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Original Article

Clinical Utilization and Practitioner Preferences of Orthodontic Mini-Implants in Romania: Survey-Based Insights

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ABSTRACT

Dental malocclusions are prevalent worldwide and often require complex, costly orthodontic interventions, negatively affecting patients' quality of life. In Romania, treatment accessibility is strongly influenced by patients' financial resources and limited public funding. Mini-implants (MIs) can provide improved anchorage and more efficient treatment, but their adoption is inconsistent due to cost and variability in practitioner training. This study aimed to examine Romanian orthodontists' usage patterns, preferences, and challenges regarding MIs. From June to September 2024, orthodontists across Romania were invited to complete a 24-item survey distributed through social media. The survey covered professional experience, MI system preference, insertion methods, and reported complications. Data analysis was conducted with IBM SPSS Statistics 25. Associations between categorical variables were tested using Fisher's Exact Test and Pearson's Chi-Square Test. Logistic binomial univariable regression was applied where relevant to predict outcomes such as placement sites, clinician experience, and complication occurrence. Statistical significance was set at $\alpha = 0.05$. Among 105 respondents, 85.7% reported using MIs in their practice. The Dual Top (60%) and Benefit (43.3%) systems were most frequently utilized. Interradicular sites were the primary placement locations (60%), while palatal and retromolar areas were significantly linked to the Benefit system ($p = 0.008$). Clinicians with more than 10 years of experience reported higher MI usage ($p = 0.001$), with 60.9% using them frequently. Complications were common, with 92.2% reporting MI mobility and 57.8% noting soft tissue injuries. The midpalatal area showed a significantly higher rate of complications than other sites ($p < 0.001$). Success rates between 76% and 100% were reported by 57.8% of respondents, with infrazygomatic placements achieving higher success ($p < 0.05$). MIs are widely used among Romanian orthodontists, particularly by experienced practitioners. Although overall success is high, frequent complications emphasize the need for improved insertion techniques and postoperative care. Further research and structured training are recommended to enhance MI effectiveness and reduce adverse outcomes.

Keywords: Orthodontic mini-implants, Skeletal anchorage, Orthodontic treatment, Romania

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Introduction

Dental malocclusions affect a substantial portion of the population, impacting approximately 56% of people worldwide and up to 72% in Europe [1]. Their diverse causes and variable clinical presentations make classification difficult [2]. These conditions can compromise patients' quality of life [3], and orthodontic treatments required to correct them may

vary greatly in complexity [4], often imposing notable financial burdens on patients and families [5]. To streamline treatment, maintain the function of the dento-maxillary system, and reduce both treatment duration and costs, innovative orthodontic approaches are continually being developed [6].

Among these advances, orthodontic mini-implants (MIs), also called Temporary Anchorage Devices (TADs), have emerged as an effective method for skeletal anchorage. They offer advantages such as small size, minimally invasive placement and removal, immediate load application, absence of surgical defects, and increased patient comfort [7, 8]. MIs are used in various procedures, including intrusion, extrusion, retraction, distalization, mesialization [8, 9], and management of rare or severe dento-skeletal anomalies [9]. Their growing popularity has led manufacturers to produce a wider range of options, with lengths from 4 to 12 mm and diameters from 1.15 to 2.5 mm, alongside diverse head and screw designs [10, 11].

Insertion of MIs is guided by clinical examination and 2D or 3D imaging [12], with CAD-designed guides available for more precise placement [13]. Proper planning is crucial to minimize failures, which can result from patient-specific factors (e.g., age, gender, oral hygiene, insertion site), MI characteristics (e.g., size, design, placement), or operator-related factors [14]. However, evidence on the impact of clinician experience, frequency of MI use, and specialist qualifications is still limited.

In Romania, detailed information on MI usage—covering operators, system types, instruments, evaluation methods, and preferred insertion sites—is scarce. Given the rising prevalence of dento-maxillary anomalies [15], MI utilization is likely to increase among Romanian orthodontists. Local practice is influenced by unique clinical, educational, and economic factors that differ from those in Western Europe, North America, and Asia [16], and treatment decisions are also shaped by patient expectations and financial constraints [17].

This study aimed to characterize Romanian orthodontists using MIs, examining professional attributes such as experience, frequency of use, and specialist qualifications, as well as preferences regarding MI systems, instruments, and pre-insertion evaluation methods. Additionally, the study provides context-specific insights and practical recommendations to improve MI application in Romanian clinical practice.

Materials and Methods

Ethical considerations

This study adhered to the guidelines set forth in the 1964 Declaration of Helsinki and its later revisions. Approval was granted by the Ethics Committee of the Faculty of Medicine and Pharmacy, University of Oradea (Approval No. CEFMF/04, 4 February 2022). Before taking part, all participants were informed about the study's objectives and assured that participation was voluntary, anonymous, and uncompensated. By submitting the questionnaire, respondents provided implicit consent to participate.

Study population and survey procedure

A cross-sectional survey was conducted over a three-month period, from 1 June to 1 September 2024. The research team developed the questionnaire, which was hosted on the Survio platform (Survio s.r.o., Brno, Czech Republic). The survey link was distributed through Romanian dental and orthodontic social media groups to ensure broad participation among professionals.

