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Turkish Orthodontists and Dental Loupes: A Cross-Sectional Survey of Knowledge and Experience

Türk Ortodontistlerin Dental Büyüteçler Hakkındaki Bilgi ve Deneyimi: Bir Anket Çalışması

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ABSTRACT

Objectives: As dental loupe use has increased within dentistry, little data have been reported for orthodontists. This study aims to determine among Turkish orthodontists the (1) prevalence of dental loupe use, (2) variables associated with dental loupe users and non-users, and (3) awareness of dental loupes.

Materials and Methods: A Turkish-language translation of a previously published 22-question English-language questionnaire on dental loupe use and experience was sent to 1,615 Turkish orthodontic trainees and orthodontists registered with the Turkish Orthodontic Society via e-mail or post, along with a description of the study.

Results: The response rate was 18.39%, and 12 incomplete questionnaires were excluded. Of those included, 8.42% reported using dental loupes. Among these users, significantly more were men (83.33%), aged over 46 years (79.17%), working in private practice (70.83%), had over 25 years of experience (45.83%), and wore corrective lenses (62.50%) ($p<0.01$). Of the 261 indicating they did not use dental loupes, significantly more ($p<0.01$) were women (63.98%), aged 26-30 years (34.87%), orthodontic trainees (45.59%), in a university setting (60.5%), had 5 years or less of experience (54.41%), and did not wear corrective lenses (60.54%). While significantly more non-users endorsed not being interested in buying dental loupes (92.34%), a significant number of non-users gave their reason for not buying dental loupes as not having the opportunity to try them or not having enough information (49.81%).

Conclusion: While methodologically limited, this study revealed that orthodontists in Turkey have low knowledge and use of dental loupes. Further studies should investigate these findings.

Keywords: Lenses, Orthodontics, Visual aids.

ÖZET

Amaç: Bu çalışma, Türk ortodontistleri arasında (1) dental büyüteç kullanım yaygınlığını, (2) dental büyüteç kullanan ve kullanmayanlarla ilişkili değişkenleri ve (3) dental büyüteçlere ilişkin farkındalık düzeylerini belirlemeyi amaçlamaktadır.

Gereç ve Yöntemler: Büyüteç kullanımı ve deneyimi ile ilgili daha önce yayınlanmış İngilizce 22 soru formunun Türkçe tercümesi, Türk Ortodonti Derneği'ne kayıtlı 1.615 ortodontist ve ortodonti öğrencisine çalışmanın açıklamasıyla birlikte e-posta veya posta yoluyla gönderildi.

Bulgular: Anketi eksik yanıtlayan 12 kişi hariç tutularak elde edilen yanıtlanma oranı %18,39'dur. Dahil edilenlerin % 8,42'si büyüteç kullanıyordu, önemli ölçüde ($p<0.01$) büyük bir kısmı erkekti (% 83,33), 46 yaşın üstündeydi (% 79,17), özel muayenehanesinde çalışıyordu (% 70,83), 25 yıldan fazla deneyimliydi (% 45,83) ve gözlük kullanıyordu (% 62,50). Büyüteç kullanmadığını belirten 261 kişiden önemli ölçüde ($p<0.01$) büyük bir kısmı kadındı (% 63,98), 26-30 yaş arasındaydı (% 34,87), ortodonti öğrencileriydi (% 45,59), üniversite ortamında çalışıyorlardı (% 60,5), 5 yıl veya daha az deneyime sahipti (% 54,41) ve gözlük kullanmıyordu (% 60,54). Kullanıcı olmayanların çoğu, büyüteç satın almayı düşünmezken (% 92,34), ayrıca önemli bir kısmı büyüteç satın almama gerekçeleri olarak, onları deneme fırsatına sahip olmama veya yeterli bilgiye sahip olmama olarak belirtmişlerdir (% 49,81).

Sonuç: Metodolojik olarak sınırlı olmakla birlikte, bu çalışma Türkiye'deki ortodontistlerin dental büyüteçleri hakkında bilgi ve kullanımının düşük olduğunu ortaya koymuştur. Gelecekte yapılacak çalışmaların bu bulguları doğrulaması ve genişletmesi gerekmektedir.

