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# Current situation, trends, and challenges navigating temporary anchorage devices usage among orthodontists in China: a comprehensive multi-center survey

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## Abstract

**Background** The temporary anchorage devices (TADs) are presently a viable and popular treatment option for orthodontics all over the world. However, there is a lack of investigation and research on its application among orthodontists in China. This study aims to explore factors influencing temporary anchorage devices usage and compare current perspectives and usage patterns between orthodontic specialists and general dentists, thereby establishing new consensus and guiding future improvements.

**Methods** A cross-sectional study using a multi-center structured questionnaire was designed. The Chi-square test, Mann-Whitney U test, and logistic regression were performed.

**Results** Respondents were from 30 provincial-level regions. Most doctors had relatively rich clinical experience in orthodontics, with 65.70% working for over 10 years. Respondents reported a relatively high usage rate (87.54%) and satisfaction with TADs (93.85%). The analysis result showed Chinese orthodontists who received more TADs training ( $P < 0.01$ ), had higher educational attainment ( $P < 0.01$ ), and used more clear aligners ( $P < 0.01$ ) tended to use TADs more frequently. About 95.90% of respondents believed TADs helped achieve higher treatment goals, 68.23% agreed they could shorten treatment duration, and 51.82% believed they reduced the probability of orthodontic-orthognathic treatment. Differences in the understanding of indications for TADs, improvement method of TADs can be observed between orthodontic specialists and general dentists ( $P < 0.05$ ).

**Conclusions** Chinese orthodontists were relatively active in using TADs. The factors most closely associated with TAD usage included related training, the type of orthodontic appliances used and the highest educational attainment. Orthodontic specialists and general dentists might had differing perspectives regarding TADs, but they tended to follow similar management procedures.

**Keywords** Orthodontists, Temporary anchorage devices, Survey, Questionnaire, Miniscrew implants

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## Introduction

Stability of the anchorage forms the foundation for orthodontic treatment. Temporary anchorage devices (TADs) are mini-screws implanted in the jawbone. The use of TADs has seen a dramatic increase in recent years. Compared to conventional methods such as headgear-face bows, their most pronounced advantage is their ability to offer significantly more stable and reliable anchorage performance with minimal patient compliance [1, 2]. This characteristic enables the maximum desired tooth movement, facilitating the achievement of ideal orthodontic outcomes.

Since the introduction of TADs, their applications have progressively expanded worldwide. However, the broadening scope of TAD applications has created novel challenges. Concerns persist regarding the effectiveness of TADs compared to that of conventional methods, understanding of indications, standardization of insertion-removal procedures, management of potential complications, and reuse. The lack of high-quality, extensive prospective studies [3] has resulted in a reliance on clinical experience for decision-making among the majority of orthodontists. Non-clinical factors such as practice institutions [4] and subjective preferences [5] also influence orthodontists' decisions regarding the use of TADs and their routine management. In some countries including China, general dentists are also allowed to perform orthodontic treatments [6]. It can be hypothesized that differences in educational background and other factors may lead to variations in how general dentists and orthodontic specialists perceive and use TADs. Currently, there is a lack of consensus or guidelines regarding TAD use [7–9]. Therefore, it is imperative to collect and clarify the current trends and perspectives of TAD usage patterns among orthodontists to establish new consensus and foster a more consistent application of TADs.

Previous studies have predominantly focused on the usage patterns of TADs by orthodontists in different countries. Surveys among orthodontists in the USA revealed that over 70–91% are using some form of TADs in their practices or during their residency programs [10]. Recently, a study identified extraction decisions in orthodontic treatment plans as the most critical factor influencing TADs usage [11]. Woolley et al. [12] conducted a survey comparing TADs usage among orthodontists in Australia and the UK. Although TADs are presently a viable treatment option all over the world, no information about the use of TADs among orthodontists in China is available. These findings suggest the need for further research to comprehensively investigate the various factors shaping TADs usage patterns and to explore potential differences across different groups.

