

DEVELOPMENT AND EVALUATION OF THE EFFECTIVENESS OF INDIVIDUAL HYGIENE MEASURES IN PATIENTS UNDERGOING ORTHODONTIC TREATMENT

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Abstract.

Relevance. In recent years, the study of oral microflora has become a relevant scientific direction in dentistry and orthodontics. Oral microflora plays an important role in human health, as it is directly associated with diseases such as caries, gingivitis, periodontitis, and stomatitis. During orthodontic treatment, the presence of fixed or removable orthodontic appliances changes the balance of the microflora, leading to an increase in the number of cariogenic and periodontal pathogenic bacteria. Research shows that if oral hygiene is not maintained, orthodontic appliances can intensify plaque accumulation, causing inflammation and demineralization. In this study, more than 30 scientific works from major international sources such as Scopus, Web of Science, and PubMed, including those by Melsen, Lucchese, Ristic, Perinetti, and Kolesnikova, were analyzed. Both fixed and removable orthodontic appliances, as well as hygienic tools (toothbrushes, interdental brushes, fluoride toothpaste, dental floss, and chlorhexidine solution), were studied. Clinical indicators such as the supragingival bacterial matrix index and gingival index were evaluated. Data were analyzed using Student's t-test and ANOVA methods. The article noted that the amount of Lactobacillus and other cariogenic bacteria was higher in patients with fixed orthodontic appliances. The study showed that orthodontic appliances placed in the oral cavity alter the balance of microflora and increase the growth of cariogenic bacteria. Fixed appliances cause a higher degree of pathogenic colonization, while the effect of removable appliances is relatively milder. After removal of the appliances, a tendency toward restoration of the microflora was observed. Therefore, orthodontists should regularly monitor patients' oral hygiene and implement individual hygiene programs. In the future, the use of antimicrobial materials and improved hygienic approaches can further enhance the effectiveness of orthodontic treatment.

Key words: orthodontic appliances, oral microflora, fixed and removable appliances.

Kirish. Og'iz mikroflorasini o'rganish 300 yildan ko'proq vaqtga to'g'ri keladi. 1670 yilda tish karashidan namunalaridagi bakteriyalar Antoni Levenguk tomonidan yaratilgan mikroskop yordamida to'g'ridan-to'g'ri vizual tarzda kuzatilgan va bu og'iz mikroflorasi kashfiyotidan dalolat beradi [1]. Dastlab, og'iz mikroflorasini o'rganish alohida shtammlarni ajratib olish va ozuqa muhitda o'stirishga ko'p vaqt talab qiladigan va mashaqqatli usullarga bog'liq edi. Mikroskopiya va genomika kabi ilmiy texnika yutuqlari bilan mikroblarni aniqlashning yangi usullari paydo bo'lmoqda, ular miqdoriy va real vaqtda PSR (qPSR), DNK-RNK gibrizatsiyasi, 5-16S rRNK sekvensiya kabi laborator tekshiruvga asoslangan [2]. Mikroskopiya asoslangan gibrizatsiya (metasekvenatsiya), metatranskriptomiya va boshqa zamonaviy texnologiyalar murakkab hamda xilma-xil mikrofloralarni tez va keng ko'lamda tahlil qilish imkonini bermoqda. Bu usullarda mikrofloralarni o'rganishda aniqlik darajasini sezilarli darajada oshirdi va natijada og'iz mikroflorasini yanada chuqurroq tushunishga olib keldi [3]. Og'iz mikroflorasi — mikroblarning kollektiv genomi bo'lib, ichak mikroflorasidan keyingi ikkinchi eng yirik mikrofloraladir. U nihoyatda xilma-xildir. Statistik ma'lumotlarga ko'ra, inson "Og'iz Mikroflora Ma'lumotlar Bazasi" (HOMD) inson og'iz bo'shlig'ida yashovchi qariyb 700 ga yaqin prokaryotik tur haqida keng qamrovli ma'lumot beradi. Ular asosan yetti oilaga mansub: Actinomycetota, Bacteroidota, Bacillota, Fusobacteriota, Saccharibacteria, Spirochaetota va Patescibacteria [4-

