orthodontists stated that a trained staff member never reviews plans, and only 6.4% of them reported any level of staff involvement beyond occasional review.

Orthodontists were also asked to indicate the types of cases they felt comfortable or uncomfortable treating with clear aligners. As shown in Table 4, there was a high level of confidence in the management of mild to moderate crowding. In contrast, more complex cases—such as severe crowding, deep bites, and crossbites—were associated with increased discomfort.

Additionally, as illustrated in Table 5, most orthodontists reported rarely or never using aligners in extraction cases or cases requiring combined orthodontic-orthognathic surgical treatments.

Regarding hybrid treatment, only 4% of respondents reported using it "most of the time" or "always." Remote monitoring was also infrequently used: 61.5% of them stated they never use it, 17.9% of respondents reported rare use, and only 6.4% indicated regular use.

Figure 2 shows that regarding wear protocols across different age groups**,** a weekly or biweekly aligner wear schedule was commonly applied in both adolescent and adult patients. For adults, 44.9% of them recommended changing aligners every two weeks, while 30.8% of them recommended weekly changes. Similar trends were observed in adolescents.

The overwhelming majority (73.5%) reported scheduling routine follow-ups every four weeks, reflecting a standardized monthly monitoring approach. Some clinicians have

Spark (6,7 %), vlastite (in-house) alignere (5,3 %) te specifične sustave poput *F22*, *Graphy* i *ClearX*, odabralo je manje od 7 % ispitanika.

Čimbenici koji su utjecali na izbor određenoga proizvođača alignera među ortodontima bili su kvaliteta digitalnog plana terapije i sofisticiranost značajki samog proizvoda, koje je kao čimbenike sa snažnim utjecajem ocijenilo 71,8 %, odnosno 60,3 % ispitanika. Ostali iznimno utjecajni čimbenici obuhvaćali su zadovoljstvo pacijenata (57,7 %), potporu pri rješavanju problema (57,7 %) te jednostavnost planiranja terapije (47,4 %), kako se vidi u tablici 2.

Kada su upitani o svojim terapijskim preferencijama, većina ortodonata istaknula je jasnu sklonost prema terapiji alignerima u obje čeljusti. Više od 88 % ispitanika navelo je da *uvijek* ili *uglavnom* liječi obje čeljusti istodobno, a samo mali dio izvijestio je se da takvim pristupom koristi povremeno ili rijetko.

Kad je riječ o digitalnom planu terapije (DTP), gotovo dvije trećine ortodonata navelo je da mijenja konačne položaje zuba *uvijek* (23,1 %) ili *uglavnom* (41,0 %). Slično tomu, više od polovine ispitanika izvijestilo je da često prilagođava protokole pomaka zuba. Također, pričvrstci su se često revidirali – 44,9 % ispitanika zatražilo je izmjene *katkad*, a dodatnih 23,1 % *često* ili *uvijek*. Suprotno tomu, ostali elementi digitalne postavke rijetko su se mijenjali – 65,4 % ispitanika izjavilo da ih *nikada* ne prilagođava. Ti su rezultati u tablici 3.

Pri pregledu DTP-a, velika većina ortodonata navela je da taj postupak obavlja osobno. Točnije, njih 89,7 % izjavilo je da *uvijek* osobno pregledaju terapijske planove, a dodatnih 5,1 % to je činilo *uglavnom*. Samo je mali broj ispitanika redovito delegirao ovaj zadatak: 84,6 % navelo je da educirano osoblje nikada ne pregledava planove, a samo 6,4 % izjavilo je da postoji bilo kakva razina uključenosti osoblja osim povremenog pregleda.

Ortodonti su također bili zamoljeni da navedu koji su im slučajevi ugodni, a koji manje ugodni pri provođenju terapije prozirnim aparatićima. Kao što se vidi u tablici 4, zabilježena je visoka razina sigurnosti u liječenju blagih do umjerenih slučajeva zbijenosti. Nasuprot tomu, složeniji slučajevi, poput izražene zbijenosti, dubokoga i križnoga zagriza, bili su povezani s većim stupnjem nesigurnosti među ispitanicima.

Uz to, kao što je prikazano u tablici 5, većina ortodonata navela je da se rijetko ili nikada ne koristi alignerima u slučajevima koji zahtijevaju ekstrakcije ili kombinirano ortodontsko-ortognatsko kirurško liječenje.

Kad je riječ o hibridnome liječenju, samo 4 % ispitanika navelo je da se njime koristi *uglavnom* ili *uvijek*. Praćenje terapije na daljinu također se rijetko primjenjuje: 61,5 % ispitanika izjavilo je da to nikada ne čini, 17,9 % čini rijetko, a samo 6,4 % navelo je redovitu primjenu.

Slika 2. prikazuje da je, kada je riječ o protokolima nošenja alignera u različitim dobnim skupinama, tjedni ili dvotjedni raspored najčešće primjenjivan i za adolescente i za odrasle. Za odrasle pacijente je 44,9 % ispitanika preporučilo promjenu alignera svaka dva tjedna, a 30,8 % savjetovalo je tjedne promjene. Slični trendovi zabilježeni su i kod adolescenata.