The survey aimed to explore how Romanian orthodontists use mini-implants (MIs), their preferences regarding MI systems and insertion methods, and the types of complications encountered. The primary independent variable was years of professional experience, grouped into <5, 5–10, 11–15, 16–20, and >20 years.

Additional variables included:

- *Gender:* male or female;
- *Specialization:* orthodontics, dento-alveolar surgery, general dentistry, oral and maxillofacial surgery, other, or resident doctor;
- *City of practice* within Romania;
- *MI systems used:* Dual Top, Benefit, OrthoEasy, etc.;
- *Frequency of MI usage:* very frequently, frequently, occasionally, rarely, very rarely;
- *Preferred placement zones :* interradicular, palatal, retromolar, etc.;
- *Reported complications:* MI mobility, soft tissue injuries, MI fracture, etc.

The questionnaire included 24 items arranged into four sections:

- *Section one (Items 1–4):* Collected demographic and professional data: gender, specialization, years of experience, and city of practice. The first three items provided predefined options, whereas the fourth allowed respondents to enter the city manually.
- *Section two (Items 5–12):* Focused on clinical experience with MIs, including system

preferences, insertion methods, and complication history. Multiple-choice responses were used for all questions. A detailed summary of these items and their response options is presented in **Table 1**.

Table 1. Items and Response Options for Section Two

Question ID	Inquiry	Available Responses
5	Are mini-implants (MI) part of your orthodontic practice?	Affirmative Negative
6	How many years have you been employing MI in treatments?	Under 1 year 1–3 years 3–6 years 6–10 years More than 10 years MI not used
7	Which MI system do you utilize in your practice?	Dual Top (Jeil Medical) Benefit (PSM) OrthAnchor (OSSTEM) OrthoEasy (Forestadent) Leone (Leone) Tomas (Dentaurum) Vector TAS (ORMCO) Fatscrew (Air Orthodontics) Infinity (IOS Ortho) Aarhus (AO) Other (please specify) MI not used
8	Who inserts MI in your clinical setting?	Orthodontic specialist Maxillofacial surgeon Alveolar surgeon General dental practitioner Other (please specify) MI not used
9	How regularly do you incorporate MI in treatments?	Very often (9–10) Often (7–8) Sometimes (5–6) Seldom (3–4) Rarely (1–2) MI not used (0)
10	What tools do you primarily use for MI insertion?	Manual tools Motorized tools Combination of both MI not used
11	How do you determine the MI insertion site?	Physical examination only Physical exam with 2D imaging Physical exam with 3D imaging Other approaches (please specify) MI not used
12	What is the primary site for MI placement in your practice?	Root-adjacent area Palate Mid-palate Subzygomatic area Behind molars Other sites (please specify) MI not used

- *Section three (Items 13–19):* This part of the survey investigated the dimensions of mini-implants (MIs) used across different anatomical sites. Specifically, item 13 addressed the maxillary interradicular area, item 14 the mandibular interradicular area, item 15 the

infrazygomatic region, item 16 the midpalatal area, item 17 the palatal region, item 18 the maxillary retromolar region, and item 19 the mandibular retromolar region. Participants were asked to provide open-ended responses detailing the MI dimensions they typically use in each location.

- *Section four (Items 20–24):* This segment evaluated clinicians' overall satisfaction with MIs and included items that explored perceived complication risks associated with their use. All items and the response options provided are summarized in **Table 2**.

Table 2. Items and Response Options for Section Four

Question ID	Inquiry Description	Response Choices
20	How content are you with these aspects of orthodontic mini-implants (MI)? a. MI planning and placement b. MI durability c. Tooth movement effectiveness d. Handling of issues e. MI cost	Highly content (9–10) Content (7–8) Neutral (5–6) Discontent (3–4) Highly discontent (1–2)
21	What is your assessment of the MI success rate in your practice?	0–25% 26–50% 51–75% 76–100%
22	What prompted your decision to use orthodontic mini-implants?	Enhanced anchorage reliability Capability to manage challenging cases Improved treatment speed Decreased patient discomfort Other reasons (please specify)
23	How would you rate the overall risk level of complications with orthodontic MI?	Extremely high (9–10) High (7–8) Moderate (5–6) Low (3–4) Extremely low (1–2)
24	What issues or complications have you faced after using mini-implants?	MI instability Soft tissue injury Hard tissue injury Post-insertion pain or discomfort MI breakage None observed Other issues (please specify)

This study targeted orthodontic practitioners actively working in Romania, including both specialists and residents performing clinical orthodontic procedures or employing mini-implants (MIs). To accurately assess MI usage, only professionals with either direct or potential clinical experience were included, allowing a thorough evaluation across different levels of expertise. The inclusion criteria were designed to capture a broad representation of orthodontic practitioners, providing insights into both practical challenges and personal preferences regarding MIs.