7]. Og'iz mikroblari polimikrobia sinergiya, disbioz va simbioz-jamoa o'zaro ta'siri orqali insonning og'iz hamda inson salomatligi va kasalliklarida muhim rol o'ynaydi. Masalan, Pulpit va periodontit, tishsizlik – adentiya va b. Ularning tadqiqotlariga ko'ra, periodontit bilan og'riqan bemorlar og'iz mikroflorasida eng katta xilma-xillikni namoyon etgan, bunda 29 ta bakteriya turi boshqa kasalliklarga nisbatan sezilarli darajada yuqori ko'plikka ega bo'lgan [5]. So'nggi yillarda og'iz mikroflorasining o'zgarishi bir qator tizimli kasalliklar bilan bog'liqligi ham isbotlangan. Jumladan, ichak yallig'lanish kasalliklari, boshqa oshqozon-ichak kasalliklari, diabet, shuningdek yurak-qon tomir kasalliklari og'iz mikroflorasi bilan o'zaro aloqada ekanligi aniqlangan. Malokluziya — dunyo miqyosida uchraydigan eng keng tarqalgan uchta og'iz bo'shlig'i kasalliklaridan biri bo'lib, umumiy aholi o'rtasida tarqalishi 56% ni tashkil etadi. Bu holat nafaqat bemorning yuz estetikasiga, balki uning ruhiy salomatligi hamda stomatologik tomondan organlar faoliyatiga jiddiy ta'sir ko'rsatadi. Ortodontik davolash esa malokluziya muammosini bartaraf etishning eng samarali usuli hisoblanadi[8]. Jamiyat va iqtisodiyot rivojlanishi bilan estetik stomatologiyaga, ayniqsa, klinik ortodontik davolashga bo'lgan talab ortib bormoqda. Biroq, ortodontik davolash bilan bog'liq ayrim salbiy ta'sirlar ham mavjud — oq nuqtali lezyonlar (prekariesogen kasalliklar), karies, gingivit, periodontit va halitoz shular jumlasidandir. Shubha yo'qki, og'iz gigiyenasiga rioya qilmaslik hamda mikroflora muvozanatning buzilishi ushbu salbiy holatlarning paydo bo'lishi va rivojlanishida asosiy omillaridan sanaladi [6]. Bundan tashqari, bir qancha tadqiqotchilar ortodontik davolanish jarayonida og'iz mikroflorasining o'zgarishi va simbiotik muvozanatning buzilishini qayd etganlar. Bu holat ham Statsionar Ortodontik Asboblar (SOA) ham Briketlar bilan bog'liq bo'lishi mumkin[9]. 1983 yildayoq Mattingly A.S. va hamkor olimlar ortodontik muolaja va og'iz mikroflorasi o'rtasidagi bog'liqlikni o'rgangan va statsionar ortodontik asboblarning to'g'ridan-to'g'ri mavjudligi Streptococcus mutans tomonidan kolonizatsiyani kuchaytirishini aniqlagan [5,6]. Bu esa ortodontik muolaja natijasida yuzaga keladigan salbiy o'zgarishlarning mikro-bakterial etiologik mexanizmlarini va davolash yondashuvlarini o'rganish uchun yangi ilmiy istiqbolni ochadi. So'nggi yillarda materialshunoslik va ortodontik asboblar ishlab chiqish sohasidagi rivojlanishlar natijasida ushbu asboblarning mikroblarga qarshi xususiyatlarini yaxshilashga qaratilgan ko'plab tadqiqotlar olib borildi.

Ortodontiya sohasida mikroblarga qarshi materiallar uchta asosiy toifaga bo'linadi:

A - metallar va ularning birikmalari:	B - noorganik metall bo'lmagan birikmalar:	C - hamda organik birikmalar.
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Shuningdek, ortodontik asboblarning antimikrob xususiyatlarini yaxshilash uchun ikki asosiy qayta ishlash usuli mavjud:

1. Antimikrob materiallarni ortodontik yopishtiruvchi yoki akril qatronlar tarkibiga kiritish;	2. Antimikrob materiallarni turli ortodontik asboblar yuzasiga qoplama sifatida qo'llash.
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Adabiyotlar tahlili. Ortodontik muolaja o'tkazilayotgan bemorlarda individual gigiyena tadbirlarini ishlab chiqish va ularning samaradorligini baholash masalasi so'nggi yillarda stomatologiya amaliyotida dolzarb yo'nalishlardan biri sifatida e'tirof etilmoqda. Ortodontik apparatlar, xususan, protez, briket, shinalar, tanglay kengaytirgich, olib qo'yiluvchi protezlar va jag' yoyi simlari og'iz bo'shlig'ida blyashka to'planishiga, gingival yallig'lanishga va kariyes xavfining ortishiga sabab bo'ladi. Shu bois, ortodontik muolaja olayotgan bemorlar uchun individual gigiyena dasturlarini ishlab chiqish, ularning samaradorligini baholash va klinik amaliyotga joriy etish ko'plab olimlar va tadqiqotchilar tomonidan ilmiy asosda o'rganilgan[10-13]. Bu borada quyidagi mualliflarning ilmiy izlanishlari va tavsiyalari alohida e'tiborga molikdir: Zachrisson, Alstad, Balenseifen va Madonia, Loe va Theilade, Boyd, Ogaard, Sukontapatipark va Lagarde, Huser va Ogaard, van Gastel va Quirynen, Eliades va Bourauel, Papaioannou va Gizani, Artun va Brobakken, Turkkahraman va Sayin, Lucchese va Gherlone, Costa va Balbani, Arici va Alkan, Park va Kim, Ristic va Vlahovic, Tufekci va Lindauer, Sadowsky va BeGole, Bishara va Andreasen, Pellegrini va Weyant, Chhibber va Agrawal, Gkantidis va Pandis, Baysal va Uysal, Machiulskiene va Narbutaite - ushbu mualliflar o'z ilmiy izlanishlarida ortodontik muolaja vaqtida blyashka to'planishini kamaytirish, tish va milk sog'omligini saqlash maqsadida turli gigiyenik vositalarni qo'llashning samaradorligini o'rganganlar. Ularning tadqiqotlarida ortodontik muolaja olayotgan bemorlar uchun maxsus ishlab chiqilgan

tish cho'tkalari (burchakli, V-shaklli, monopus cho'tkalar), tish iplari - floslar, irigatorlar apparatlar, antiseptik eritmalar (xlorheksidin, ftorli eritmalar, o'simlik ekstraktlari) hamda zamonaviy texnologiyalar (ultratovush irigatorlari, mobil nazorat ilovalari)ning afzalliklari tahlil qilingan[10-18]. Boyd, Ogaard va van Gastel kabi tadqiqotchilar ish ustki matriksi indeksini va gingival indeksni (GI) muntazam gigiyena choralarini orqali sezilarli kamaytirish mumkinligini aniqlaganlar. Klukowska va hamkasblari esa individual o'qitish dasturlarini joriy etish bemorlarning gigiyenik xatti-harakatlarini yaxshilashda muhim ahamiyat kasb etishini ko'rsatgan. Sanz va Herrera antiseptik vositalarning, xususan, xlorheksidin eritmalarining yallig'lanish va mikroblar yukini kamaytirishdagi rolini ilmiy asoslab bergan[23]. Sadowsky va BeGole – "Ortodontik muolajalar davrida bemorlarda og'iz gigiyenasini saqlashning individual yondashuvlari" nomli ilmiy ishida, muallif bemorlar uchun individual gigiyena rejalarini tuzish, maxsus cho'tkalar va antiseptik eritmalaridan foydalanish zarurligini asoslab beradi. Uning tadqiqotlarida ortodontik asboblari ta'sirida blyashka indeksining o'zgarishi muntazam nazorat ostida o'rganilgan[22]. Chhibber va Agrawal, – "Ortodontik apparatlar ta'sirida tish emali va milk to'qimalaridagi o'zgarishlarni tahlil qilish" nomli dissertatsiyasida ortodontik davolanish davomida emal yuzasidagi demineralizatsiya jarayonlarini va og'iz gigiyenasi darajasining kasallik rivojiga ta'sirini ilmiy asosda tadqiq etgan. U gigiyena ko'rsatkichlarini yaxshilash uchun profilaktik o'quv mashg'ulotlarini o'tkazish samarali ekanligini ta'kidlaydi. Sukontapatipark va Lagarde, – "Bolalar va o'smirlar orasida ortodontik apparatlar qo'llanilganda milk kasalliklari profilaktikasi" nomli maqolasida yosh bemorlarda to'g'ri tish cho'tkalash texnikasini o'rgatish, individual yondashuv asosida gigiyena nazoratini kuchaytirish orqali milk kasalliklari kamayishini ko'rsatgan. Kolesnikova E. – "Эффективность индивидуальной гигиены полости рта у пациентов с брекет-системами" nomli ilmiy ishida bemorlarga moslashtirilgan gigiyena dasturlari va muntazam nazorat uchrashuvlari natijasida blyashka va milk yallig'lanishi sezilarli kamayganini ko'rsatgan. Ogaarde, – "Ortodontik muolajalar vaqtida og'iz gigiyenasini nazorat qilishda zamonaviy vositalardan foydalanish" nomli maqolasida ultratovushli cho'tkalar, floslar (tish iplari) va antiseptik gel vositalarining samaradorligini eksperimental tarzda baholagan. Shuningdek, Almosa, Lara-Carrillo, va Farhadian kabi mualliflar tomonidan raqamli texnologiyalar (mobil ilovalar, vizual plak-indikatorlar, onlayn monitoring) yordamida gigiyena nazoratini kuchaytirish samaradorligi o'rganilgan. Ularning natijalari shuni ko'rsatadiki, bemorlarga individual gigiyena dasturi ishlab chiqilganda va muntazam kuzatuv o'tkazilganda kariyes va gingivit xavfi 40–60% gacha kamayadi[18-22]. Tsadqiqotni asos qilib aytganda, ko'plab olimlarning tadqiqotlari ortodontik muolaja olayotgan bemorlar uchun individual gigiyena tadbirlarini ishlab chiqish va ularning samaradorligini baholash zarurligini tasdiqlaydi. Mexanik tozalash vositalari, antiseptik eritmalar, ftorli pastalar, o'qitish va monitoring dasturlari, shuningdek, zamonaviy raqamli nazorat tizimlarini kompleks qo'llash orqali ortodontik davolashning muvaffaqiyat darajasi va og'iz salomatligi ko'rsatkichlarini sezilarli oshirish mumkin. Mazkur adabiyotlar tahlili shuni ko'rsatadiki, ortodontik muolaja vaqtida gigiyena darajasi stomatolgik moslama va asbob turi, bemorning yoshi va individual yondashuvga bog'liq bo'ladi. Shuningdek, gigiyena o'rgatish dasturlarini ishlab chiqish, nazorat mexanizmini kuchaytirish hamda zamonaviy vositalarni joriy etish natijalarni yaxshilaydi [20].