Table 2. Factors that influence decisions in choosing to use a particular aligner company/provider
Tablica 2. Čimbenici koji utječu na odluku o korištenju određenog proizvođača/pružatelja alignera

Factor • Čimbenik	No influence • Bez utjecaja	Slight influence • Blagi utjecaj	Moderate influence • Umjereni utjecaj	Strong influence • Snažni utjecaj
Cost • Trošak	6 (7.7%)	13 (16.7%)	29 (37.2%)	30 (38.5%)
Simplicity of treatment planning • Jednostavnost planiranja terapije	2 (2.6%)	7 (9.0%)	32 (41.0%)	37 (47.4%)
Quality of treatment planning • Kvaliteta planiranja terapije	3 (3.8%)	3 (3.8%)	16 (20.5%)	56 (71.8%)
Sophistication of product features • Sofisticiranost značajki proizvoda	2 (2.6%)	8 (10.3%)	21 (26.9%)	47 (60.3%)
Aesthetic appeal of the device • Estetika naprave	7 (9.0%)	15 (19.2%)	21 (26.9%)	35 (44.9%)
Patient satisfaction • Zadovoljstvo pacijenata	3 (3.8%)	8 (10.3%)	22 (28.2%)	45 (57.7%)
Brand recognition among patients • Prepoznatljivost brenda među pacijentima	6 (7.7%)	18 (23.1%)	32 (41.0%)	22 (28.2%)
Continuing education from the provider • Edukacija koju pruža proizvođač	6 (7.7%)	15 (19.2%)	25 (32.1%)	32 (41.0%)
Troubleshooting support • Podrška pri rješavanju problema	5 (6.4%)	9 (11.5%)	19 (24.4%)	45 (57.7%)
Corporate support (marketing) • Korporativna podrška (marketing)	18 (23.1%)	22 (28.2%)	17 (21.8%)	21 (26.9%)

Table 3. Factors in most need of a change from the initial plan recieved from aligner provider
Tablica 3. Čimbenici kojima je najčešće potrebna izmjena u odnosu na početni plan zaprimljen od pružatelja alignera

Area of the digital plan • Područje digitalnog plana	Always • Uvijek n (%)	Most of the time • Uglavnom n (%)	Sometimes • Katkad n (%)	Rarely • Rijetko n (%)	Never • Nikad n (%)
Attachments • Pričvrstci	6 (7.7%)	12 (15.4%)	35 (44.9%)	18 (23.1%)	7 (9.0%)
Tooth movement protocols • Protokoli pomaka zuba	15 (19.2%)	27 (34.6%)	25 (32.1%)	5 (6.4%)	6 (7.7%)
Final tooth positions • Konačni položaji zuba	18 (23.1%)	32 (41.0%)	21 (26.9%)	2 (2.6%)	5 (6.4%)
Other • Ostalo	8 (10.3%)	3 (3.8%)	6 (7.7%)	10 (12.8%)	51 (65.4%)

Table 4. Comfort with treating different patient types with CAT
Tablica 4. Razina ugode u liječenju različitih tipova pacijenata prozirnim alignerima (CAT)

Case type • Tip slučaja	Comfortable • Ugodno (n, %)	Uncomfortable • Neugodno (n, %)
Spacing • Rastresitost	43 (56.6%)	13 (17.3%)
Mild crowding • Blaga zbijenost	73 (96.1%)	0 (0.0%)
Moderate crowding • Umjerena zbijenost	56 (73.7%)	0 (0.0%)
Severe crowding • Teška zbijenost	13 (17.1%)	52 (68.4%)
Deep bite • Duboki zagriz	30 (39.5%)	33 (43.4%)
Open bite • Otvoreni zagriz	41 (53.9%)	25 (32.9%)
Increased overjet • Povećani pregriz	25 (32.9%)	33 (43.4%)
Reverse overjet • Obrnuti pregriz	26 (34.2%)	28 (36.8%)
Unilateral crossbite • Jednostrani križni zagriz	36 (47.4%)	16 (21.1%)
Bilateral crossbite • Obostrani križni zagriz	22 (28.9%)	40 (52.6%)
Other • Ostalo		
Orthognathic surgery prep • Priprema za ortognatsku kirurgiju	0 (0.0%)	1 (1.3%)
Rotations • Rotacije	0 (0.0%)	1 (1.3%)
Extraction cases • Ekstrakcijski slučajevi	0 (0.0%)	2 (2.6%)
Impacted teeth • Impaktirani zubi	0 (0.0%)	3 (3.9%)

Table 5. Treatment modalities used with CAT
Tablica 5. Terapijski modaliteti koji se koriste u terapiji prozirnim alignerima (CAT)

Case type • Tip slučaja	Always • Uvijek n (%)	Most of the time • Uglavnom n (%)	Sometimes • Katkad n (%)	Rarely • Rijetko n (%)	Never • Nikad n (%)
Premolar extraction cases • Slučajevi s ekstrakcijom pretkutnjaka	–	1 (1.3%)	12 (15.4%)	22 (28.2%)	43 (55.1%)
Lower incisor extraction cases • Slučajevi s ekstrakcijom donjih sjekutića	2 (2.6%)	4 (5.1%)	16 (20.5%)	20 (25.6%)	36 (46.2%)
Combined orthodontic-orthognathic surgical cases • Kombinirani ortodontsko-ortognatski slučajevi	–	–	6 (7.7%)	6 (7.7%)	66 (84.6%)
Deep bite with bite ramps • Duboki zagriz	1 (1.3%)	14 (17.9%)	24 (30.8%)	21 (26.9%)	18 (23.1%)
Cases with temporary anchorage devices (TADs) • Slučajevi s privremenim sidrenim uređajima (TADs)	1 (1.3%)	6 (7.7%)	22 (28.2%)	22 (28.2%)	27 (34.6%)

Table 6. Tools used to carry out IPR
Tablica 6. Alati koji se koriste za provođenje interproksimalne redukcije (IPR)