Consequently, we conducted a questionnaire-based multi-center survey targeting the current trends and

perspectives of TAD using among orthodontists. This study aimed to investigate the factors influencing TADs using and compare them between orthodontic specialists and general dentists.

## Materials and methods

This study was approved by the Human Research Ethics Committee of Peking University School and Hospital of Stomatology (Approval No.: PKUSSIRB-202060204). All respondents were selected among members of the Orthodontic Committee of Chinese Stomatological Association. Finally, a total of 1003 individuals were recruited comprising orthodontic specialists and general dentists who engaged in orthodontic treatment. Their main practice areas were distributed in 30 provincial-level administrative regions of China (Figure S1). All respondents had received at least one orthodontic case per month in the past year. They completed the questionnaires as required, and informed consent was obtained to utilize pertinent information for this survey.

In the selection criteria for the respondents, most similar studies have relied on local academic societies to identify orthodontic specialists [6, 13, 14]. However, there is a relative scarcity of orthodontic specialists in China, prompting some general dentists to engage in orthodontic treatment through continued education or other methods. Therefore, we defined respondents with at least a master's degree and specialized orthodontic training as orthodontic specialists, while the remaining were classified as general dentists.

The questionnaire was modified from those used in previous surveys on TAD usage [13, 15–17]. To assess the content validity of the revised version, five orthodontic specialists were invited to participate in a pilot test prior to the formal survey. Each specialist independently rated the validity of every question on a scale from 0 (lowest validity) to 5 (highest validity). Questions with an average score below 3 were excluded from the final version of the questionnaire. The formal survey was conducted using an online questionnaire which encompassed various aspects, including demographic data, detailed TAD usage patterns, advantages of TADs over conventional methods, indications and complications, and pertinent perspectives and challenges. The complete version of the questionnaire can be found in the Supplementary table. The questionnaire consisted of three sections comprising 28 questions. The first Sect. (10 questions) captured demographic data such as sex, age, and career profiles. The second Sect. (16 questions) primarily focused on the detailed usage patterns of TADs and respondents' attitudes and perspectives. This section was completed exclusively by the current TAD users. Targeting current non-users of TADs, the third section (two questions) delved into the factors impeding their adoption of TADs

and under what circumstances they might reconsider their usage.

The Chi-square test, Mann-Whitney U test, and logistic regression were performed between groups. Before performing logistic regression, a chi-square test was first used to identify independent variables with significant differences between the two groups. Multicollinearity was then assessed for the remaining variables. Any variable with a variance inflation factor (VIF)  $\geq 5$  was excluded. The logistic regression was performed using the “Forward: LR” method. Statistical analyses were performed using SPSS Statistics for Windows (version 26.0; IBM Corp, Armonk, NY USA). A P-value less than 0.05 was considered significant.

## Results

### Basic information of the respondents

Among all 1003 respondents, women comprised 64.31% and men accounted for 35.69%. The main age group was 30–49 years old (76.57%). The highest educational level of respondents was undergraduate (43.97%), master's (34.30%) and doctoral (14.36%). In terms of practice institutions, the proportion of Chinese orthodontists in public medical institutions and private dental clinics was approximately 2:1. Most of the respondents had relatively rich experience in orthodontic practice, with 65.70% having worked for more than 10 years, while only 10.87% had less than 5 years of experience. The above basic information of the respondents was showed in Fig. 1.