Participants who were not legally qualified to practice orthodontics in Romania or who were practicing abroad were excluded, in order to focus solely on the local clinical environment. Additionally, professionals from non-orthodontic specialties who did not use MIs were omitted to maintain relevance to the study objectives. Practitioners who neither currently use MIs nor intend to incorporate them into their practice were also excluded, except in cases where they were orthodontic residents or certified specialists.

The required sample size was calculated using Python 3 (Python Software Foundation, Wilmington, DE, USA). A confidence level of 95% ($Z \approx 1.96$) and a 5% margin of error were adopted, consistent with standard scientific methodology. Assuming a population proportion of 0.5, which maximizes the sample size, the initial calculation applied the formula:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{E^2} \quad (1)$$

where ZZZ is the Z-score, ppp is the population proportion, and EEE is the margin of error.

Because the total population of the Romanian Association of Excellence in Orthodontics (AREO) is limited (N = 123), a finite population correction was applied:

$$n_{adjusted} = \frac{n}{1 + \frac{n-1}{N}} \quad (2)$$

Following this adjustment, the final calculated sample size was approximately 94 participants. This number ensures that the findings accurately reflect the target population while maintaining the specified confidence level and margin of error.

Statistical analysis

Data were analyzed using IBM SPSS Statistics 25, while Microsoft Excel and Word 2021 were used for creating visual summaries. Categorical variables were expressed as counts and percentages to describe their distribution across groups. To evaluate differences between groups, either Fisher's Exact Test or Pearson's Chi-Square Test was applied, selected according to the data type and sample size.

Logistic binomial univariable regression models were implemented, when appropriate, to examine the effect of independent factors—such as type of MI system and frequency of MI use—on key outcomes including MI placement locations, clinician experience, and reported complications. Model performance was assessed using significance tests and goodness-of-fit measures, and odds ratios with 95% confidence intervals were calculated to quantify the influence of independent variables.

To investigate statistically significant associations found in contingency tables, Z-tests with Bonferroni adjustment were employed to control for multiple testing and minimize Type I error risk. These combined methods ensured a comprehensive analysis of the dataset, supporting the validity and reliability of the study's conclusions. All tests were conducted at a significance level of $\alpha = 0.05$.

Results and Discussion

Section one: socio-demographic characteristics

A total of 105 dental professionals participated in the survey regarding their use of mini-implants (MIs) in orthodontic treatments. Women made up the majority of respondents, accounting for 70.5% (n = 74), whereas men represented 29.5% (n = 31), indicating a pronounced female predominance in the sample.

Most participants were specialized orthodontists (88.6%, n = 93). Regarding professional experience, 32.4% (n = 34) reported having less than 5 years of clinical practice, while 25.7% (n = 27) had between 11 and 15 years of experience. Concerning practice locations, Oradea hosted the largest proportion of respondents (23.8%, n = 25), followed by Cluj-Napoca (18.1%, n = 19) and Bucharest (15.2%, n = 16). **Table 3** presents a detailed summary of the distribution of responses for items 1 through 4.

Table 3. Distribution of responses for items 1–4.

Category	Count	Proportion
Gender		
Women	74	70.5%
Men	31	29.5%
Professional Field		
Orthodontic Practice	93	88.6%
Alveolar Surgery	5	4.8%
General Dental Practice	1	1.0%
Maxillofacial Surgery	0	0.0%
Other Fields	0	0.0%
Resident Physician	6	5.7%
Years of Practice		
Under 5 years	34	32.4%
5–10 years	19	18.1%
11–15 years	27	25.7%
16–20 years	12	11.4%
More than 20 years	13	12.4%
Location		
Oradea	25	23.8%
Cluj-Napoca	19	18.1%

Timișoara	9	8.6%
Iași	5	4.8%
Târgu Mureș	5	4.8%
București	16	15.2%
Mediaș	1	1.0%
Ploiești	1	1.0%
Arad	2	1.9%
Brăila	2	1.9%
Craiova	3	2.9%
Buzău	3	2.9%
Bistrița	2	1.9%
Baia Mare	1	1.0%
Turda	4	3.8%
Pitești	4	3.8%
Sibiu	2	1.9%
Satu Mare	1	1.0%

Section two: practitioners' experience with mini-implants (MIs)

Among the 105 dentists who completed the survey, 90 individuals (85.7%) reported incorporating mini-implants (MIs) into their orthodontic practice, whereas 15 respondents (14.3%) do not use these devices. Within the group of MI users, 24 participants (26.7%) had been placing MIs for 1–3 years, while 23 practitioners (25.6%) had experience exceeding 10 years.

The most commonly employed MI systems were Dual Top (n = 54, 60%), Benefit (n = 39, 43.3%), OrthAnchor (n = 21, 23.3%), and OrthoEasy (n = 13, 14.4%). The majority of MI insertions were performed solely by orthodontists (n = 71, 78.9%), although in 36 cases (40%), procedures were done in collaboration with dentoalveolar surgeons. Regarding placement, the interradicular site was preferred in 54 cases (60%). Detailed distributions for the other items in this section are provided in **Table 4**.

Table 4. Response distribution for items 5–12.