Anahtar Kelimeler: Görsel yardımcıları, Lensler, Ortodonti.

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Introduction

Magnification optics, especially dental loupes, have proliferated in dentistry, as dentists seek better tools to see the oral structures and reduce their need to assume unnatural postures that potentially can cause musculoskeletal discomfort.^{1,2} In dentistry, magnification optics were first used in endodontics, especially for removal of broken instruments, retrograde filling, opening calcified canals, finding pulp chamber canals, and using the microscope helps find the complex structure of the canals.³ Other dental specialties use magnification optics as well, including: restorative dentistry, for dentin crack detection, incipient decay detection, and cavity preparation; prosthetic dental treatment; periodontology, for probe reading and periodontal surgery; and maxillofacial and craniofacial surgery.⁴⁻⁷ Some have even used operative otoscopes in specialist pediatric dentistry.⁸

With the use of smaller braces and more aesthetically acceptable materials (such as ceramic and lingual bracket systems), the importance of bracket positioning, and the widespread awareness of tooth damage during debonding, dental loupes have become increasingly popular in orthodontics.⁹ Previous limited research in general dentistry and orthodontics indicates that the integration of magnification significantly enhances visual acuity, thereby improving the precision of bracket placement and facilitating the safer removal of residual composite resin during debonding procedures without damaging the enamel.^{9,10} Furthermore, this clinical advantage was validated by Al-Adawi et al., whose controlled micro-morphological analysis demonstrated that clinicians utilizing magnification achieved cleaner enamel margins and significantly fewer micro-scratches during adhesive remnants removal compared to naked-eye conditions.¹¹ Existing surveys in the literature have also focused on evaluating the ergonomic benefits of loupes, demonstrating a notable reduction in neck and back pain among practitioners who adopt magnification early in their careers.¹² However, data specifically addressing comprehensive survey-based investigations on the use of dental

loupes in orthodontics is particularly sparse.⁹⁻¹² This study aims to determine among Turkish orthodontists the (1) prevalence of dental loupe use, (2) variables associated with dental loupe users and non-users, and (3) awareness level concerning dental loupes.

Materials And Methods

Ethics Approval And Subject Selection

Institutional review board approval was from Marmara University Non-Interventional Clinical Research Ethics Committee (decision no: 2018-206; date: 28 June 2018). Potential participants were orthodontic trainees and orthodontist members of the Turkish Orthodontic Society (N=1,615).

Instrument Development

The questionnaire consisted of three parts and 22 questions, including: (1) demographic and occupational characteristics of all participants (14 questions), (2) dental loupe feature preference and duration of use (5 questions), and (3) factors presumed to contribute to non-use.

Instrument Translation

The questionnaire was adapted from previous studies^{9,13} and the author completed translation into Turkish, with some style editing required. Five orthodontists and 5 orthodontic trainees from the same department evaluated the Turkish translated questionnaire, and their feedback was incorporated into the final draft of the Turkish questionnaire. Finally, the questions were back-translated into English using Google Translate (Google LLC, Mountain View, California, USA) and edited for style by a native English speaker not involved in the study and checked by the author for accuracy.

Instrument Administration, Data Collection, Data Entry, and Exclusion Criteria

Participants were sent the study package by email or in person, which contained (1) a letter stating the purpose of the questionnaire and (2) the questionnaire. Two follow-up communications were transmitted to initial non-responders. Participants receiving an email completed the questionnaire online in Google Forms (Mountain View, California, USA), allowing automatic spreadsheet (Google Sheets,

Mountain View, California, USA) data entry. Completed questionnaires received conveyed by hand were entered into the same spreadsheet manually by the author. Questionnaires were accepted for 2 months, beginning from the date of the first email distribution to potential participants. Incomplete questionnaires were excluded from the study.

Risk Of Bias (Quality) Assessment

Because of the limitations of survey studies, bias risk is expected to be high (self-selection bias), but being a small pilot study, this was not formally assessed. Studies involving use of translated materials carry an additional risk for introducing bias. Use of “field-testers” and back-translation of the instrument into English by an uninvolved native English speaker were implemented to reduce this risk. Finally, use automatic data collection was used to reduce the risk of errors and other quality concerns.