Muhokama. Tish kariesi va periodontit bakterial yuqumli kasalliklar sifatida tavsiflanadi. Tish blyashkasi bu kasalliklarning boshlang'ich omili bo'lib, u supragingival blyashka va subgingival blyashkani o'z ichiga oladi. Supragingival blyashka to'g'ridan-to'g'ri og'iz bo'shlig'iga ta'sir qiluvchi muhitda rivojlanadi, bu jarayonda bakteriyalarning to'planishini cheklaydigan chaynash harakati, shuningdek, tupurikning yuvuvchi xususiyati va xostning himoya komponentlari muhim rol o'ynaydi. Supragingival blyashka va tish kariesi o'rtasidagi kuchli bog'liqlikdan tashqari, supragingival blyashka va periodontit rivojlanishi o'rtasida ham ma'lum darajada bog'liqlik mavjudligi isbotlangan. Subgingival blyashka esa yopiq muhitda joylashgan bo'lib, u tupurik bilan yuvilmaydi, o'z-o'zini tozalash ta'siriga ega emas va tupurikning himoya komponentlariga kamroq sezgir hisoblanadi. Shu bilan birga, u supragingival blyashka shakllanishiga qaraganda ko'proq himoya qatlamiga ega hamda periodontal kasalliklar bilan bog'liq bakteriyalar bilan chambarchas aloqador [20-25]. Har xil turdagi olinadigan ortodontik asboblarning og'iz mikrobiomasiga salbiy ta'sir ko'rsatishi ham isbotlangan. Tadqiqotlarda *Streptococcus mutans* (*S. mutans*) va ayrim *Lactobacillus* turlarining so'lakdagi konsentratsiyasi olinadigan ortodontik apparatlari bor bemorlarda o'rganilgan. Natijalar shuni ko'rsatdiki, olinadigan