Tool • Alat	Always • Uvijek n (%)	Most of the time • Uglavnom n (%)	Sometimes • Katkad n (%)	Rarely • Rijetko n (%)	Never • Nikad n (%)
Perforated strip • Perforirana trakica	9 (11.5%)	18 (23.1%)	21 (26.9%)	12 (15.4%)	18 (23.1%)
Solid strip • Puna trakica	11 (14.1%)	35 (44.9%)	23 (29.5%)	2 (2.6%)	7 (9.0%)
Perforated disk • Perforirani disk	2 (2.6%)	4 (5.1%)	15 (19.2%)	11 (14.1%)	46 (59.0%)
Solid disk • Puni disk	4 (5.1%)	—	16 (20.5%)	12 (15.4%)	46 (59.0%)
Diamond bur (high-speed) • Dijamantno svrdlo (velika brzina)	2 (2.6%)	21 (26.9%)	25 (32.1%)	16 (20.5%)	14 (17.9%)
Oscillating disk • Oscilirajući disk	2 (2.6%)	6 (7.7%)	9 (11.5%)	8 (10.3%)	53 (67.9%)
Reciprocating strip • Recipročna trakica	6 (7.7%)	13 (16.7%)	24 (30.8%)	7 (9.0%)	28 (35.9%)
Other • Ostalo	4 (5.1%)	2 (2.6%)	4 (5.1%)	5 (6.4%)	63 (80.8%)

reported basing follow-up frequency on specific treatment milestones such as IPR.

The vast majority (83.3%) reported that patients always saw the orthodontist directly, with an additional 10.3% stating that this occurred most of the time.

Regarding IPR, the median percentage of cases in which it was prescribed in the initially accepted treatment plan was 80% (IQR: 50–90), indicating that IPR is a routine component in the majority of aligner treatments. In contrast, the refinement phase included IPR in a substantially smaller proportion of cases, with a median of 20% (IQR: 10–45). These findings suggest that IPR is primarily planned at the outset of treatment and is less commonly introduced during refinement. Those who prescribed IPR in refinement aligner stages were further asked how the amount typically compared to that in the initial treatment plan.

The prescription of IPR in initial aligner treatment plans for specific therapeutic goals is shown in Figure 3. IPR is most commonly used to reduce crowding and minimize the need for arch expansion, as well as to address black triangle reduction and tooth-size discrepancies. Other goals, such as midline correction and overjet improvement, were associated with more variable usage. The "Other" category was rarely selected, and only a few participants specified additional indications (triangular or ovoid tooth shape).

Velika većina ispitanika (73,5 %) navela je da rutinske kontrolne preglede dogovara svaka četiri tjedna, što je standardizirani mjesečni pristup praćenju terapije. Neki su kliničari izvijestili da učestalost kontrola prilagođavaju prema određenim fazama terapije, primjerice, tijekom primjene IPR-a.

Velika većina ispitanika (83,3 %) navela je da pacijente uvijek osobno pregleda ortodont, a dodatnih 10,3 % izjavilo da se to događa u većini slučajeva.

Što se tiče IPR-a, medijan udjela slučajeva u kojima je bio uključen u početno prihvaćeni terapijski plan iznosio je 80 % (IQR: 50 – 90), što pokazuje da je IPR rutinska komponenta u većini terapija alignerima. Nasuprot tomu, dorada je uključivala IPR u znatno manjem udjelu slučajeva, s medijanom od 20 % (IQR: 10 – 45). Ti rezultati upućuju na to da se IPR uglavnom planira na početku terapije, a rjeđe se uvodi tijekom dorade. Ispitanici koji su primjenjivali IPR u fazama dorade dodatno su upitani kako se njegova količina u toj fazi obično uspoređuje s količinom planiranom u početnom terapijskom planu.

Primjena IPR-a u početnim terapijskim planovima s alignerima za postizanje određenih terapijskih ciljeva prikazana je na slici 3. IPR se najčešće koristi za smanjenje zbijenosti zuba i smanjenje potrebe za ekspanzijom zubnoga luka, te za korekciju crnih trokuta te nerazmjera u veličini zuba. Osta-

Table 7. Patient-reported CAT-related issues by an orthodontist
Tablica 7. Problemi povezani s terapijom prozirnim alignerima (CAT) koje prijavljuju pacijenti, prema procjeni ortodonta

Reported issue • Prijavljeni problem	Always • Uvijek n (%)	Most of the time • Uglavnom n (%)	Sometimes • Katkad n (%)	Rarely • Rijetko n (%)	Never • Nikad n (%)
Discomfort • Nelagoda	–	3 (3.8%)	24 (30.8%)	32 (41.0%)	19 (24.4%)
Speech difficulties / lisping • Poteškoće s govorom / šuškanje	–	13 (16.7%)	31 (39.7%)	27 (34.6%)	7 (9.0%)
Difficulty adhering to wear schedule • Poteškoće u održavanju rasporeda nošenja alignera	2 (2.6%)	11 (14.1%)	37 (47.4%)	22 (28.2%)	6 (7.7%)
Aligner wear or breakage • Trošenje ili pucanje alignera	–	2 (2.6%)	20 (25.6%)	34 (43.6%)	22 (28.2%)
Loss of aligners • Gubitak alignera	–	5 (6.4%)	24 (30.8%)	37 (47.4%)	12 (15.4%)
Poor aligner fit • Loše prianjanje alignera	–	4 (5.1%)	25 (32.1%)	31 (39.7%)	18 (23.1%)
Aligner appearance • Izgled alignera	–	1 (1.3%)	6 (7.7%)	31 (39.7%)	40 (51.3%)
Appearance/discomfort caused by attachments • Izgled / nelagoda prouzročena pričvrstcima	–	4 (5.1%)	22 (28.2%)	36 (46.2%)	16 (20.5%)
Tooth discoloration around attachments • Promjena boje zuba oko pričvrstaka	–	7 (9.0%)	20 (25.6%)	34 (43.6%)	17 (21.8%)
Dissatisfaction with treatment duration • Nezadovoljstvo trajanjem terapije	1 (1.3%)	1 (1.3%)	17 (21.8%)	43 (55.1%)	16 (20.5%)
Dissatisfaction with final treatment outcome • Nezadovoljstvo konačnim ishodom terapije	–	1 (1.3%)	10 (12.8%)	40 (51.3%)	27 (34.6%)
Dissatisfaction with need for refinements • Nezadovoljstvo potrebom za doradom	–	4 (5.1%)	17 (21.8%)	34 (43.6%)	23 (29.5%)
Other • Ostalo	–	–	4 (5.1%)	8 (10.3%)	66 (84.6%)

As expected, IPR was primarily performed by orthodontists, with 85.7% of respondents reporting that they always performed it themselves. The instruments used for IPR are presented in Table 6.