### Influencing factors of clinical use of TAD

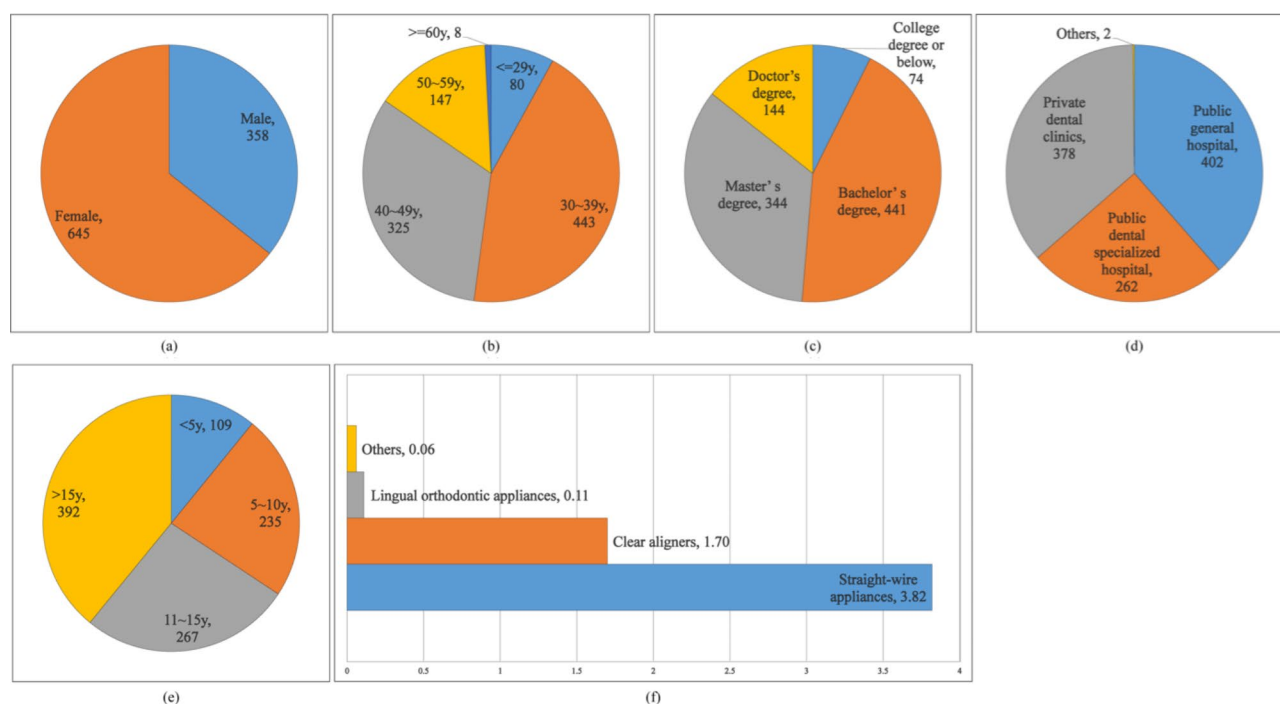
The survey respondents were divided into two groups: TADs users (87.54%) and non-users (12.46%). They exhibited a notably more degree of satisfaction with TADs (93.85%), compared with reported studies. The analysis of investigation exhibited significant disparities across demographic data and career profiles. There was a significant correlation between TAD usage and various factors (Table 1).

### The correlation of gender, age, employer property and TADs use

The proportion of men was higher among users than non-users. However, the difference was not statistically significant ( $P = 0.086$ ).

When calculating the usage rates of TADs within each age group, the highest proportion was in the 40–49 years group (90.77%), and the lowest was in the 20–29 years age group (75.00%). Age was significantly correlated with the usage rate ( $P = 0.002$ ), suggesting that users were generally older. This phenomenon might imply that orthodontists become more inclined to adopt TADs as they gradually accumulate skills and experience. Users demonstrated significantly higher educational attainment than non-users ( $P < 0.001$ ).

Our respondents exhibited a relatively high proportion of practices in public medical institutions (61.51%). There was a significant correlation between practice institutions and TAD usage ( $P < 0.001$ ). The usage rate was



**Fig. 1** The basic information of the respondents: (a) gender, (b) age, (c) highest education, (d) institution of practice, (e) length of practice, (f) appliance used