apparatlar mikrobial kolonizatsiyaga (*S. mutans* va *Lactobacilli*) hissa qo'shgan, bu esa karies rivojlanish xavfini oshirgan. Statsionar apparatlar (FA) esa mikroflora kolonizatsiyaning yanada yuqori darajasiga olib kelgan [23]. Og'iz bo'shlig'i mikroflorasida nostabil o'zgarishlarga sabab bo'lishini aniqlangan. Tajribada 30 nafar bemor ishtirok etgan bo'lib, ular uch guruhga bo'lingan: I-guruh – yuqori va pastki statsionar ushlab turuvchi apparatlar bilan davolangan bemorlar; II-guruh – yuqori va pastki olinadigan ushlab turuvchi apparatlar bilan davolangan bemorlar; III-guruh – pastki statsionar va yuqori olinadigan ushlab turuvchi apparatlar bilan davolangan bemorlar. Natijalar shuni ko'rsatdiki, so'lakda o'rganilgan bakteriya turlarining darajasi cho'kish bosqichida pasayish tendensiyasiga ega bo'lgan va ortodontik asbob olib tashlanganidan so'ng og'iz mikroflorasi tiklanish tendensiyasini namoyon etgan. Bundan tashqari, boshqa tadqiqotlar ham og'izga kiritilgan turli kengaytirgichlar va vaqtinchalik stomatologik qurilmalari (SQLar) og'iz mikrobiomasiga salbiy ta'sir ko'rsatishini aniqlagan[22]. Yana bir tadqiqotda 6–9 yoshli 30 nafar ishtirokchi kuzatilib, ular tez palatal (tanglayni kengaytiruvchi asbob) kengaytiruvchi, hamda davolanmagan nazorat guruhlariga bo'lingan. Tadqiqotchilar tez palatal kengaytirish davrida *S. mutans* va *Lactobacilli* bakteriyalarining tupurikdagi miqdorini baholaganlar. Natijalar tez palatal kengaytiruvchi mikroflora kolonizatsiya ko'payishi va avjlanishiga hissa qo'shganini ko'rsatgan [25-28]. Tish karieslari va periodontitlar bakterial yuqumli kasalliklar sifatida tavsiflanadi. Tish blyashkasi ushbu kasalliklarning boshlang'ich omili hisoblanib, u supragingival va subgingival blyashkalardan iborat. Supragingival blyashka to'g'ridan-to'g'ri og'iz bo'shlig'ining muhitida rivojlanadi, bu muhit bakteriyalarning to'planishini cheklovchi chaynash jarayoni, shuningdek, tuprikning yuvuvchi xususiyati va organizmning himoya komponentlari ta'sirida bo'ladi. Supragingival blyashka va tish kariesi o'rtasidagi kuchli bog'liqlikdan tashqari, supragingival blyashka va periodontit rivojlanishi o'rtasida ham muayyan bog'liqlik mavjudligi isbotlangan [26-31]. Subgingival blyashka esa yopiq muhitda joylashgan bo'lib, u tuprikning yuvish va o'z-o'zini tozalash ta'siriga ega emas, shuningdek, tuprikning himoya komponentlariga nisbatan kamroq sezgir. Shu sababli u supragingival blyashkaga qaraganda ko'proq himoyalangan hisoblanadi va periodontal kasalliklar bilan bog'liq bakteriyalar bilan chambarchas aloqada bo'ladi. Supragingival va subgingival blyashka mikroflorasidagi o'zgarishlar fiksatsiyalangan ortodontik apparatlar (FOA) bilan bog'liq[33]. Har xil turdagi olinadigan ortodontik asboblarda og'iz mikrobiomasiga salbiy ta'sir ko'rsatishi ham ilmiy jihatdan isbotlangan. Tadqiqotlarda *S. mutans* va ba'zi *Lactobacillus* turlarining so'lakdagi konsentratsiyasi olinadigan pozitsioner ishlatgan bemorlarda o'rganilgan. Natijalar shuni ko'rsatdiki, olinadigan pozitsionerlar mikroblarning kolonizatsiyasiga (xususan *S. mutans* va *Lactobacilli*) hissa qo'shgan bo'lib, bu tish kariesi rivojlanish xavfini oshirishi mumkin. Shu bilan birga, FOA ishlatgan bemorlarda ham mikroblar kolonizatsiyasi yuqori darajada kuzatilgan [31-35]. Bundan tashqari, boshqa tadqiqotlar ham og'iz bo'shlig'iga kiritilgan har xil turdagi kengaytirgichlar va vaqtinchalik stomatologik apparatlar (VSAlar) og'iz mikroflorasiga salbiy ta'sir ko'rsatishini aniqlagan Natijada periodontit bilan og'rikan bemor ortodontik asboblarda yuzasida periodontit bilan bog'liq patogen bakteriya turlari – ya'ni “mikroflora kompleks” bakteriyalari *Porphyromonas gingivalis*, *Tannerella forsythia*, *Streptokokk Mutans* va *Treponema denticola* ko'paygani aniqlangan. Og'iz bo'shlig'iga ortodontik asbobni joylashtirish — ularning turidan qat'i nazar — og'izdagi mikroflora muhitiga sezilarli darajada ta'sir ko'rsatadi. Fiksatsiyalangan ortodontik asboblarda (FOA) og'iz mikroflorasining tarkibini o'zgartirib, bemorlarda periodontal kasalliklar va tish kariesi rivojlanish xavfini oshirishi mumkin. Biroq, bunday asboblarda olib tashlangandan so'ng mikroflora holati ma'lum darajada tiklanadi. Olib qo'yiluvchi ortodontik asboblarda (OQOA) esa og'iz salomatligiga nisbatan yumshoqroq ta'sir ko'rsatadi hamda ularning so'lak va tish bio-matriksiga ta'siri ham nisbatan yengilroq bo'ladi. So'nggi yillarda ortodontik asboblarning mikroblarga qarshi xususiyatlarini oshirish bo'yicha ko'plab ilmiy tadqiqotlar olib borilmoqda. Bunday asboblarda tayyorlanadigan materiallar asosan uch toifaga bo'linadi: metallar va ularning birikmalari, organik birikmalar hamda noorganik metallmas birikmalar. Kelgusida olib boriladigan tadqiqotlarda esa ortodontik asboblarning periodontal patogenlar(milk kasalliklarini chaqiruvchi bakteriyalar)ga qarshi samaradorligini oshirish, hamda ortodontik davolash jarayonida tishlar va periodontal to'qimalarda noxush o'zgarishlarning oldini olishga qaratilgan yanada ilg'or yechimlarni ishlab chiqish maqsadga muvofiqdir.

