ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2023; 9(3): 186-190

www.oraljournal.com
Received: 16-05-2023
Accepted: 20-06-2023

Reyna Devanhy Sierra Villarreal
Master's in Sciences Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Irene Meester
Professor, Universidad de Monterrey, Escuela de Medicina, Ciencias Basicas, San Pedro Garza Garcia, Nuevo Leon, 66238 ZIP, Mexico

Johnny Rylander Yamada
Professor, Universidad Veracruzana, Facultad de Odontología, Veracruz, Mexico

Teresita de Jesus Mendez Quevedo
Professor, Universidad Veracruzana, Facultad de Odontología, Veracruz, Mexico

Rosa Isela Sanchez Najera
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Rosendo Carrasco Gutierrez
Professor, Benemerita Universidad Autonoma de Puebla, Facultad de Estomatologia, Puebla, Puebla, Mexico

Estela del Carmen Velasco Leon
Professor, Benemérita Universidad Autonoma de Puebla, Facultad de Estomatologia, Puebla, Puebla, Mexico

Juan Manuel Solis Soto
Professor, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Corresponding Author:
Reyna Devanhy Sierra Villarreal
Master's in Sciences Student, Universidad Autonoma de Nuevo Leon, Facultad de Odontologia, Monterrey, Nuevo Leon, 64460 ZIP, Mexico

Prevotella intermedia, an orthodontic point of view

Reyna Devanhy Sierra Villarreal, Irene Meester, Johnny Rylander Yamada, Teresita de Jesus Mendez Quevedo, Rosa Isela Sanchez Najera, Rosendo Carrasco Gutierrez, Estela del Carmen Velasco Leon and Juan Manuel Solis Soto

DOI: https://doi.org/10.22271/oral.2023.v9.i3c.1807

Abstract
Introduction: Prevotella intermedia is a gram-negative obligate anaerobic bacterium that participates in the development of periodontal disease and is present in the bacterial biofilm of patients with fixed appliances.
Objective: To analyze the literature on virulence factors, diagnostic methods, treatment and relationship with other diseases of Prevotella intermedia in orthodontic patients.
Methodology: Articles on the subject published in the databases PubMed, EBSCO, Scopus, and Web of Science with publication dates in the last 5 years were analyzed. The search was carried out with the keywords: "Prevotella intermedia", "dentistry", "orthodontics", "virulence factors", "diagnostic methods", "treatment" and "systemic diseases".
Results: INP A protease is one of the most important virulence factors of the bacterium. The type of orthodontic appliance influences the alteration of the patient's subgingival microbiota and PCR is the most commonly used method for the detection of these microbial agents. Scaling and root planning remain the most effective treatment for periodontal disease. The presence of Prevotella intermedia may aggravate systemic diseases present in patients.
Conclusions: The biofilm of microbial agents in orthodontic patients favours the development of periodontal disease, due to the retentive areas of fixed appliances. It is therefore essential to maintain good oral hygiene, especially during orthodontic treatment.

Keywords: Prevotella intermedia, orthodontics, virulence factors, diagnostic methods, treatment, systemic diseases

1. Introduction
Prevotella is a group of anaerobic, gram-negative bacilli characterized by similarities in phenotype [1].
Prevotella intermedia (P. Intermedia) is one of the main periodontopathogens, part of the orange complex, which is the group of bacteria most closely related to periodontitis. The literature shows that its colonization is manifested by the presence of enlarged periodontal pockets [2, 3, 4].
Periodontitis is an inflammatory-infectious disease that is induced by subgingival biofilm and host response, initiated by bacterial colonization, including P. intermedia [3, 5]. This disease can be associated with systemic conditions, including adverse pregnancy outcomes, cardiovascular disease, type 2 diabetes mellitus, respiratory disorders, fatal pneumonia in hemodialysis patients, chronic kidney disease and metabolic syndrome [6, 7].
Regarding the orthodontic area, fixed appliances that are used for the correction of malocclusions influence the oral microbiota with an increase in the counts of Streptococcus mutans, Lactobacillus spp and in the percentage of potentially pathogenic gram-negative bacteria. This bacterial increase is caused by the accumulation of dental plaque in fixed appliances and its virulence factors, orthodontic treatment can cause anything from mild transient gingival inflammation to periodontitis [7].
P. Intermedia is present in large numbers during orthodontic treatment. At present, there are not enough review articles to evaluate the consequences of this bacterium in orthodontic