**Table 1** Distribution of various factors between TADs users and non-users

		TADs users (n=878)	Non-users (n=125)	P-value
Sex	Men	36.67%	28.80%	0.086
	Women	63.33%	71.20%	
Age	20–29y	6.83%	16.00%	0.002**
	30–39y	44.19%	44.00%	
	40–49y	33.60%	24.00%	
	≥ 50y	15.38%	16.00%	
Highest educational attainment	College degree or below	4.78%	25.60%	< 0.001***
	Bachelor's degree	41.91%	58.40%	
	Master's degree	37.24%	13.60%	
	Doctor's degree	16.06%	2.40%	
Practice institutions	Public general hospital	36.22%	45.60%	< 0.001***
	Public specialized hospital	25.85%	12.00%	
	Private clinics	33.49%	42.40%	
	Multiple institutions	4.44%	0.00%	
Years of professional experience	< 5y	9.11%	23.20%	< 0.001***
	5–10y	23.12%	25.60%	
	11–15y	27.33%	21.60%	
	> 15y	40.43%	29.60%	
Participation in TADs-related training	Only theoretical training	13.33%	35.20%	< 0.001***
	Only practical training	2.05%	4.00%	
	Theoretical and practical training	76.19%	22.40%	
	No, but learned from literature or conferences	6.38%	24.80%	
	Absolutely not	2.05%	13.60%	
Average monthly orthodontic patient count in the past year	< 50	46.58%	82.40%	< 0.001***
	50–100	15.26%	9.60%	
	100–150	11.05%	4.80%	
	150–200	7.06%	1.60%	
	200–250	6.04%	0.00%	
	250–300	4.10%	0.80%	
	> 300	9.91%	0.80%	
Utilized orthodontic appliances	Straight-wire	97.38%	92.00%	0.004**
	Clear aligners	59.11%	20.80%	< 0.001***
	Lingual	5.01%	0.80%	0.033*
	Others	2.16%	4.00%	0.345

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ 

highest among those who practiced in multiple institutions (100%).

#### The correlation of professional experience, training participation, appliances utilization and TADs use

A notable correlation existed between the respondents' years of professional experience and TAD usage ( $P < 0.001$ ). Furthermore, the usage rate gradually

**Table 2** Logistic regression results

Independent variables	P-value	OR
Participation in TADs-related training	< 0.001***	5.277
Whether to use clear aligners	< 0.001***	4.329
Whether to use straight-wire appliances	0.012*	4.099
Highest educational attainment	< 0.001***	3.883
Average monthly orthodontic patient counts in the past year.	0.005**	1.396
Years of professional experience	0.003**	1.386
Practice institutions	0.018*	1.366

\* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ 

increased from 73.39% in the group with less than 5 years of experience to 90.56% in the group with over 15 years of experience, underscoring the growing willingness of orthodontists to adopt TADs as their expertise and experience accumulate.

There was a significant correlation between participation in TAD-related training and its use ( $P < 0.001$ ). Among users, the proportion of individuals who did not receive any form of training was 8.43%, whereas this proportion was 38.40% among non-users.

A significant correlation ( $P < 0.001$ ) was observed between the number of orthodontic patients per month and TAD use. Among users, the proportion of orthodontic patients treated per month who numbered less than 50 was 46.58%, whereas the corresponding figure for non-users was 82.40%.