Refinements represent a frequent step in aligner therapy, with a median of 50% of cases requiring at least one refinement (IQR: 20–80).

Respondents (59.0%) reported never initiating treatment with fixed appliances and then switching to aligners. A smaller proportion used this hybrid approach in 1–2% of cases (17.9%), 2.1–5% (6.4%), 5.1–10% (10.3%), or more than 10% of cases (6.4%).

Retention protocols varied between arches. For the upper arch, the majority of respondents reported using either a thermoplastic retainer alone (57.1%) or a combination of fixed and thermoplastic retainer (36.4%). Only a small number reported using a fixed retainer alone (3.9%).

For the lower arch, over half of the participants indicated they typically prescribe a combination of fixed and thermoplastic retainers (53.8%), followed by thermoplastic (28.2%) and fixed retainers alone (11.5%). These findings indicate a strong preference for dual retention protocols, especially in the lower arch.

Additionally, participants were asked how frequently patients reported specific problems related to aligner use. Table 7 summarizes the frequency of reported issues such as discomfort, speech difficulties, compliance challenges, and dissatisfaction with various aspects of treatment.

Orthodontists were asked to compare aligner treatment

li ciljevi, poput korekcije sredine i smanjenja pregriza, pokazali su veću varijabilnost u učestalosti primjene. Kategorija *Ostalo* rijetko je bila odabrana, a samo je nekoliko sudionika navelo dodatne indikacije, poput trokutastoga ili ovalnoga oblika zuba.

Kao što se i očekivalo, IPR su primarno obavljali ortodonti, pri čemu je 85,7 % ispitanika navelo da ga uvijek sami provode. Instrumenti koji se koriste za IPR-a prikazani su u tablici 6.

Dorada je česta u terapiji alignerima, pri čemu je medijan od 50 % slučajeva zahtijevao barem jednu doradu (IQR: 20 – 80).

Ispitanici (59,0 %) naveli su da nikada ne počinju terapiju fiksnom ortodontskom napravom, a zatim prelaze na alignere. Manji dio ortodonata primjenjuje taj hibridni pristup u 1 do 2 % slučajeva (17,9 %), u 2,1 do 5 % (6,4 %), u 5,1 do 10 % (10,3 %) ili u više od 10 % slučajeva (6,4 %).

Protokoli retencije razlikovali su se između čeljusti. Za gornju čeljust većina ispitanika navela je da odabire isključivo termoplastične retainere (57,1%) ili kombinacije fiksnoga i termoplastičnoga retainera (36,4 %). Samo malobrojni ispitanici (3,9 %) izvijestili su o korištenju isključivo fiksnog retainera.

Za donju čeljust više od polovine ispitanika (53,8 %) navelo je da najčešće propisuju kombinaciju fiksnoga i termoplastičnoga retainera, zatim samo termoplastični retainer (28,2 %) te isključivo fiksni retainer (11,5%). Ti rezultati pokazuju veliku sklonost prema primjeni dvostrukih retencijskih protokola, osobito u donjoj čeljusti.

Table 8. Orthodontist opinions regarding CAT duration and treatment quality
Tablica 8. Mišljenja ortodonata o trajanju terapije prozirnim alignerima (CAT) i kvaliteti liječenja

Statement • Izjava	Strongly Agree • U cijelosti se slažem	Somewhat Agree • Djelomično se slažem	Neutral • Neutralno stajalište	Somewhat Disagree • Djelomično se ne slažem	Strongly Disgree • U cijelosti se ne slažem
For comparable cases with identical treatment outcomes, aligners require longer treatment time than fixed appliances. • U usporedivim slučajevima s identičnim terapijskim ishodima, terapija alignerima zahtijeva dulje trajanje od terapije fiksnim napravama,	5.2%	26.0%	13.0%	32.5%	23.4%
For comparable cases, aligners provide superior therapeutic outcomes compared to fixed appliances. • U usporedivim slučajevima, terapija alignerima pruža bolje terapijske ishode u usporedbi s terapijom fiksnim napravama.	7.7%	17.9%	26.9%	21.8%	25.6%

with fixed appliances in terms of treatment duration and perceived treatment outcomes for comparable cases. Responses are summarized in Table 8.

Discussion

The aim of this study was to investigate CAT protocols among orthodontic specialists in the Republic of Croatia and it represents the first study of this kind conducted in the country. Over 80% of respondents reported using orthodontic aligners in their clinical practice, a result comparable to that reported in the United Kingdom and the Republic of Ireland (77.3%) (17), but lower than in New Zealand (89%) (15), and Australia and the United States, where usage rates are approximately 93% (13,18). This difference may be explained by the fact that a substantial proportion of orthodontists (45%) in Croatia work within the public healthcare system, where aligner therapy is not covered by national (HZZO) health insurance fund.

Furthermore, only 10% of all annual orthodontic cases were treated using CAT, which is in line with findings from France (11) and New Zealand (15), but slightly lower than the proportions reported in Australia and the U.S. (13,18). This observation may be supported by the fact that, in 2023, the clear aligner market size was estimated at USD 2.49 billion in the United States, compared to USD 1.3 billion in Europe. This indicates that orthodontists in the US are likely to treat significantly more cases with aligners than their European colleagues, primarily due to the larger market size and greater availability of aligner providers (19, 20). Approximately 60% of respondents stated that they "always" or "most of the time" used aligners in adult patients, a trend consistent with findings from other studies (21, 22, 23). This trend may reflect both the increased esthetic concerns of adult patients and the financial aspect, as orthodontic treatment in Croa-

Sudionici su također bili upitani koliko često pacijenti prijavljuju određene probleme povezane s uporabom alignera. Tablica 7. pokazuje učestalost prijavljenih poteškoća, poput nelagode, poteškoća s govorom, problema sa suradljivošću te nezadovoljstva različitim aspektima terapije.