therapy,
therefore, the aim of this article is to review and analyze the literature about P. intermedia in orthodontic treatment, particularly the virulence factors, methods of diagnosis and treatment; as well as, the relationship of the bacterium with other diseases.

2. Materials and Methods

Articles on the subject published through the PubMed, Scopus and Google Scholar databases were analyzed, with emphasis on the last 5 years. The quality of the articles was evaluated using guidelines, i.e., identification, review, choice and inclusion. The quality of the reviews was assessed using the measurement tool for evaluating systematic reviews. The search was performed using Boolean logical operators AND, OR and NOT, with the keywords: "Prevotella intermedia", "dentistry", "orthodontics", "virulence factors", "diagnostic methods", "treatment" and "systemic diseases".

3. Results and Discussion

3.1 Virulence Factors

P. intermedia expresses a 90 kDa cysteine protease called interpain A (inpA) that oxidizes and subsequently degrades haemoglobin, releasing heme, which is a requirement for the growth, survival and virulence of this bacterium [8]. Adhesion, competition with surrounding microbes and horizontal gene transfer are the main driver of Prevotella intermedia evolution [9].

Virulence factors of periodontal pathogens, including P. intermedia, stimulate the secretion of inflammatory cytokines, causing chronic systemic inflammation [10]. Estradiol was found to significantly increase the bacterial dipeptidyl peptidase IV enzyme activities of the eight Prevotella strains, this being a virulence factor contributing to the pathogenesis of pregnancy-related gingivitis [11]. The virulence genes inpA, csxA, fadA and bspA have potential effects on cellular gene expression in patients with oral squamous cell carcinoma [12].

P. Intermedia and P. Nigrescens have highly dynamic genomes, strains at sites of infection release virulence factors related to the synthesis of capsules, lipopolysaccharides, secretion systems, proteinases and toxins. P. intermedia nucleases allow evasion of host neutrophil extracellular traps, which increases its pathogenicity [13, 14].

Periodontal pathogens in general have a wide variety of virulence factors such as lipopolysaccharides, fimbriae and proteases, which allow them to infect periodontal tissues. This is why P. intermedia, Fusobacterium nucleatum, Treponema denticola and Campylobacter rectus can cause mild and transient gingival inflammation during fixed appliance treatment [7].

The production of viscous polysaccharides (EPS) is considered one of the major virulence factors, however, they have been shown in experimental practices with rats to cause abscess formation [3].

P. intermedia presents multiple virulence factors such as proteases, enzymes, lipopolysaccharides, fimbriae and toxins that help to invade and infect humans, being INP A protease one of the most important factors of the bacterium. This bacterium is associated with periodontal diseases such as gingivitis, which is frequently seen in patients undergoing orthodontic treatment.

3.2 Diagnostic methods

The association between periodontitis and cardiovascular disease is partially mediated by the immune response of periodontal pathogens, including P. Intermedia, Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Porphyromonas endodontics, Tannerella forsythia, C. Rectus and Fusobacterium nucleatum, this was determined by DNA-DNA hybridization [15].

Through bacterial culture, PCR-based evaluation, hybridization techniques, pyrosequencing and transcriptomic analysis, A. actinomycetemcomitans and P. Intermedia have been detected in peri-implantitis biofilms compared to healthy implants [16].