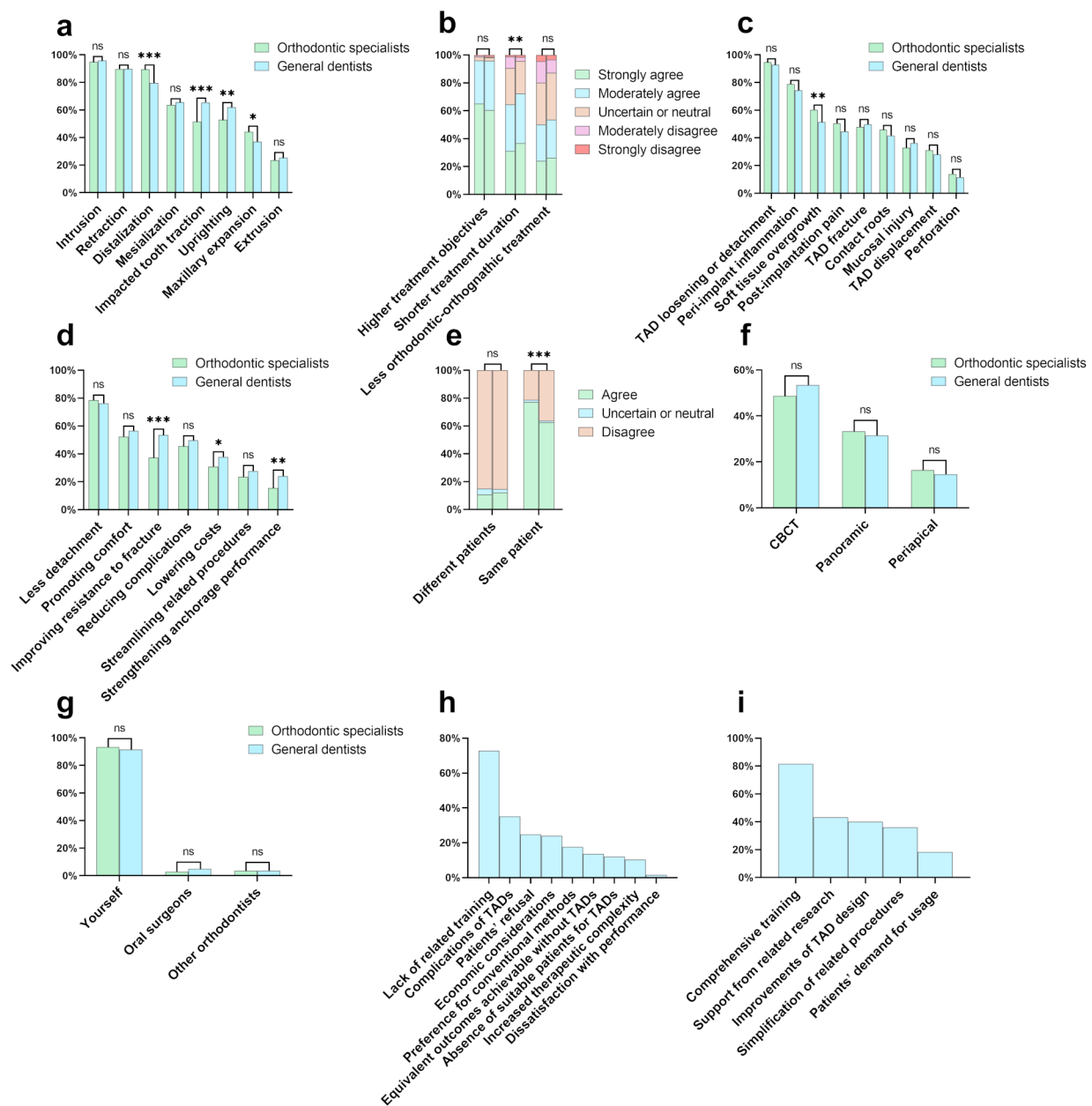
There was a significant difference in orthodontic appliances utilized between TAD users and non-users, with TAD users showing a greater willingness to try new appliance types such as clear aligners and lingual appliances.

In summary, to explore the significance sequence of these factors, we employed binary logistic regression with TAD usage as the dependent variable. For the independent variables, gender and the 'others' category for utilized orthodontic appliances were excluded due to the lack of significant differences between the two groups (Table 1). No variables were removed due to multicollinearity. In the logistic regression analysis, a stepwise inclusion of variables led to the exclusion of age and the 'lingual' category for utilized orthodontic appliances. The analysis (Table 2) confirmed that the training received, educational attainment and clear aligners use had the most substantial influence on TADs usage.

#### Comparison between orthodontic specialists and general dentists

Among the TAD users, 53.3% were orthodontic specialists, 47.7% were general dentists engaged in orthodontic treatment. The following section compared their perspectives and usage patterns of TADs (Fig. 2).