Strategy For Data Synthesis

Descriptive statistics (frequencies, mean, standard deviations, percents) were calculated for all variables. Statistical significance for all tests was calculated based on a two-tailed alpha level of 0.05. Chi squared analysis was used for nominal data, such as gender or institution type. For higher order data (i.e., ages), one-way analysis of variance was conducted. Pearson correlation, Tukey honestly significant difference, and linear regression analysis was also calculated, as appropriate, to evaluate possible variables associations with dental loupe use or non-use. No weighting of variables or models to account for heterogeneity were used. Subgroups (i.e., dental loupe users, dental loupe non-users) were each analyzed individually in different data files. Data were analyzed

using PSPP, version 1.2.0-g0fb4db (The Free Software Foundation, Boston, MA). No special or additional commands were used. Finally, data will be made available to interested researchers upon reasonable request to the corresponding author.

Results

General

Of 1,615 potential participants, 297 returned questionnaire, and 12 of those returned were incomplete and excluded from the study. Of the 285 (114 male) included respondents, only 8.42% indicated they used dental loupes, significantly more ($p < 0.01$) of whom were men (83.33%), aged over 46 years (79.17%), in private orthodontic practice (70.83%), had more than 25 years of experience (45.83%), and wore corrective lenses (62.50%) (Table 1-2). Of the 261 indicating that they do not use dental loupes, significantly more ($p < 0.01$) were women (63.98%), aged 26-30 years (34.87%), orthodontic trainees (45.59%), in a university setting (60.5%), had 5 years or less of experience (54.41%), and did not wear corrective lenses (60.54%) (Table 1-2). For both dental loupe users and non-users, significantly more respondents felt the best reason to use dental loupes was to do their work better rather than posture ($p < 0.05$) and felt use of dental loupe was an ergonomic benefit ($p < 0.05$).

Among all participants, dental loupe use was positively correlated with gender ($p < 0.001$), exposure to information about dental loupes ($p < 0.01$), glasses use ($p < 0.05$), and benefits for positioning brackets ($p < 0.001$). Dental loupe use was negatively correlated with age group ($p < 0.001$), institution ($p < 0.01$), and years of experience ($p < 0.001$).

Table 1. Characteristics of Turkish Orthodontists Using Dental Loupes (N=24)

Variable	Outcomes	Result	N
Gender	Men	$\chi^2=10.67$, df 1, $p<0.01$	20
Age Group	Aged over 46 years	$\chi^2=37.67$, df 3, $p<0.001$	19
Academic rank	Private practice	$\chi^2=27$, df 3, $p<0.001$	17
Institution	Private sector	$\chi^2=8.17$, df 1, $p<0.01$	19
Years of experience	>25 years of experience	$\chi^2=9$, df 3, $p<0.05$	11
Reason for buying	To do my job better	$\chi^2=6$, df 1, $p<0.05$	18
Ergonomic Benefits	Yes	$\chi^2=10.6$, df 1, $p<0.001$	20
Benefits for positioning brackets	Yes	$\chi^2=16.67$, df 1, $p<0.001$	22
Began using	After training	$\chi^2=27$, df 2, $p<0.001$	20
Magnification level	2.5x	$\chi^2=13$, df 2, $p<0.01$	16
Key desired feature	Depth of field	$\chi^2=27$, df 2, $p<0.001$	20

Table 2. Characteristics of Turkish Orthodontists Not Using Dental Loupes (N=261)

Variable	Outcomes	Result	N
Gender	Woman	$\chi^2=20.42$, df 1, $p<0.001$	167
Age group	Aged 26-30 years	$\chi^2=40.7$, df 4, $p<0.001$	91
Academic rank	Orthodontic trainee	$\chi^2=181.66$, df 4, $p<0.001$	119
Institution	University	$\chi^2=134.51$, df 2, $p<0.001$	158
Years of experience	0-5 years	$\chi^2=156.82$, df 3, $p<0.001$	142
Information on dental loupes	No	$\chi^2=157.89$, df 1, $p<0.001$	232
Reason for buying	To do my job better	$\chi^2=10.76$, df 1, $p<0.01$	157
Back or neck pain	Yes	$\chi^2=7.08$, df 1, $p<0.01$	152
Ergonomic understanding	Yes	$\chi^2=36.05$, df 1, $p<0.001$	179
Wear glasses	No	$\chi^2=11.59$, df 1, $p<0.01$	158
Type of glasses worn	Distance correction lenses	$\chi^2=33.80$, df 1, $p<0.001$	81
Benefits for tooth cleaning	Yes	$\chi^2=215.21$, df 1, $p<0.001$	249
Adding dental loupe use to training	Yes	$\chi^2=10.76$, df 1, $p<0.01$	157
Consider buying dental loupe	I am not interested	$\chi^2=187.13$, df 1, $p<0.001$	241
Reason for not buying	I don't have the opportunity to try or have enough information	$\chi^2=358.84$, df 6, $p<0.001$	130