Question	Responses	Count	Proportion
Q5: Do you employ mini-implants (MI) in your orthodontic work?			
Not using	15	14.3%	
Using	90	85.7%	
Q6: How long have you integrated MI into your treatments?			
Less than a year	12	13.3%	
1 to 3 years	24	26.7%	
3 to 6 years	15	16.7%	
6 to 10 years	16	17.8%	
More than 10 years	23	25.6%	
Q7: Which MI brand do you use in your practice?			
Jeil Medical (Dual Top)	54	60%	
PSM (Benefit)	39	43.3%	
OSSTEM (OrthAnchor)	13	14.4%	
Forestadent (OrthoEasy)	21	23.3%	
Leone	9	10.0%	
Dentaurum (Tomas)	3	3.3%	
ORMCO (Vector TAS)	4	4.4%	
Air Orthodontics (Fatscrew)	5	5.6%	
IOS Ortho (Infinity)	1	1.1%	
AO (Aarhus)	0	0.0%	
Alternative brands	8	8.9%	
Q8: Who inserts MI in your clinic?			

Orthodontist	71	78.9%
Oral surgeon	13	14.4%
Dentoalveolar specialist	36	40%
General practitioner	4	4.4%
Other personnel	0	0.0%
Q9: How frequently do you use MI?		
Very often	16	17.8%
Regularly	40	44.4%
Sometimes	24	26.7%
Infrequently	9	10.0%
Almost never	1	1.1%
Q10: What tools do you use for MI placement?		
Hand tools	37	41.1%
Motorized tools	20	22.2%
Both tool types	33	36.7%
Q11: How do you assess MI insertion sites?		
Visual inspection only	69	76.7%
Visual with 2D scans	65	72.2%
Visual with 3D scans	63	70%
Other techniques	3	3.3%
Q12: Where do you most often place MI?		
Root-adjacent	54	60.0%
Palatal area	14	15.6%
Mid-palatal area	3	3.3%
Subzygomatic area	9	10.0%
Retromolar area	6	6.7%

Analysis revealed distinct associations between the type of mini-implant (MI) system and the anatomical site of placement. The Dual Top system was predominantly selected for palatal insertions, accounting for 24.1% of cases compared with just 2.8% for other systems (Fisher's Exact Test: $p = 0.004$; LR: OR = 11.098; 95% CI: 1.382–89.129; $p = 0.024$). Users of the Benefit (PSM) system also showed a clear tendency to place MIs in the palatal and retromolar regions (Fisher's Exact Test: $p = 0.008$). Specifically, palatal placement occurred in 25.6% of cases for Benefit (PSM) users versus 7.8% for other systems (LR: OR = 4.052; 95% CI: 1.163–14.120; $p = 0.028$), while retromolar placement was 12.8% compared to 2% (LR: OR = 7.353; 95% CI: 0.822–65.752; $p = 0.074$), indicating a trend toward preference for this site among Benefit (PSM) practitioners.

Additional Z-tests incorporating Bonferroni correction confirmed further links between MI systems and insertion sites. The Fatscrew system (Air Orthodontics) was overwhelmingly associated with retromolar insertions (80% vs. 2.4%) (Fisher's Exact Test: $p < 0.001$; LR: OR = 166; 95% CI: 12.308–2238.78; $p < 0.001$). Similarly, the Vector TAS system (Ormco) showed a notable association with infrazygomatic placements, observed in 50% of cases compared with 8.1% for other systems (Fisher's Exact Test: $p = 0.028$; LR: OR = 11.286; 95% CI: 1.373–92.796; $p = 0.024$). **Table 5** summarizes the detailed distribution of MI placement according to system type.

Table 5. Distribution of MI placement by system usage.

Placement Location/System (Not Used/Used)	Dual Top	Benefit (PSM)
Between tooth roots	28 (77.8%)/26 (48.1%)	34 (66.7%)/20 (51.3%)
Mid-palatal area	1 (2.8%)/2 (3.7%)	1 (2%)/2 (5.1%)
Behind molars	4 (11.1%)/2 (3.7%)	1 (2%)/5 (12.8%)
Subzygomatic region	2 (5.6%)/7 (13%)	7 (13.7%)/2 (5.1%)
Palatal region	1 (2.8%)/13 (24.1%)	4 (7.8%)/10 (25.6%)
Other sites	0 (0%)/4 (7.4%)	4 (7.8%)/0 (0%)
p-value *	0.004	0.008

Placement Location/System (Not Used/Used)	Fatscrew—Air	Vector TAS
Between tooth roots	53 (62.4%)/1 (20%)	54 (62.8%)/0 (0%)
Mid-palatal area	3 (3.5%)/0 (0%)	3 (3.5%)/0 (0%)
Behind molars	2 (2.4%)/4 (80%)	6 (7%)/0 (0%)
Subzygomatic region	9 (10.6%)/0 (0%)	7 (8.1%)/2 (50%)
Palatal region	14 (16.5%)/0 (0%)	12 (14%)/2 (50%)
Other sites	4 (4.7%)/0 (0%)	4 (4.7%)/0 (0%)
p-value *	<0.001	0.028

Fisher's Exact Test. Data are summarized in combined contingency tables, where MI placement zones are presented as counts and percentages relative to the total cases, reflecting whether a specific system was used.