Ortodonti su zatim bili zamoljeni da usporede terapiju alignerima s fiksnim napravama, kad je riječ o trajanju liječenja i percipiranim terapijskim ishodima u usporedivim slučajevima. Odgovori su sažeti u tablici 8.

Rasprava

Cilj ovog istraživanja bio je ispitati protokole primjene CAT terapije među specijalistima ortodoncije u Republici Hrvatskoj i to je ujedno prvo istraživanje takve vrste provedeno u zemlji. Više od 80 % ispitanika navelo je da se u kliničkoj praksi koristi ortodontskim alignerima, što se može usporediti s rezultatima zabilježenima u Ujedinjenom Kraljevstvu i Republici Irskoj (77,3 %) (17), ali manje u odnosu na Novi Zeland (89 %) (15) te Australiju i Sjedinjene Američke Države gdje je stopa primjene oko 93 % (13, 18). Ta se razlika može objasniti činjenicom da znatan broj ortodonata u Hrvatskoj (45 %) radi u sklopu javnoga zdravstvenog sustava u kojemu terapija alignerima nije pokrivena sredstvima Hrvatskoga zavoda za zdravstveno osiguranje. Nadalje, samo je 10 % svih godišnjih ortodontskih slučajeva bilo liječeno CAT terapijom, što je u skladu s nalazima iz Francuske (11) i Novog Zelanda (15), ali nešto manje u odnosu na udjele prijavljene u Australiji i Sjedinjenim Američkim Državama (13, 18). Ta se pojava može objasniti činjenicom da je 2023. godine veličina tržišta prozirnih alignera u Sjedinjenim Američkim Državama procijenjena na 2,49 milijardi američkih dolara, u usporedbi s 1,3 milijarde dolara u Europi. To upućuje na to da ortodonti u SAD-u vjerojatno liječe znatno više pacijenata alignerima od svojih europskih kolega, ponajprije zbog većega tržišnog opsega i veće dostupnosti proizvođača prozirnih aparatića (19, 20).

Otprilike 60 % ispitanika navelo je da se *uvijek* ili *uglavnom* koristi alignerima za odrasle pacijente, što je u skladu s nalazima drugih istraživanja (21, 22, 23). Taj se trend može objasniti povećanom estetskom sviješću odraslih pacijenatia is no longer covered by public health insurance fund after the age of 18, making adults self-paying patients. Nevertheless, slightly more than 40% of respondents reported treating adolescent patients with aligners, highlighting a growing trend in the use of this therapy among younger populations.

Among the aligner brands currently in use, Invisalign was the most frequently selected, with approximately 60% of orthodontists reporting its use. This is comparable to the findings from Australia and the United States (13), but somewhat lower than reported usage rates in New Zealand where 70–80% of practitioners use the same brand (15). The quality of the DTP and the sophistication of the product itself were identified as the primary reasons for brand selection.

Nevertheless, nearly two-thirds of orthodontists reported modifying their initial DTP. Specifically, almost two-thirds of respondents adjusted the final tooth positions, while more than half altered the planned tooth movement protocols, most often independently, without assistance from the provider. This pattern of routinely modifying the initial DTP has also been observed in studies from New Zealand, Australia, the United Kingdom, and the Republic of Ireland (13, 15, 17, 24 and 25).

The need for these modifications may be due to the current limitations of digital planning software, which is still unable to accurately account for the biological response of the tissues to tooth movement. As a result, a significant number of orthodontists continue to adapt the proposed digital protocols based on clinical judgment and experience.

The vast majority of respondents reported feeling highly confident in managing mild to moderate crowding, consistent with previous studies (13, 15, 26-28). In contrast, most participants expressed uncertainty when treating deep bite cases, a trend confirmed in a study conducted in Australia (13). The prevailing skepticism toward the use of aligners for deep bite correction may be attributed to studies that have highlighted the specific challenges and limitations associated with treating this type of malocclusion (8, 29).

Furthermore, most respondents reported rarely or never using aligners to treat extraction cases or those requiring orthodontic preparation for orthognathic surgery. A similarly low rate of premolar extraction as part of CAT has been observed in France and the United States (11,18). In contrast, studies from New Zealand and Australia found that approximately 40% of respondents treated lower incisor extraction cases with aligners (13,15). It can be assumed that the complexity of cases requiring tooth extractions leads clinicians to rely on fixed appliances because of their greater predictability.

The hybrid treatment approach, defined as a combination of fixed appliances and clear aligners, was not popular among the respondents. Only 4% of respondents reported frequently combining these two treatment modalities simultaneously. In contrast, this approach appears to be more commonly applied elsewhere: 25% of orthodontists in New Zealand reported using hybrid protocols, while significantly higher rates were observed in Australia, the United States, and Canada, where 50–60% of clinicians incorporated this method into their practice (12,13,18).

ta, ali i financijskim aspektom, zato što ortodontska terapija u Hrvatskoj nakon navršene 18. godine više nije pokrivena sredstvima javnoga zdravstvenog osiguranja, pa odrasli pacijenti sami snose troškove. Ipak, nešto više od 40 % ispitanika izvijestilo je da provodi terapiju alignerima i kad je riječ o adolescentnim pacijentima, što upućuje na sve češću primjenu te terapije među mlađom populacijom.