The TAD users reported a broad range of indications for TADs (Fig. 2a), including intrusion/extrusion,



**Fig. 2** Perspectives and usage patterns of TAD users: (a) indications for TADs; (b) advantages of TADs, left: orthodontic specialists, right: general dentists; (c) complications of TADs; (d) the most pressing issues for improving the performance of TADs; (e) reuse of TADs, left: orthodontic specialists, right: general dentists; (f) guiding methods; (g) person in charge of the insertion and removal of TADs; (h) factors that prevented respondents from using TADs; (i) factors that could encourage non-users to initiate or reconsider TADs usage  
ns: not significant, \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$

distalization/mesialization, and maxillary expansion, suggesting that TADs contribute to effective anchorage performance in the vertical, sagittal, and coronal directions. However, differences in the understanding of certain indications can be observed between orthodontic specialists and general dentists. Orthodontic specialists tended to use TADs more frequently for distalizing

molars ( $P < 0.001$ ) and maxillary expansion ( $P = 0.031$ ), while general dentists were more likely to apply TADs for impacted tooth traction ( $P < 0.001$ ) and tooth uprighting ( $P = 0.007$ ).

The primary advantage of TADs was their significant contribution towards achieving higher treatment objectives (Fig. 2b), as supported by most TAD users (95.90%).



A majority of them (68.23%) also agreed that TADs help shorten the treatment duration, though general dentists appeared to hold a more favorable view on this viewpoint ( $P=0.007$ ). Some divergence also remained among TAD users regarding whether TADs could reduce the need for orthodontic-orthognathic treatment, with the largest proportion of individuals (31.66%) option for “uncertain or neutral.”

Orthodontic specialists and general dentists showed no significant difference in the reporting rates of most complications (Fig. 2c) except soft tissue overgrowth caused by TADs ( $P=0.009$ ). Among the TAD users, 27.68% believed that the loosening and detachment rates of TADs exceeded 10%, while orthodontic specialists reported a higher incidence than general dentists ( $P=0.001$ ). Both groups agreed that factors, including the selection of implantation sites, oral hygiene, operator skill level, and patient age, could affect the stability of TADs.

A total of 62.53% of the TAD users reported that 0–25% of the patients experienced discomfort within 1 month of insertion, and general dentists reported a higher incidence than orthodontic specialists ( $P=0.001$ ). While both orthodontic specialists and general dentists agreed that design inadequacies of TADs, such as sharp contours, were the primary cause of patient discomfort, the two groups differed in their views on secondary factors like the implantation procedure ( $P=0.006$ ) and dental fear ( $P=0.007$ ).

Improvements of TADs were suggested by respondents (Fig. 2d). General dentists exhibited a greater demand for improving the fracture resistance ( $P<0.001$ ) and anchorage performance ( $P=0.001$ ) of TADs, as well as lowering their cost ( $P=0.033$ ).

We categorized the reuse of TADs into two scenarios: reuse within the same patient and reuse among different patients (Fig. 2e). The majority of both groups (85.20%) disagreed with the reuse of thoroughly sterilized TADs among different patients. However, general dentists mainly opposed the reuse among different patients out of concern for potential TAD fracture, whereas orthodontic specialists were more focused on ethical issues. In the scenario within the same patient, orthodontic specialists showed greater support for the reuse of TADs than general dentists ( $P<0.001$ ).

Compared to general dentists, orthodontic specialists had a longer usage experience of TADs ( $P<0.001$ ) and reported a higher quantity of TADs used in the past year ( $P=0.001$ ). Both groups predominantly relied on cone-beam computed tomography (CBCT) to guide TAD placement (50.91%), followed by panoramic radiography (32.46%) (Fig. 2f). A substantial majority (92.48%) of general dentists and orthodontic specialists performed the insertion and removal of TADs themselves (Fig. 2g),

while a smaller fraction (3.87%) entrusted these procedures to oral surgeons.