The analysis explored how practitioners' years of experience influenced the frequency of mini-implant (MI) use **(Table 6)**. A significant association was identified (Fisher's Exact Test: p = 0.001). Among clinicians with more than 10 years of practice, frequent MI use was most common, reported in 39.1% of cases, whereas those with 1–3 years of experience demonstrated frequent use in 16.7% of responses. Practitioners with 3–10 years of experience indicated frequent MI use in over 40% of cases, which increased to 60.9% among those exceeding 10 years in practice. Occasional MI use was mostly observed in professionals with less than 1 year (50%) or 1–3 years (37.5%) of experience. Rare or very infrequent use was predominantly reported by clinicians with under 10 years of experience. Importantly, none of the participants with more than 10 years of experience indicated occasional, rare, or very infrequent MI utilization.

Table 6. Frequency of MI use according to practitioners' professional experience.

MI Usage Duration/Frequency	Under 1 Year	1–3 Years	3–6 Years	6–10 Years	Over 10 Years	p-value *
Almost never	0 (0%)	1 (4.2%)	0 (0%)	0 (0%)	0 (0%)	<0.001
Seldom	1 (8.3%)	2 (8.3%)	4 (26.7%)	2 (12.5%)	0 (0%)	
Sometimes	6 (50%)	9 (37.5%)	4 (26.7%)	5 (31.3%)	0 (0%)	
Often	5 (41.7%)	8 (33.3%)	6 (40%)	7 (43.8%)	14 (60.9%)	
Very often	0 (0%)	4 (16.7%)	1 (6.7%)	2 (12.5%)	9 (39.1%)	

Fisher's Exact Test. The table presents MI usage frequency as row categories and practitioner experience with MIs as column categories. Values are shown as counts with percentages relative to the total number of cases in each frequency group.

When MI usage was grouped into two categories—frequent/very frequent versus occasional/rare/very rare—and practitioner experience was classified as less than 3 years or 3 years and above, the association remained statistically meaningful. Those who reported frequent or very frequent MI use were more likely to have over 3 years of experience (72.2%, 39 participants) than those with less frequent use (47.2%, 17 participants; p = 0.026; LR: OR = 2.906, 95% CI: 1.200–7.039, p = 0.018). **Figure 1** illustrates the distribution of MI usage frequency across different levels of practitioner experience.

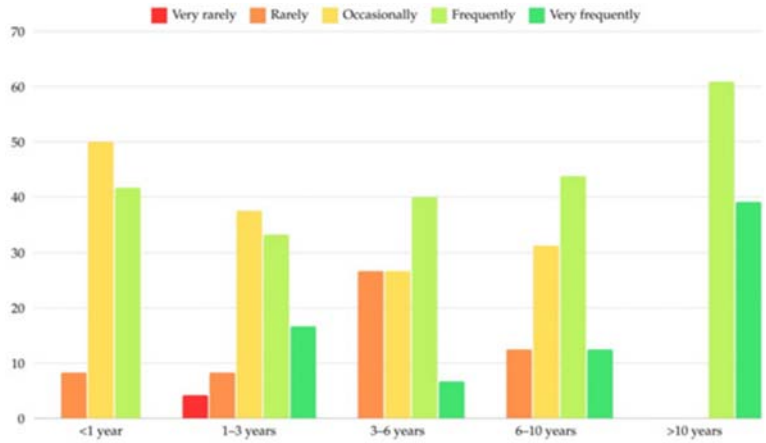

Figure 1. MI usage frequency stratified by years of practitioner experience.

Section four: practitioner experience and MI-related complications

This section included items 20–24. The majority of orthodontists reported a high success rate for MI application in their practices, with 57.8% (n = 52) indicating success between 76% and 100%. Overall, complications were relatively uncommon. The main motivations for using MIs were enhanced anchorage stability (77.8%, n = 70) and the ability to manage complex cases (75.6%, n = 68).

Despite the generally positive outcomes, some complications were reported. The most frequent issues included MI mobility (92.2%, n = 83), soft tissue injury (57.8%, n = 52), and post-insertion discomfort or pain (54.4%, n = 49) **(Table 7)**.

Table 7. Summary of responses for items 20–24, including MI complications and reported success rates.

Question and Response	Count	Proportion
Q20: Level of satisfaction with orthodontic mini-implants (MI)		
(a) MI planning and placement		
Extremely pleased	38	42.2%
Pleased	49	54.4%
Neutral	2	2.2%
Unpleased	1	1.1%
Highly unpleased	0	0.0%
(b) MI durability		
Extremely pleased	12	13.3%
Pleased	64	71.1%
Neutral	8	8.9%
Unpleased	6	6.7%
Highly unpleased	0	0.0%
(c) Effectiveness in tooth alignment		
Extremely pleased	54	60%
Pleased	34	37.8%
Neutral	2	2.2%
Unpleased	0	0.0%
Highly unpleased	0	0.0%
(d) Handling of issues		
Extremely pleased	20	22.2%
Pleased	62	68.9%
Neutral	4	4.4%
Unpleased	4	4.4%
Highly unpleased	0	0.0%
(e) MI cost		
Extremely pleased	17	18.9%