Među trenutačno korištenim markama alignera, najčešća je bila Invisalign, pri čemu je približno 60 % ortodonata navelo da se njome koristi u svojoj praksi. Taj je rezultat usporediv s nalazima iz Australije i Sjedinjenih Američkih Država (13), ali nešto manje u odnosu na Novi Zeland gdje 70 – 80 % kliničara odabire isti brend (15). Kvaliteta DTP-a i sofisticiranost proizvoda identificirani su kao glavni razlozi za izbor određenoga brenda.

Unatoč tomu, gotovo dvije trećine ortodonata navelo je da mijenja svoj početni DTP. Konkretno, gotovo dvije trećine ispitanika prilagođava konačne položaje zuba, a više od polovine mijenja planirane protokole pomaka zuba, najčešće samostalno, bez pomoći proizvođača. Takav model rutinskoga mijenjanja početnoga DTP-a zabilježen je i u istraživanjima provedenim u Novom Zelandu, Australiji, Ujedinjenom Kraljevstvu i Republici Irskoj (13, 15, 17, 24, 25).

Potreba za tim prilagodbama može se pripisati trenutačnim ograničenjima softvera za digitalno planiranje koji još uvijek ne može točno uzeti u obzir biološki odgovor tkiva na pomak zuba. Kao rezultat toga, znatan broj ortodonata i dalje prilagođava predložene digitalne protokole na temelju vlastite kliničke procjene i iskustva.

Velika većina ispitanika izjavila je da se osjeća vrlo sigurno u liječenju blagih do umjerenih slučajeva zbijenosti, što je u skladu s dosadašnjim istraživanjima (13, 15, 26 – 28). Nasuprot tomu, većina sudionika izrazila je nesigurnost pri liječenju dubokoga zagriza, što potvrđuje i istraživanje provedeno u Australiji (13). Prevladavajući skepticizam prema primjeni alignera u korekciji dubokoga zagriza može se pripisati studijama u kojima su istaknuti specifični izazovi i ograničenja povezana s liječenjem te vrste malokluzije (8, 29).

Nadalje, većina ispitanika navela je da se rijetko ili nikada ne koristi alignerima u liječenju ako je uključena ekstrakcija zuba ili se zahtijeva ortodontska priprema za ortognatsku kirurgiju. Slična niska stopa ekstrakcija pretkutnjaka, kao dio CAT terapije, zabilježena je u Francuskoj i Sjedinjenim Američkim Državama (11, 18). Suprotno tomu, istraživanja u Novom Zelandu i Australiji pokazala su da je približno 40 % ispitanika liječilo slučajeve s ekstrakcijom donjih sjekutića s pomoću alignera (13, 15). Može se pretpostaviti da složenost slučajeva koji zahtijevaju ekstrakcije zuba potiče kliničare da se oslanjaju na fiksne naprave zbog njihove veće predvidivosti.

Hibridni terapijski pristup, definiran kao kombinacija fiksnih ortodontskih naprava i prozirnih alignera, nije bio popularan među ispitanicima. Samo njih 4 % navelo je da često istodobno kombinira te dvije terapijske metode. Suprotno tomu, taj se pristup češće primjenjuje u drugim zemljama: 25 % ortodonata u Novom Zelandu izvijestilo je o korištenju hibridnih protokola, a znatno više stope zabilježene su u Australiji, Sjedinjenim Američkim Državama i Ka-

Regarding remote monitoring, just over 60% of orthodontists reported not using it routinely, which aligns with the findings of studies conducted in Australia (13), Canada (12), and New Zealand (15). However, approximately 60% of orthodontists in the United States reported the routine use of this feature. Since remote monitoring is an optional, paid component of the treatment software, the additional cost may discourage many orthodontists from adopting it in clinical practice. However, previous studies have shown that remote monitoring can reduce the number of in-office appointments by an average of 3.5 visits over the course of treatment (16). Therefore, the cost of digital monitoring, along with the associated doctor and staff time, should be weighed against the financial and clinical burden of additional physical appointments. This balance between cost-effectiveness, efficiency, and clinical outcomes represents an important area for future research.

Among orthodontists, the two-week aligner wear protocol was most commonly prescribed for both adolescent and adult patients (45%), followed by the one-week protocol, which was used slightly less frequently (30%). This approach is consistent with clinical practice in New Zealand (15), whereas the one-week protocol is more prevalent in the United Kingdom, Republic of Ireland, and United States (14, 17). Given the current lack of consensus in the literature and the conflicting findings across studies, further research is warranted to clarify the clinical implications of different wear schedules (30, 31).

To maintain better control over treatment progress, just over 70% of respondents reported scheduling patient visits every four weeks. In contrast, a study from New Zealand (15) found that most clinicians reviewed their patients every eight weeks. The shorter interval between in-office visits observed in the present sample may be explained by the limited use of remote monitoring, which has the potential to reduce the frequency of in-office appointments.

During aligner therapy, IPR is routinely used to create additional space and enhance long-term stability (32, 33). Findings from this survey indicate that IPR is included in 80% of initial treatment plans, whereas its use during the refinement phase drops to 20%. A similar trend was observed in New Zealand (15). Interestingly, the opposite pattern was reported in the United States, where IPR is prescribed 20% more frequently during the refinement phase than in the initial plan. These results suggest that orthodontists consider that the initial DTP is generally effective in predicting sufficient space for planned tooth movements.

Refinement, as an additional phase of CAT, was a reported requirement in 50% of cases. In contrast, this additional treatment phase is present in approximately 90% of cases in the United Kingdom, the Republic of Ireland, and Canada (12,17).

To ensure long-term stability of orthodontic treatment outcomes, approximately 60% of orthodontists reported using a thermoplastic retainer for the upper arch, while around 50% of them prescribe a combination of a thermoplastic and a fixed retainer for the lower arch. In contrast, the Canadian and Australian approach differs slightly, with fixed retain-

nadi, gdje je od 50 do 60 % kliničara uključilo tu metodu u svoju praksu (12, 13, 18).