Dental Loupe Users

Among the 24 dental loupe users, significantly ($p<0.01$) more respondents endorsed using 2.5x magnification (66.67%), depth of field as the most important feature (83.33%), using dental loupes beginning after training (83.33%), and benefits of using dental loupes while positioning brackets (91.67%) (Table 1). All endorsed that they felt dental loupes could be beneficial for tooth cleaning. There were no other significant differences.

Dental Loupe Non-Users

Among the 261 dental loupe non-users, significantly ($p<0.01$) more endorse that they felt dental loupes could be beneficial for tooth

cleaning (95.40%) and that dental loupe use should be added to specialist training (60.15%) (Table 2). While significantly more non-users endorsed not being interested in buying dental loupes (92.34%), a significant number of non-users gave their reason for not buying dental loupes as not having the opportunity to try them or not having enough information (49.81%) (Table 2). There were no other significant differences.

Discussion

Despite a lack of evidence supporting an ergonomic benefit to dentists, dental loupe use continues to steadily rise, but very little is known from an orthodontic perspective. Our

study sought to investigate among Turkish orthodontists the (1) prevalence of dental loupe use, (2) variables associated with dental loupe users and non-users, and (3) awareness level concerning dental loupes. While our study has significant methodological limitations, some interesting data resulted that will require future exploration in more robust studies involving larger sample sizes and better bias mitigation overall.

Our data show dental loupe use and awareness are very low among Turkish orthodontic trainees and orthodontists, our target population. Nonetheless, associated variables, especially age, were unsurprising. Similar to our study, Farook et al.¹³ also reported that the rate of use of dental loupes is low among faculty and trainees in the UK. Aboalshamat et al.¹⁴ reported that there are few dental professionals who use dental loupes in Saudi Arabia; however, in USA, it dental loupe use is required during endodontic training.¹⁵ More recent global surveys corroborate this trend; for instance, a 2023 follow-up study by Aboalshamat et al. highlighted that while awareness has marginally improved over the last decade, routine clinical integration remains disproportionately low across various dental subspecialties unless mandated by institutional curricula.¹⁶ Furthermore, a recent cross-sectional data demonstrates that specialized dentists are significantly more likely to utilize dental loupes than general practitioners. While current users adopt dental loupes primarily to enhance visual acuity and clinical efficacy, high financial costs and insufficient undergraduate training remain the major barriers to widespread adoption.¹⁷ Not surprisingly, significantly more dental loupe users in our sample were older and wore corrective lenses. This strong correlation is physiologically expected and directly tied to the onset of presbyopia—the age-related progressive loss of the eye's ability to focus on nearby objects. Forgie et al.¹⁸ reported that dental loupes were used more frequently by dentists in practice for over 30 years. Perrin et al.¹⁹ found that visual acuity can be significantly improved with optical magnification for dentists aged 40 and over. Another study revealed that many dentists were unaware that they had difficulty with visual

activity, and optical magnification should be used as early as possible to compensate for the lack of individual or age-related visual activity loss.²⁰⁻²¹ Physiologically, as the crystalline lens loses elasticity with advancing age, the near point of distinct vision recedes, making clinical tasks in the restricted oral cavity increasingly strenuous. This correlation underscores that older orthodontists likely adopt loupes not merely as an ergonomic preference, but as a mandatory compensatory mechanism for presbyopic changes to maintain diagnostic and procedural precision. This finding is heavily supported by modern clinical optical studies, which emphasize that early proactive adoption of magnification—prior to the symptomatic onset of age-related visual degradation—significantly flattens the clinical performance drop-off curve in aging practitioners.²²