Pleased	54	60%
Neutral	10	11.1%
Unpleased	7	7.8%
Highly unpleased	2	2.2%
Q21: Success rate assessment of MI in practice		
0–25%	0	0.0%
26–50%	6	6.7%
51–75%	32	35.6%
76–100%	52	57.8%
Q22: Reasons for adopting orthodontic mini-implants		
Improved anchorage reliability	70	77.8%
Handling complex cases	68	75.6%
Enhanced treatment speed	53	58.9%
Reduced patient discomfort	16	17.8%
Other factors	0	0.0%
Q23: Perceived risk level of MI complications		
Extremely high	0	0.0%
High	1	1.1%
Moderate	27	30.0%
Low	53	58.9%
Very low	9	10.0%
Q24: Observed complications with MI use		
MI instability	83	92.2%
Soft tissue injury	52	57.8%
Hard tissue injury	10	11.1%
Post-placement pain	49	54.4%
MI breakage	19	21.1%
None observed	0	0.0%
Other issues	0	0.0%

In this analysis, a significant link was found between the overall complication risk and the MI insertion site, as detailed in **Table 8**. Fisher's Exact Test confirmed the differences between placement locations were statistically significant ($p < 0.001$). Further analysis using Z-tests with Bonferroni correction indicated that MIs positioned in the midpalatal area were considerably more likely to be associated with higher complication rates compared to the interradicular area (33.3% vs. 0%). Due to the limited number of cases in several subgroups, logistic regression could not be performed for this comparison. **Figure 2** displays how complication risk varies with different MI placement sites.

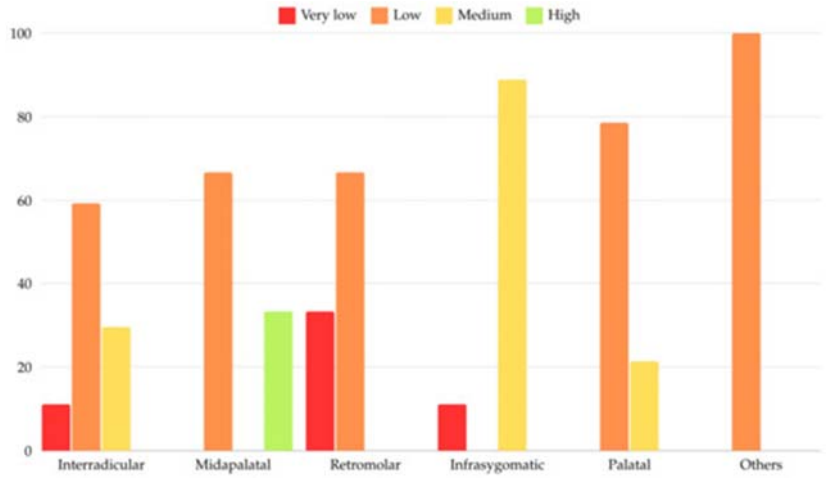

Figure 2. Correlation between MI placement sites and overall complication risk.

Table 8. Number and percentage of cases by MI site and overall complication risk.

Complication Risk/Site	Between Roots	Central Palate	Posterior Molar	Zygomatic Area	Palate Surface	Alternative Areas	p-value *
Very minimal	6 (11.1%)	0 (0%)	2 (33.3%)	1 (11.1%)	0 (0%)	0 (0%)	<0.001
Slight	32 (59.3%)	2 (66.7%)	4 (66.7%)	0 (0%)	11 (78.6%)	4 (100%)	
Moderate	16 (29.6%)	0 (0%)	0 (0%)	8 (88.9%)	3 (21.4%)	0 (0%)	
Significant	0 (0%)	1 (33.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	

Fisher's Exact Test. Data are presented as counts with corresponding percentages relative to the total number of cases in each MI placement category.

As presented in **Table 9**, retromolar MI placement showed a significantly greater likelihood of fractures than other sites (26.3% vs. 1.4%; p = 0.016; LR: OR = 25; 95% CI: 2.709–230.734; p = 0.005). Conversely, interradicular placements were significantly less associated with hard tissue injury (63.7% vs. 30%; p < 0.001; LR: OR = 0.244; 95% CI: 0.058–1.016; p = 0.053). While logistic regression indicated only a tendency toward significance, the data suggest that interradicular sites carry a lower risk of hard tissue complications.

Table 9. Distribution of MI systems and placement sites with corresponding complications.

Site/Complication (None/Observed)	Breakage	Bone Damage
Between roots	45 (63.4%)/9 (47.4%)	51 (63.7%)/3 (30%)
Central palate	3 (4.2%)/0 (0%)	2 (2.5%)/1 (10%)
Behind molars	1 (1.4%)/5 (26.3%)	6 (7.5%)/0 (0%)
Subzygomatic area	7 (9.9%)/2 (10.5%)	9 (11.3%)/0 (0%)
Palatal surface	11 (15.5%)/3 (15.8%)	12 (15%)/2 (20%)
Other locations	4 (5.6%)/0 (0%)	0 (0%)/4 (40%)
p-value *	0.016	<0.001

*Analysis was performed using Fisher's Exact Test. The results are displayed in combined contingency tables, where the counts and percentages of MI placement locations are shown as column values relative to the total cases with or without the respective complication.