Kad je riječ o praćenju terapije na daljinu, nešto više od 60 % ortodonata navelo je da to ne čini rutinski, što je u skladu s rezultatima istraživanja u Australiji (13), Kanadi (12) i Novom Zelandu (15). Međutim, približno 60 % ortodonata u Sjedinjenim Američkim Državama izvijestilo je o redovitoj primjeni takvog načina praćenja. Budući da je praćenje na daljinu opcionalna, dodatno naplaćivana komponenta softvera za planiranje terapije, dodatni troškovi mogu odvratiti mnoge ortodonte od njegove implementacije u kliničkoj praksi. Ipak, autori dosadašnjih istraživanja pokazali su da praćenje na daljinu može smanjiti broj kontrolnih pregleda u ordinaciji u prosjeku za 3,5 posjeta tijekom terapije (16). Zato bi trošak digitalnog praćenja, zajedno s vremenom liječnika i osoblja, trebalo usporediti s financijskim i kliničkim opterećenjem koje prati dodatne fizičke preglede. Ta ravnoteža između isplativosti, učinkovitosti i kliničkih ishoda važno je područje za buduća istraživanja.

Među ortodontima je dvotjedni protokol nošenja alignera bio najčešće propisivan i za adolescentne i za odrasle pacijente (45 %), a slijedio ga je tjedni protokol koji se predlagao nešto rjeđe (30 %). Takav pristup u skladu je s kliničkom praksom u Novom Zelandu (15), a tjedni protokol češći je u Ujedinjenom Kraljevstvu, Republici Irskoj i Sjedinjenim Američkim Državama (14, 17). S obzirom na trenutačni nedostatak konsenzusa u literaturi i proturječne rezultate dosadašnjih istraživanja, potrebna su daljnja istraživanja kako bi se razjasnile kliničke implikacije različitih protokola nošenja alignera (30, 31).

Da bi se održala bolja kontrola napretka terapije, nešto više od 70 % ispitanika navelo je da dogovara kontrolne preglede svaka četiri tjedna. Suprotno tomu, istraživanje provedeno u Novom Zelandu (15) pokazalo je da većina kliničara pregledava pacijente svakih osam tjedana. Kraći razmak između kontrolnih pregleda u ovom uzorku može se objasniti ograničenom primjenom praćenja terapije na daljinu koje ima potencijal smanjiti učestalost fizičkih dolazaka u ordinaciju.

Tijekom terapije alignerima IPR se rutinski koristi za stvaranje dodatnoga prostora i postizanje dugoročne stabilnosti (32, 33). Rezultati ovog istraživanja pokazuju da je IPR uključen u 80 % početnih terapijskih planova, a njegova se primjena u doradi smanjuje na 20 %. Sličan trend zabilježen je i u Novom Zelandu (15). Zanimljivo je da su u Sjedinjenim Američkim Državama opaženi suprotni modeli – IPR se propisuje 20 % češće tijekom dorade nego u početnome planu. Ti rezultati sugeriraju da ortodonti smatraju da je početni digitalni plan terapije općenito učinkovit u predviđanju dovoljnog prostora za planirane pomake zuba. Dorada, kao dodatna faza CAT terapije, bila je potrebna u 50 % slučajeva. Suprotno tomu, ta se dodatna faza liječenja pojavljuje u približno 90 % slučajeva u Ujedinjenom Kraljevstvu, Republici Irskoj i Kanadi (12, 17).

Kako bi se osigurala dugoročna stabilnost rezultata ortodontske terapije, oko 60 % ortodonata navelo je da se koristi termoplastičnim retainerom za gornju čeljust, a približno 50 % propisuje kombinaciju termoplastičnoga i fiksnoga retaiers being the most commonly used option for the lower arch (34, 35).

In the final section of the questionnaire, respondents reported that the most common patient-reported issues with aligners were speech difficulties/lisping (17%) and difficulty adhering to the prescribed wear schedule (14%), findings consistent with those reported in Australia (13). These observations are further supported by a cohort study, which found that adherence to the wear protocol in CAT was poor among 74% of participants (6).

Although more than half of clinicians believe that CAT is not slower than fixed appliance therapy in comparable cases, almost half of the respondents do not consider the outcomes achieved with aligners to be superior. In contrast, a study from New Zealand (15) found that just over 40% of clinicians perceive CAT to be slower than fixed appliance therapy, while an Australian study (13) reported that over half of respondents believe that aligners deliver superior treatment outcomes compared to fixed appliances. The relatively low number of cases treated with aligners annually may be attributed to limited CAT training and education among orthodontic specialists, leading to a continued preference for conventional fixed appliance therapy.

A potential limitation of the present study may be response bias: orthodontists who employ CAT were more likely to respond, potentially exaggerating (88.0%) the reported prevalence of aligner use in Croatia At the same time, non-response may in part be linked to the survey's extensive length and detail. The high frequency of online studies in this field may also have contributed to the limited interest among respondents.

Conclusion

Eighty-eight percent of respondents reported using clear aligner therapy (CAT) in their daily clinical practice. Nevertheless, only 10% of all annual orthodontic cases are actually treated with CAT. Among the available aligner systems, Invisalign emerged as the most commonly used brand, which, in the opinion of the respondents, is primarily due to the quality of its digital treatment planning and the sophistication of the product itself. Participants indicated that they feel most confident in managing cases involving mild to moderate crowding. Furthermore, adults were identified as the most common patient group for whom CAT is prescribed. These findings highlight potential areas for future research, such as exploring innovations in remote monitoring, hybrid treatment approaches, or the use of aligners in managing more complex orthodontic cases.