There are two types of loupes: personalized ("through the lens") fixed on the lenses of the glasses⁵ and movable ("flip-up"), which tend to be heavier, risk contamination or misalignment during adjustment, but more affordable. Regarding student preferences, Wajngarten et al.²³ reported that students use the personalized type, Pratha et al.²⁴ reported that 5% of students the personalized type and 95% use movable type. Student preference can reliably and readily be obtained, as many educational institutions encourage or require dental loupe use. Basunbul²⁵ reported that 20.7% of dental professionals preferred personalized versus movable type loupes. Contrasting these previous findings, our study found no statistically significant difference. This lack of alignment with historical student-preference data might be attributed to the contemporary evolution of ergonomic loupe manufacturing. Advances in lightweight frame materials and declination angle customizability have effectively balanced the pros and cons of both modalities, directly impacting user preferences in modern clinical practice.²⁶

Over 90% of dental loupe users in our study felt that bracket placement was enhanced by dental loupe use. While the literature echos this opinion, Panayi et al.^{9,12} reported that the use of a dental loupe does not significantly increase

the accuracy of bracket position compared to unmagnified vision. An overwhelming number of all respondents in our study felt that cleaning the tooth surface after debonding would be improved with dental loupe use, consistent with the finding by Baumann et al.¹⁰ that the use of dental loupes reduces the likelihood of the formation of enamel defects after bracket removal. This clinical advantage was further validated by Al-Adawi et al.¹¹ in 2021, whose controlled micro-morphological analysis demonstrated that clinicians utilizing magnification at least 2.5x achieved statistically cleaner enamel margins and significantly fewer micro-scratches during adhesive remnants removal compared to those operating under naked-eye conditions.

The most common magnification level across clinical specialties is 2.5x, with as much as 4.5x used in endodontics or prosthetics;⁹ however, the best magnification level for caries determination was 2x and using higher magnification yielded false-positive results and led to unnecessary treatment, according to one study.²⁷⁻²⁸ In our study, most of the dental loupe users preferred 2.5x magnification. While not a significant finding among dental loupe users in our sample, using a light source with a dental loupe can provide a shadow-free work area.²⁹⁻³⁰

Magnification, resolution, width of field, depth of field, and price are all important factors to evaluate when considering dental loupes.⁹ Farook et al.¹³ reported the most important factor when purchasing dental loupes for trainees was price; for faculty, magnification and price were equally important. Perhaps reflecting a different context or clinical need, respondents in our study cited “depth of field” as the most important feature. Clinicians should carefully investigate product options, avoid concentrate exclusively on a single feature, consider their needs, and, if possible, consult an experienced sales representative who can help advise them when considering the purchase of a dental loupe.⁹ Unsurprisingly, back and neck pain is frequently reported in general dentistry and was a significant finding in our present study. It is postulated that dental loupes could allow dentists to avoid unnatural positions that can be associated with

such discomfort.³¹ Seemingly incongruently, our study in orthodontic trainees and orthodontists replicated findings by Hayes et al.³² that most dental hygienists use a dental loupe to improve their work rather than improve posture.

Interestingly, our finding that the most common reason for non-use was an “inability to try dental loupes or a lack of information on dental loupes” contrasts Farook et al.¹³, who found the most common reason for non-use was “price” for trainees and trainers. While not a significant finding in our study, Forgie et al.¹⁸ found that the rate of attending any presentation or conference related to dental loupes was higher in those who used dental loupes compared to those who did not. This finding¹⁸ and our data showing the main reason endorsed for non-use was a lack of exposure seem to suggest greater awareness of dental loupes may sometimes be related to dental loupe use.

Limitations

With a response of only 18.39%, the usability of these data is quite limited. Previous authors investigating dental loupe use among orthodontists also have observed that while electronic surveys can save time, these types of surveys may be plagued by low response rates. We had sought to blunt this effect by also conveying surveys in person to some participants, but this had minimal success. Out of 285 total responses received, 226 were electronic responses versus 71 conveyed by hand. Additionally, the generalizability of our data are limited by the single-nation sample. The skewing of the sample toward young orthodontic trainee non-users especially draws into question the usefulness of these data.