Real-time polymerase chain reaction (qPCR) helps to detect periodontal pathogens including P. Gignivalis, A. actinomycetemcomitans, T. Forsythia, Treponema denticola and P. intermedia in the microflora of periodontal pockets and gingival fluid [17, 18].

Internal LiPA has a high specificity and sensitivity for detecting major periodontal pathogens. In one study, LiPA and PCR diagnostic methods were performed, and no remarkable differences were observed [19]. The presence of bacteria in deep pockets of patients with periodontitis has been confirmed by anaerobic culture and nucleic acid amplification [20]. There is an in-office bacterial test (CST) that can detect P. intermedia and other typical periodontal pathogens, with a somewhat lower sensitivity than qPCR, which can be classified as "good" [21].

The "OralDisk" test includes bacterial DNA extraction, purification and detection by hydrolysis probe qPCR of ten periodontal pathogens, including P. intermedia. Comparison of this test with the laboratory reference method reveals 90% agreement between targets detected as positive and negative [22].

In one study, deboned brackets and aligners rinsed after 30 days of use were stored and processed for analysis with checkerboard DNA-DNA hybridization. Fusobacterium periodontium and P. intermedia were found in higher percentages in the fixed labial appliance, and microbial contamination in metal brackets was higher than in aligners [23]. The type of orthodontic appliance influences the subgingival microbiota, which is why the total bacterial load was determined by qPCR, which increased in the fixed appliance group and was maintained in the aligner group [24].

In another study, brackets were collected from maxillary and mandibular central incisors after being debonded and adhesions of A. Actinomycetemcomitans, P. Gingivalis, P. Intermedia, Fusobacterium nucleatum (F. Nucleatum) and T. forsythia were determined by qPCR [25].

Conclusion: Currently, there are several methods that help us to detect the presence of P. intermedia in the oral cavity of patients, however, real-time polymerase chain reaction is the most complete, reliable and widely used method for the detection of periodontal pathogens. The type of orthodontic appliance influences the alteration of the patient's subgingival microbiota, with aligners being the most hygienic of all.

3.3 Treatment

Scaling and root planing (SRP) is the standard non-surgical procedure for periodontal disease, the focus is on removing bacterial deposits and reversing the inflammatory process [26].

Lascufloxacin has high efficacy against S. pneumoniae and P. intermedia, for the treatment of pneumonia [27]. Treatments of systemic metronidazole 400mg plus amoxicillin 500mg and antimicrobial photodynamic therapy (aPDT) significantly improved the effects of SRP in smoker patients with periodontitis [28]. Similarly, aPDT promotes additional clinical

benefits in uncompensated diabetic patients [29]. It has been reported that 1000 μA of direct current can kill P. Gingivalis and P. Intermedia by promoting the overproduction of reactive oxygen species [3]. A high pulse power neodymium-doped yttrium aluminium garnet laser monotherapy before the surgical protocol of periodontal treatment reduces almost 60% of periodontal pathogens of the red/orange complex [30].

The use of probiotics in pregnant patients helps to reduce inflammatory indices; and they function as very good adjuvants to periodontal therapy, reducing P. Gingivalis, T. Forsythia, T. Denticola, P. Intermedia and A. Actinomycetemcomitans [1, 31]. Within the diversity of oral probiotics, Weissella cibaria CMU and CMS1 inhibit biofilm formation by reducing bacterial species and Limosilactobacillus fermentum ALAL020 shows higher antibacterial activity against P. gingivalis and P. Intermedia [32, 33].

Chlorhexidine at 0.12% and ethanolic extract of propolis type 3 at 3% decrease the count of gram-negative and positive microorganisms [34]. Tetracycline hydrochloride dissolved in distilled water, saline and 2% lidocaine with epinephrine is used as an antiseptic adjuvant for inhibition of F. Nucleatum, P. Intermedia and P. Gingivalis [35].