### Questions for non-users

Factors impeding current non-users from using TADs (Fig. 2h) included lack of related training, concerns regarding the risks and complications associated with TADs, and economic considerations. Factors that could encourage respondents to initiate or reconsider TAD usage were identified (Fig. 2i), including comprehensive training, high-quality research endorsing the advantages of TADs, and improvements in TAD design. Consequently, enhancing the accessibility of TAD-related training may effectively augment usage rates.

### Discussion

To explore the use of TADs among orthodontists, we conducted a questionnaire-based survey. With 1,003 valid responses received, we were able to analyze the correlation between multiple factors and TAD usage among users and non-users. We then compared related perspectives and usage patterns of TADs between orthodontic specialists and general dentists engaged in orthodontic treatment. Finally we collected opinions from current TAD non-users.

### Factors contributing to or impeding TADs usage between users and non-users

We identified several underlying factors that potentially facilitate TAD use (Table 2), with training undoubtedly being paramount. There was a significant correlation between participation in TAD-related training and TAD usage, while the primary obstacle for current non-users was the lack of training (Fig. 2h). Woolley et al. [12] also identified “insufficient postgraduate education” as one of the key reasons orthodontists choose not to use TADs, which is consistent with our findings.

Orthodontists employing lingual orthodontic appliances use TADs more frequently [16, 18]. However, our survey revealed a notably low prevalence of lingual orthodontic appliances in China, which hindered the derivation of statistically significant conclusions. Nonetheless, respondents who favored clear aligners demonstrated a greater inclination towards the adoption of TADs, which might be attributed to the fact that patients opting for clear aligners generally have higher aesthetic demands. TADs are indeed more aesthetically pleasing than certain traditional methods of anchorage reinforcement. Additionally, while clear aligners exhibit slightly diminished control over tooth positioning compared with straight-wire appliances, their combination with TADs could potentially facilitate more precise tooth movements [19].

In the realm of educational background, we observed a propensity among respondents with higher educational

attainment to favor the use of TADs. With an increase in educational level, respondents may have greater exposure to emerging techniques, such as TADs.

Within this survey, we observed that the proportion of Chinese orthodontists working in public medical institutions (61.51%) was significantly higher compared to that observed in similar surveys conducted in other countries [4, 6, 20]. A survey conducted in Saudi Arabia revealed a higher frequency of TAD use among orthodontists working in private clinics [4]. Our survey revealed the impact of practice institutions on TAD usage, especially for those who practiced in multiple institutions with 100% usage rate of TADs.

### General dentists in China

Orthodontic communities in China have several distinctive characteristics. Owing to multiple reforms over several decades in medical education in China, the composition of educational backgrounds among Chinese orthodontists is intricate. Therefore, there is a relative scarcity of orthodontic specialists in China, prompting some general dentists to engage in orthodontic treatment through continued education or other methods. This situation is also associated with a lack of division into specialties within the stomatology departments of some public general hospitals.

As direct evidence of the characteristics described above, most respondents (92.48%) conducted the insertion and removal of TADs on their own. Such a high proportion is rarely seen in other countries with similar published studies. This can be attributed to two factors. First, some respondents were actually general dentists. Second, comprehensive education, including oral surgery during the undergraduate phase of Chinese stomatology programs, equips students with fundamental surgical skills, even when they choose to specialize in other fields.

While general dentists help address the shortage of orthodontic specialists, this approach also raises certain concerns. Therefore, we explored whether differences between general dentists and orthodontic specialists would affect their usage pattern of TADs and related perspectives.

Although respondents reported a broad range of indications for TADs, differences mainly existed in the prevalence of indications compared to those reported in previous surveys [5, 10, 13, 15, 16, 21]. No novel indications of TADs were identified. There were differences in the proportion of orthodontic specialists and general dentists with certain indications, which may be related patient composition.