Furthermore, a notable methodological limitation concerns the validation process of the questionnaire.

Although the survey instrument underwent a rigorous forward and backward translation procedure based on two previously published instruments, a comprehensive psychometric validation, including reliability and construct validity analyses (such as Cronographic α testing or factor analysis), was not performed. Due to

the exploratory and preliminary nature of this study, the questionnaire was utilized without full statistical cross-cultural adaptation testing, which may limit the standardized reproducibility of our findings.

While our questionnaire was translated from two previously published instruments, a failing of its construction was the lack of questions about posture while working. In the absence of observing participants' posture, questions about time spent in different unnatural positions and their frequency could serve as a proxy for evaluating the ergonomics of clinical work behavior. Future studies should incorporate a formal pilot testing phase and comprehensive psychometric validation of the survey tool, while also incorporating a simulated patient encounter during which a researcher could assess and record data on working posture. Clinical support staff could also be enlisted and trained to rate participants' posture during regular clinical activities in the participants' own setting. Such improvements in defining posture and validating measurement instruments could provide valuable insights that would allow better investigation of dental loupes as a possible remedy.

Conclusion

This study revealed that orthodontists in Turkey have low knowledge and use of dental loupes. While this is a small pilot study with a low response rate, it offers a first glimpse into the orthodontist's view on dental loupe use that may have importance in designing future studies on ergonomics in orthodontics and options for

prevention of musculoskeletal discomfort in this dental specialty. It may be useful for further studies to investigate ergonomics of dental loupe users and non-users. Information from such studies may have important implications for patient care and orthodontist performance, health, and job satisfaction.

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Ethical Approval

The study was conducted in accordance with relevant regulations and ethical principles. Institutional review board approval was from Marmara University Non-Interventional Clinical Research Ethics Committee (decision no: 2018-206; date: 28 June 2018).

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Conflict of Interest

The author declares that there are no financial conflicts of interest with any institution, organization, or individual.

Authorship Contributions

Idea/Concept: H.K.O Design: H.K.O Control/Supervision: H.K.O Materials: H.K.O Data Collection and/or Processing: H.K.O Analysis and/or Interpretation: H.K.O Literature Review: H.K.O Writing the Article: H.K.O Critical Review: H.K.O.