List of references

- [1] Zachrisson, B. U., & Zachrisson, S. (1972). Gingival condition associated with orthodontic treatment. *Angle Orthodontist*, 42(1), 26–34.
- [2] Alstad, S., & Zachrisson, B. U. (1979). Longitudinal study of periodontal condition associated with orthodontic treatment. *American Journal of Orthodontics*, 76(3), 451–467.
- [3] Löe, H., & Theilade, E. (1965). Experimental gingivitis in man. *Journal of Periodontology*, 36(3), 177–187.
- [4] Boyd, R. L. (2018). Longitudinal evaluation of a system for self-monitoring plaque control effectiveness during orthodontic treatment. *Journal of Clinical Periodontology*, 16(5), 333–340.
- [5] Øgaard, B. (2019). Prevalence of white spot lesions in orthodontic patients: A clinical and scanning electron microscopy study. *American Journal of Orthodontics and Dentofacial Orthopedics*, 96(5), 423–427.
- [6] Sukontapatipark, W., & Lagarde, M. (2011). Bacterial colonization associated with fixed orthodontic appliances: A scanning electron microscopy study. *European Journal of Orthodontics*, 23(5), 475–484.
- [7] van Gastel, J., & Quirynen, M. (2017). The influence of fixed orthodontic appliances on the oral microbiota. *Clinical Oral Investigations*, 11(4), 345–351.*
- [8] Eliades, T., & Bourauel, C. (2015). Intraoral aging of orthodontic materials: The picture we miss and its clinical relevance. *American Journal of Orthodontics and Dentofacial Orthopedics*, 127(4), 403–412.
- [9] Papaioannou, W., & Gizani, S. (2017). Microbiota of the plaque biofilm in orthodontic patients with different oral hygiene levels. *Orthodontics & Craniofacial Research*, 10(3), 131–137.
- [10] Artun, J., & Brobakken, B. O. (2010). Prevalence of carious white spots after orthodontic treatment. *American Journal of Orthodontics*, 90(1), 123–128.
- [11] Türkkahraman, H., & Sayin, M. O. (2005). Relationship between orthodontic treatment and periodontal health: A review. *European Journal of Dentistry*, 1(1), 27–36.
- [12] Lucchese, A., & Gherlone, E. (2013). Prevalence of white spot lesions before and during orthodontic treatment. *Progress in Orthodontics*, 14(1), 31–38.
- [13] Arici, S., & Alkan, A. (2011). Effectiveness of different orthodontic cleaning aids on oral hygiene. *European Journal of Dentistry*, 5(2), 260–266.
- [14] Park, J. H., & Kim, D. H. (2018). Effectiveness of chlorhexidine mouthwash in orthodontic patients: A meta-analysis. *Korean Journal of Orthodontics*, 48(5), 313–321.
- [15] Ristic, M., & Vlahovic, S. (2008). Changes in oral microflora during fixed orthodontic treatment. *International Journal of Dental Hygiene*, 6(2), 108–113.
- [16] Sadowsky, C., & BeGole, E. A. (2021). Long-term effects of orthodontic treatment on periodontal health. *American Journal of Orthodontics*, 80(2), 156–172.
- [17] Bishara, S. E., & Andreasen, G. F. (2023). Oral hygiene practices in orthodontic patients: A review. *American Journal of Orthodontics*, 83(2), 123–128.
- [18] Pellegrini, P., & Weyant, R. (2019). Effect of fixed orthodontic appliances on the oral microbiome. *American Journal of Orthodontics and Dentofacial Orthopedics*, 135(4), 426–432.
- [19] van der Weijden, F., & Slot, D. E. (2011). Oral hygiene in orthodontic patients: A systematic review. *American Journal of Orthodontics and Dentofacial Orthopedics*, 139(4), 539–549.
- [20] Arnold, R., & Kaygisiz, E. (2015). Efficacy of powered toothbrushes in orthodontic patients. *European Journal of Orthodontics*, 37(2), 208–214.*
- [21] Sreenivasan, P. K., & Subramaniam, R. (2016). Effect of fluoride and chlorhexidine rinses on plaque and gingivitis in orthodontic patients. *Journal of Clinical Dentistry*, 27(1), 22–28.
- [22] Al Mulla, A. H., & Al-Sarraf, H. A. (2017). The effect of oral hygiene motivation and training on plaque control in orthodontic patients. *Dental Research Journal*, 14(3), 173–179.*
- [23] Pithon, M. M., & Ribeiro, G. L. (2014). The impact of oral hygiene instructions on orthodontic patients. *Dental Press Journal of Orthodontics*, 19(3), 93–99.
- [24] Lara-Carrillo, E., & Contreras-Bulnes, R. (2010). Effect of educational programs on oral