Regarding the advantages of TADs over traditional methods, orthodontic specialists and general dentists primarily diverged on whether TADs could shorten treatment duration, while both groups were uncertain

whether TADs could reduce the need for orthodontic-orthognathic treatment. Some case reports [22–27] indicated that for adult patients with Class III malocclusion with anterior open bite who were unwilling to undergo surgical treatment due to various reasons, TAD-assisted camouflage treatment provided them with an effective alternative. The prioritization of intrusion and distalization in the indications for TADs partly reflected this trend. Furthermore, TAD-assisted camouflage treatment may not affect long-term occlusal function as compared to orthodontic-orthognathic treatment [28]. Notably, three studies conducted by the Journal of Clinical Orthodontics in 2008, 2014, and 2020<sup>17,29,30</sup> demonstrated a relatively consistent proportion of respondents who perceived that the usage of TADs did not reduce the necessity for orthodontic-orthognathic treatment. Conversely, those who agreed with this standpoint increased from 25% in 2008 to 46% in 2020, primarily because of a shift in perspective among respondents who initially held neutral viewpoints.

Most studies [10, 12, 13, 18, 29, 30] have confirmed that loosening or detachment is indeed the most common complication of TADs, consistent with the findings of our study. Improving the comfort of TADs was the second most pressing concern in our survey. As noted by Van Sant et al. [18], patients who used TADs reported higher levels of pain and discomfort. Barthelemi et al. [16] also reported that 73.1% of respondents noted slight discomfort experienced by patients after insertion. Improvements are required in the design of TADs to reduce complications and promote comfort, including enhancing mechanical performance, removing sharp edges, and establishing standardized guidelines through further clinical research. These guidelines will assist orthodontists in making treatment decisions, such as how to appropriately select insertion sites and design surgical procedures or how to take suitable measures to minimize soft tissue inflammation and overgrowth around implants.

The reusability of thoroughly sterilized TADs has received limited attention in previous studies. Patil et al. [5] reported that 20% of respondents believed that TADs could be reused after sterilization, whereas Acar et al. [31] found this proportion to be 29.3%. To further elucidate this issue, our survey included a finer segmentation. When considering different cases and scenarios involving the same patient, there was a significant shift in respondents' opinions. The agreement on permissibility increased from 11.50 to 70.50%. The primary driver of this shift may have been the ethical alleviation provided by situations involving the same patient. The reuse of TADs reduces treatment expenses. However, some studies [32, 33] have reported varying degrees of deformation and wear on the surfaces and tips of reused TADs. The impact of these microscopic changes on the initial

stability and anchorage performance of TADs has yet to yield a consensus [34–37].

General dentists may have different perspectives and concerns regarding TAD usage compared to orthodontic specialists, including the indications for TADs, their potential to shorten treatment time, and the need for improvements. These differences could be related to the more frequent and long-term use of TADs by orthodontic specialists, but are likely influenced by various other factors that warrant further investigation. However, there appeared to be no significant difference between the two groups in their routine management procedures of TADs, such as guiding methods, which could be attributed to effective continued education.

## Conclusions

Chinese orthodontists were relatively active in using TADs (87.54%). A prominent advantage of TADs over conventional methods was their contribution toward achieving higher treatment objectives. The factors closely associated with TAD usage included related training, the type of orthodontic appliances used, and the highest educational attainment. Orthodontic specialists and general dentists might have differing perspectives regarding TADs, but they tended to follow similar management procedures.

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12903-025-05649-4>.

Supplementary Material 1

Supplementary Material 2

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## Author contributions

C.Z.: Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualization; W.H.: Methodology, Formal analysis, Investigation; L.Q.: Methodology, Investigation; Z.N.: Writing - Review & Editing; W.X. and Z.J.: Conceptualization, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

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## Data availability

The complete version of the questionnaire and the data of results is provided within the supplementary table.

## Declarations

### Ethics approval and consent to participate

This study was performed in accordance with the principles of the Declaration of Helsinki, and approved by the Human Research Ethics Committee of Peking University School and Hospital of Stomatology (Approval No.: PKUSSIRB-202060204). Informed consent was obtained from each respondent to utilize pertinent information for this survey.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

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