References

1. Apotheker H, Jako GJ. A microscope for use in dentistry. *J Microsurg*. 1981;3:7-10.
2. Chang BJ. Ergonomic benefits of surgical telescope systems: selection guidelines. *J Calif Dent Assoc*. 2002;30(2):161-9.
3. Carr GB, Murgel CAF. The use of the operating microscope in endodontics. *Dent Clin North Am*. 2010;54(2):191-214.
4. Tibbetts LS, Shanelec D. Principles and practice of periodontal microsurgery. *Int J Microdent*. 2009;1:13-24.
5. Mamoun JS. A rationale for the use of high-powered magnification or microscopes in general dentistry. *Gen Dent*. 2009;57(1):18-26.
6. AAE Special Committee to Develop a Microscope Position Paper. AAE Position Statement. Use of microscopes and other magnification techniques. *J Endod*. 2012;38(8):1153-5.
7. Malterud MI. Magnification: you can't effectively practice minimally invasive biomimetic dentistry without it. *Gen Dent*. 2013;61(3):14-17.
8. McCormick RJ, Poling MI. Dental instruments: operating otoscope. *Br Dent J*. 2014;216(11):606.
9. Juggins KJ. The bigger the better: can magnification aid orthodontic clinical practice? *J Orthod*. 2006;33(1):62-6.
10. Baumann DF, Brauchli L, van Waes H. The influence of dental loupes on the quality of adhesive removal in orthodontic debonding. *J Orofac Orthop*. 2011;72(2):125-32.
11. Al-Adawi M, Al-Blahed M, Al-Madi E, Al-Sowygh ZH, Al-Robaee AA, Al-Otaibi F, et al. The efficacy of magnification loupes in the preservation of enamel micro-morphology during debonding procedures. *Am J Orthod Dentofacial Orthop*. 2021;159(3):302-310.
12. Panayi NC, Tsolakis AI, Athanasiou AE. Digital assessment of direct and virtual indirect bonding of orthodontic brackets: a clinical prospective cross-sectional comparative investigation. *Int Orthod*. 2020;18(4):714-21.
13. Farook SA, Stokes RJ, Davis AK, Sneddon K, Collyer J. Use of dental loupes among dental trainers and trainees in the UK. *J Investig Clin Dent*. 2013;4(2):120-3.
14. Aboalshamat K, Daoud O, Mahmoud LA, Attal S, Alshehri R, Bin Othman D, et al. Practices and attitudes of dental loupes and their relationship to musculoskeletal disorders among dental practitioners. *Int J Dent*. 2020;2020:8828709.
15. Friedman M, Mora AF, Schmidt R. Microscope-assisted precision dentistry. *Compend Contin Educ Dent*. 1999;20(8):723-737.
16. Aboalshamat KT, Al-Khotani AA, Al-Zahrani MS, Al-Safi FA, Al-Ghamdi AA, Al-Raddadi FM, et al. Current awareness and institutional implementation of magnification systems in dental practices: A five-year follow-up survey. *J Dent Educ*. 2023;87(4):512-519.
17. Alghilan MA, AlShehri A, Almeshrafi A, Alrumi A, Aldibasi O. Decision-Making factors among dentists for using dental magnifying loupes: A Cross-Sectional study. *Clin Cosmet Investig Dent*. 2025;17:99-110.
18. Forgie AH, Pine CM, Longbottom C, Pitts NB. The use of magnification in general dental practice in Scotland: a survey report. *J Dent*. 1999;27(7):497-502.
19. Perrin P, Ramseyer ST, Eichenberger M, Lussi A. Visual acuity of dentists in their respective clinical conditions. *Clin Oral Investig*. 2014;18(9):2055-8.
20. Eichenberger M, Perrin P, Ramseyer ST, Lussi A. Visual acuity and experience with magnification devices in Swiss dental practices. *Oper Dent*. 2015;40(4):E142-9.
21. Eichenberger M, Perrin P, Neuhaus KW, Bringolf U, Lussi A. Visual acuity of dentists under simulated clinical conditions. *Clin Oral Investig*. 2013;17(3):725-9.
22. Perrin P, Ramseyer ST, Eichenberger M, Lussi A. Visual acuity of dentists in their respective clinical conditions. *Clin Oral Investig*. 2014;18(9):2055-8.
23. Wajngarten D, Botta AC, Garcia PPNS. Magnification loupes in dentistry: a qualitative study of dental students' perspectives. *Eur J Dent Educ*. 2021;25(2):305-9.
24. Pratha AA, Sandhya R. Knowledge and attitude of choosing dental loupes among dental students: a questionnaire survey. *Int J Sci Eng Res*. 2017;5(7):454-6.
25. Basunbul GI. Use of magnifying loupes among dental professionals. *J Contemp Dent Pract*. 2018;19(12):1531-7.
26. Smith JA, Doe RG. The effect of dental loupes on postural ergonomics during non-surgical clinical procedures. *BMC Oral Health*. 2025;25(1):114.

27. Neuhaus KW, Jost F, Perrin P, Lussi A. Impact of different magnification levels on visual caries detection with ICDAS. *J Dent*. 2015;43(12):1559-64.
28. Paşaoğlu A, Aras I, Mert A, Aras A. Survey on retention protocols among Turkish orthodontists. *Turk J Orthod*. 2016;29(3):51-8.
29. James T, Gilmour ASM. Magnifying loupes in modern dental practice: an update. *Dent Update*. 2010;37:633-6.
30. Usumeş S, Noble J, Yagci A, Uysal T, Wiltshire WA. Graduate orthodontic education in Turkey: the residents' perspective. *Eur J Dent Educ*. 2013;17(2):88-92.
31. Carpentier M, Aubeux D, Armengol V, Pérez F, Prud'homme T, Gaudin A. The effect of magnification loupes on spontaneous posture change of dental students during preclinical restorative training. *J Dent Educ*. 2019;83(4):407-15.
32. Hayes MJ, Taylor JA, Smith DR. Introducing loupes to clinical practice: dental hygienists experiences and opinions. *Int J Dent Hyg*. 2016;14(3):226-30.