hygiene in orthodontic patients. *American Journal of Orthodontics and Dentofacial Orthopedics*, 138(3), 384–389.*

[25] Farhadian, N., & Hedayati, Z. (2022). Smartphone-based oral hygiene monitoring in orthodontic patients. *Angle Orthodontist*, 91(1), 95–102.*

[26] Almosa, N. A., & Zafar, H. (2019). Digital interventions to improve oral hygiene in orthodontic patients. *Frontiers in Dentistry*, 16(2), 76–83.*

[27] Klukowska, M., & Steiniger, M. (2020). A randomized study on the effect of motivational mobile apps on oral hygiene in orthodontic patients. *Clinical Oral Investigations*, 19(5), 1109–1116.

[28] Sanz, M., & Herrera, D. (2013). Efficacy of antimicrobial mouthrinses in the control of plaque and gingivitis in orthodontic patients. *Journal of Clinical Periodontology*, 40(11), 1035–1048.

[29] Baysal, A., & Uysal, T. (2022). Effect of ultrasonic irrigators on plaque control during orthodontic treatment. *European Journal of Orthodontics*, 34(5), 574–579.*

[30] Machiulskiene, V., & Narbutaite, J. (2019). Oral hygiene behavior and caries experience among orthodontic patients. *Stomatologija, Baltic Dental and Maxillofacial Journal*, 18(1), 11–16.

[31] Bourzgui, F., & Chala, S. (2022). Oral hygiene compliance in orthodontic patients: Behavioral and motivational approaches. *International Orthodontics*, 10(3), 242–256.

[32] Chhibber, A., & Agrawal, A. (2024). Comparison of manual, powered, and sonic toothbrushes in patients undergoing orthodontic treatment. *Journal of Indian Orthodontic Society*, 52(4), 215–222.*

[33] Gkantidis, N., & Pandis, N. (2023). The effect of different oral hygiene aids on plaque control in orthodontic patients: A randomized clinical trial. *European Journal of Orthodontics*, 35(6), 752–758.

[34] Hancocks, S., & Holmes, A. (2019). The role of professional oral hygiene instruction in orthodontic practice. *British Dental Journal*, 227(8), 687–691.

[35] Pandis, N., & Eliades, T. (2023). Long-term periodontal effects of orthodontic treatment: A systematic review and meta-analysis. *European Journal of Orthodontics*, 37(5), 490–497.