MIs inserted in the retromolar region were markedly more associated with success rates between 76% and 100% than those placed in the midpalatal area (100% vs. 0%; p = 0.038), as summarized in **Table 10**. Logistic regression analyses could not be executed because most subgroups contained too few cases. **Figure 3** presents the distribution of MI placement sites according to overall treatment success.

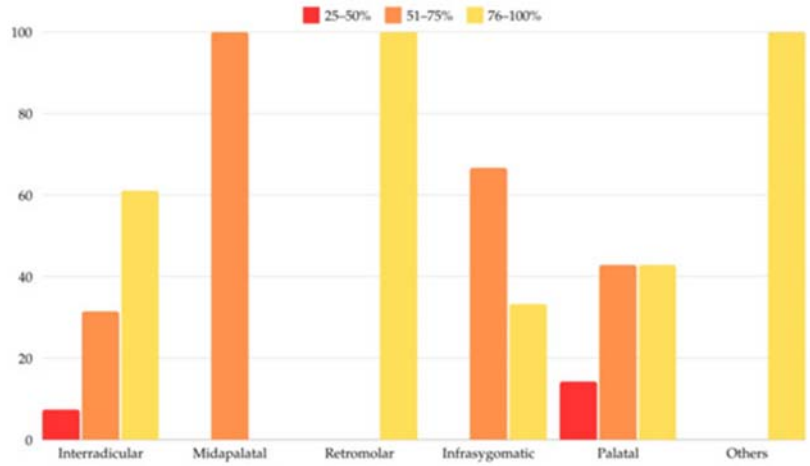

Figure 3. MI placement distribution and corresponding overall success rates.

Table 10. Case counts and percentages by MI placement location and overall success rate.

Outcome Range/Location	Among Roots	Palatal Center	Behind Molars	Zygomatic Area	Palatal Region	Miscellaneous Sites	p-value *
26–50% Success	4 (7.4%)	0 (0%)	0 (0%)	0 (0%)	2 (14.3%)	0 (0%)	0.038
51–75% Success	17 (31.5%)	3 (100%)	0 (0%)	6 (66.7%)	6 (42.9%)	0 (0%)	
76–100% Success	33 (61.1%)	0 (0%)	6 (100%)	3 (33.3%)	6 (42.9%)	4 (100%)	

Fisher's Exact Test. Column values indicate the number of cases and percentages relative to the total cases for each specific MI placement site.

This study offers a comprehensive analysis of how Romanian orthodontists incorporate mini-implants (MIs) into clinical practice, emphasizing their preferences, experiences, and associated challenges. Among the 105 survey participants, 85.7% reported routinely using MIs, demonstrating their central role in contemporary orthodontic treatment in Romania. This usage rate exceeds that reported in several other countries. For example, a 2020 survey in Canada indicated that 65.8% of orthodontists utilized TADs or MIs in treatment [18]. In India, only 43.7% of practitioners reported MI usage [19], while a German study by Bock and Ruf (2015) found that 50% of orthodontists regularly applied skeletal anchorage devices [20]. In Saudi Arabia, 74% of orthodontists reported MI usage [21], and in the United States, nearly 70% of orthodontists in private practice employed MIs [22]. It is important to note that some of these comparative figures are based on older studies, and adoption rates may have increased due to ongoing advancements in orthodontic technologies [23-29].

With respect to experience, 26.7% of Romanian orthodontists reported using MIs for 1–3 years, while 25.6% had over a decade of experience. This distribution suggests that both newer practitioners and long-standing professionals actively integrate MIs into their treatment routines. Similar international patterns exist: Canadian orthodontists predominantly reported 6–10 years of experience with MIs [18], whereas the majority of practitioners in India and Saudi Arabia had fewer than 3–5 years of experience [19, 21]. This variation in experience among Romanian orthodontists highlights broad adoption across generations, fostering a collaborative environment in which both emerging and established clinicians recognize the clinical benefits of MIs. Such a mix of expertise likely contributes to Romania's higher adoption rate relative to other countries [30-32].

In terms of system preference, the Dual Top system was the most commonly employed among Romanian orthodontists, followed by the Benefit system. The widespread use of these systems likely reflects favorable design characteristics and reported stability. Although these two systems dominate the market, a variety of other MI options are also utilized, indicating that clinicians select systems according to specific treatment needs. Future research could examine the European market share of different MI systems to allow for more accurate cross-country comparisons.

The analysis demonstrated a clear association between the type of MI system and its placement location. Specifically, the Dual Top system was predominantly utilized in the palatal and interradicular regions, whereas the Benefit system showed higher usage in palatal and retromolar areas. Users of the Fatscrew system exhibited a marked preference for the retromolar site. These tendencies likely reflect each system's design characteristics, which appear optimized for certain anatomical zones. Such findings emphasize the necessity for system-specific training and expertise to enhance MI placement outcomes, particularly in complex regions like interradicular, palatal, and retromolar areas [33-35].