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nera za donju čeljust. Suprotno tomu, pristup u Kanadi i Australiji donekle se razlikuje zato što su fiksni retaineri najčešće korištena opcija za donju čeljust (34, 35).

U završnome dijelu upitnika ispitanici su naveli da su najčešći problemi koje pacijenti prijavljuju tijekom terapije alignerima poteškoće s govorom, odnosno šuškanje (17 %) te poteškoće u održavanju propisanog rasporeda nošenja alignera (14 %), što je u skladu s nalazima istraživanja provedenoga u Australiji (13). Ta opažanja dodatno potvrđuje kohortna studija u kojoj su autori ustanovili da se 74 % ispitanika nije dosljedno držalo propisanog protokola nošenja alignera tijekom CAT terapije (6).

Iako više od polovine kliničara smatra da CAT terapija nije sporija od terapije fiksnom ortodontskom napravom u usporedivim slučajevima, gotovo polovima ispitanika ne smatra da su rezultati postignuti alignerima superiorniji. Suprotno tomu, istraživanje provedeno u Novom Zelandu (15) pokazalo je da nešto više od 40 % kliničara smatra da je CAT sporiji od terapije fiksnom napravom, a u australskome istraživanju (13) izvješćuje se da više od polovine ispitanika vjeruje da aligneri omogućuju bolje terapijske ishode u usporedbi s fiksnim napravama. Razmjerno mali broj slučajeva liječenih alignerima na godinu može se pripisati ograničenoj izobrazbi i osposobljenosti iz područja CAT terapije među specijalistima ortodoncije, što rezultira trajnom sklonošću prema tradicionalnoj terapiji fiksnim napravama.

Potencijalno ograničenje ovog istraživanja može biti pristranost u odabiru ispitanika (response bias): ortodonti koji se već koriste CAT terapijom vjerojatnije su sudjelovali u istraživanju, što bi moglo rezultirati precijenjenom stopom prijavljene primjene alignera u Hrvatskoj (88,0 %). Istodobno, nedostatak odgovora mogao bi se djelomično objasniti duljinom i detaljnošću upitnika. Dodatno, visoka učestalost sličnih internetskih istraživanja u ovom području mogla je pridonijeti smanjenom interesu ispitanika za sudjelovanje.

Zaključak

Osamdeset i osam posto ispitanika navelo je da se koristi terapijom prozirnim ortodontskim alignerima (CAT) u svakodnevnoj kliničkoj praksi. Ipak, samo se 10 % svih godišnjih ortodontskih slučajeva zapravo liječi na taj način. Među dostupnim sustavima alignera, *Invisalign* se pokazao kao najčešće korišten, što ispitanici uglavnom pripisuju kvaliteti digitalnog planiranja terapije i sofisticiranosti proizvoda. Sudionici su naveli da se najugodnije osjećaju tijekom liječenja blage do umjerene zbijenosti. Nadalje, odrasli pacijenti identificirani su kao najčešća skupina za koju se propisuje CAT terapija. Ti nalazi ističu potencijalna područja za buduća istraživanja, poput razvoja inovacija u praćenju terapije na daljinu, hibridnih pristupa liječenju, ili primjenju alignera u liječenju složenijih ortodontskih slučajeva.

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Sažetak

Svrha: Cilj ovoga presječnog istraživanja bio je ispitati praksu i protokole za primjenu terapije prozirnim ortodontskim alignerima (CAT) među specijalistima ortodoncije u Republici Hrvatskoj. **Ispitanici i postupci:** Revidirana verzija već objavljenog upitnika distribuirana je putem interneta na adrese 180 ortodonata. Upitnik je sadržavao 46 pitanja otvorenoga i zatvorenoga tipa raspoređenih u 11 cjelina koje su obuhvaćale demografske podatke, kliničku primjenu CAT terapije, preferencije prozirnoga aparatića, digitalno planiranje terapije (DTP), indikacije, protokole, interproksimalnu redukciju (IPR), doradu, retenciju, probleme koje prijavljuju pacijenti te opća stajališta ispitanika. Ispitanici koji se ne koriste CAT-om bili su preusmjereni na zaseban odjeljak o razlozima neprimjene. **Rezultati:** Većina ispitanika (88 %) navela je da se koristi CAT-om u kliničkoj praksi, iako samo 10 % njihovih godišnjih slučajeva uključuje CAT. Odrasli pacijenti bili su češća skupina (57,9 %), a glavna indikacija bila je blaga do umjerena zbijenost. Invisalign je bio najkorišteniji sustav alignera (58,7 %), ponajprije zbog kvalitete digitalnoga planiranja terapije (DTP) i sofisticiranosti značajki proizvoda. Dvije trećine ispitanika navele su da mijenjaju digitalni plan terapije, osobito pri prilagođavanju konačnih položaja zuba. Dorada je bila potrebna u 50 % slučajeva. IPR je bio uključen u 80 % početnih planova terapije, a u doradi se primjenjivao u samo 20 % slučajeva. Konačno, 52,6 % ortodonata smatralo je da CAT omogućuje bolje terapijske ishode u usporedbi s konvencionalnim fiksnim napravama. **Zaključak:** CAT je široko rasprostranjen među ortodontima u Hrvatskoj, uglavnom za liječenje blagih slučajeva. Ipak, aligneri se još uvijek ne percipiraju kao metoda koja daje superiorne rezultate u odnosu prema fiksnim ortodontskim napravama.

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Adresa za dopisivanje
Ana Marija Miličević, dr. med. med.
Sveučilište u Zagrebu Stomatološki fakultet
Zavod za ortodonciju
Gundulićeva 5, 10000 Zagreb, Hrvatska
Telefon: +385 1 4802 117
amilicevic@sfzg.unizg.hr

MeSH pojmovi: ortodonti; mobilne ortodontske naprave; stručno djelovanje
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