Another important finding concerns the relationship between MI usage frequency and the clinician's professional experience. Practitioners with more than 10 years in practice were more likely to employ MIs regularly, while those with under three years of experience tended to use them only occasionally or rarely. This pattern indicates that seasoned clinicians possess greater confidence in applying MIs across diverse clinical situations, likely stemming from familiarity with the devices and procedural protocols. Less experienced practitioners may rely on traditional anchorage approaches in simpler cases until they gain proficiency.

In the Romanian context, a majority of orthodontists personally perform MI placement, with 78.9% reporting direct involvement. This is particularly noteworthy since many clinicians practice outside large interdisciplinary clinics where surgical specialists are accessible. Independent placement skills allow orthodontists to manage treatment efficiently, maintain control over planning, and potentially achieve improved clinical outcomes. Similar trends appear internationally: in Canada, 72% of orthodontists insert MIs themselves [18], and in Saudi Arabia, this rises to 80% [21]. Conversely, in Germany, only 2% of

orthodontists carry out self-placement, with most relying on oral or maxillofacial surgeons, influenced by regulatory limitations and differing levels of surgical confidence [20]. These contrasts highlight the impact of training, legal frameworks, and practitioner experience on MI usage globally.

Instrument choice varied among respondents. Approximately 41.1% used exclusively manual tools, while 36.7% combined manual and rotary instruments. Preferences likely reflect prior training, individual comfort, and the perceived control manual instruments provide during delicate MI insertion. Hand tools, such as screwdrivers, are cost-effective, easy to maintain, and suited for smaller practices. Nonetheless, as Romanian orthodontic practices evolve toward larger multidisciplinary settings and rotary systems become more widely available—offering increased precision and efficiency—a gradual shift toward greater use of rotary instruments is anticipated [36].

The reported effectiveness of mini-implants (MIs) in this study was notably high, with 57.8% of participants indicating success rates between 76% and 100%. These findings align with previous research demonstrating that MIs provide reliable skeletal anchorage for orthodontic procedures [37, 38]. However, complications were still observed. The most prevalent issue was implant mobility (92.2%), followed by soft tissue injury (57.8%) and discomfort or pain after placement (54.4%). Such complications have been documented in prior studies and are often linked to factors such as suboptimal oral hygiene, incorrect placement technique, or challenging anatomical conditions [39].

The frequent occurrence of MI mobility suggests a need for further evaluation of factors affecting implant stability, particularly regarding insertion protocols and implant design [40, 41]. Likewise, the common incidence of soft tissue damage and post-procedural discomfort highlights the importance of post-operative patient care. Future strategies may include improved placement techniques and patient guidance to minimize complications and optimize treatment outcomes [14, 42].

This research addresses a notable gap in the literature by providing data on MI usage among Romanian orthodontists, offering insights that can inform both clinical practice and training. The extensive adoption of MIs, combined with the variety of systems and techniques reported, underscores the necessity for standardized protocols and continued professional development. With complex orthodontic treatments requiring skeletal anchorage becoming more prevalent, ensuring that practitioners receive current, evidence-based training in MI application is critical.

Due to the volume of collected data, only Sections One, Two, and Four of the questionnaire were analyzed in this article. Section Three, which focuses on the specific dimensions of mini-implants utilized in various anatomical regions, will be reported separately. This approach allows a more detailed exploration of how implant size and design influence treatment outcomes and are customized for individual patients.

The study emphasizes the clinical value of incorporating MIs into routine orthodontic practice, given their high success rates and ability to address complex cases effectively. Enhancing practitioner education and hands-on training could reduce complications and improve patient outcomes. This reinforces the importance of incorporating MI-focused content into dental education curricula and professional development programs. Future studies should investigate long-term outcomes and factors influencing MI success. Comparative research across diverse populations and healthcare systems could provide further insight into optimizing MI use. Additionally, advancements in MI materials and technology may help overcome current clinical limitations and drive innovation in orthodontic treatments.

Some limitations should be noted. First, as a cross-sectional survey, these findings provide a single-time snapshot of MI practices without capturing temporal trends. Longitudinal research would enable a better understanding of how MI usage evolves among Romanian orthodontists. Second, reliance on self-reported responses may introduce bias, particularly regarding reported success rates and complications. Including objective clinical data in future studies could strengthen these findings. Lastly, although this study focuses on Romanian practitioners, the results may have broader implications for regions with similar practice conditions. International comparisons could help identify best practices applicable across different settings.

Conclusion

This study demonstrates that mini-implants (MIs) are extensively employed by Romanian orthodontists, primarily to enhance anchorage and facilitate the management of complex orthodontic cases. A clear relationship was observed between the frequency of MI use and practitioners' clinical experience, with more seasoned orthodontists applying MIs more consistently. Although the overall reported success rate remains high, frequent complications such as implant mobility and soft tissue injury highlight the need for

refined placement techniques and improved post-procedural management. These findings emphasize the importance of ongoing professional education and further investigations to optimize MI application and outcomes in routine orthodontic practice.

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