The application of orthodontic appliances makes oral hygiene difficult and increases plaque accumulation, which often leads to gingival inflammation, especially lingual appliances, followed by labial appliances and finally aligners [23, 36].

P. intermedia levels decreased 13 weeks after fixed appliance debonding [37]. Photodynamic therapy as an adjunct to SRP helps to improve clinical gingival parameters in adolescent patients undergoing orthodontic treatment with fixed appliances [38].

SRP is the most effective treatment for periodontal diseases; however, there are effective adjuvants such as 0.12% chlorhexidine rinses, 3% ethanolic extract of propolis, oral probiotics, among others, to complement this treatment. Orthodontic patients experience alteration of microbial agents, so it is of vital importance to maintain good oral hygiene.

3.4 Relationship of Prevotella Intermedia with other diseases

Alteration of the gut microbiota composition by orally derived periodontal pathogenic bacteria is the causative mechanism for the relationship between periodontitis and liver disease [39].

P. intermedia may influence cognitive impairment in Alzheimer's disease, as it can trigger pathological changes in the brain that resemble and/or induce the accumulation of Aβ peptides and promote tau hyperphosphorylation [40]. A study detected that a high rate of periodontal pathogens such as A. actinomycetemcomitans, P. intermedia and Fusobacterium spp in patients with chronic generalized periodontitis significantly increases the risk of coronary artery disease [41].

P. intermedia and bacterial species associated with periodontal disease are enriched in the supragingival microbiota of women with suboptimal vaginal communities, so there is a relationship between oral and vaginal dysbiosis [21]. During pregnancy, there is the growth of some pathogenic bacteria, including A. actinomycetemcomitans, F. Nucleatum and selective growth of P. Intermedia, P. Gingivalis and T. Forsythia, because these bacteria use progesterone as a source of nutrition, which favours the development of periodontal disease [1, 42].

In patients with oral squamous cell carcinoma, the diversity of oral bacteria was found to be significantly higher in tumour sites than in normal patient tissues [43].

P. Gingivalis, T. Forsythia and P. Intermedia are involved in the pathogenesis of rheumatoid arthritis, as these are often detected in the synovial fluid of these patients [10]. Elevated levels of P. intermedia have also been found to be associated with the presence of severe asthma and impaired thyroid function [44, 45].

P. intermedia is mainly found in the oral cavity, however, it is associated with various systemic diseases. Because of this, it is of utmost importance to pay attention to the maintenance of good oral hygiene to avoid the aggravation of these diseases.

4. Conclusions

P. Intermedia is one of the main periodontopathogens involved in periodontal disease. This gram-negative anaerobic bacterium presents virulence factors that allow it to infect humans. It has been found mainly by means of qPCR that P. intermedia and other pathogens favour the development of gingivitis in patients with fixed appliances; SRP being the most effective treatment to treat this condition; there are several coadjutants methods such as oral probiotics that in patients with orthodontics would be very useful to maintain good oral hygiene. The presence of P. intermedia in patients with other diseases can aggravate their systemic condition.

5. Conflict of Interest

Not available

6. Financial Support

Not available

7. References

1. Kottrashetti VS, Bhat KG, Kugaji MS, Naik SS, Tanakanti P. Simultaneous detection and evaluation of *Prevotella intermedia, Prevotella nigrescens, Prevotella loescheii,* and *Prevotella melaninogenica* in subgingival plaque samples of chronic periodontitis and healthy individuals through multiplex polymerase chain reaction. J Indian Soc Periodontol. 2023 May-Jun;27(3):283-289.
2. Seo BY, Son K, Son YT, Dahal RH, Kim S, Kim J, *et al*. Influence of Dental Titanium Implants with Different Surface Treatments Using Femtosecond and Nanosecond Lasers on Biofilm Formation. J Funct Biomater. 2023 May 26;14(6):297.
3. Kwack KH, Jang EY, Yang SB, Lee JH, Moon JH. Genomic and phenotypic comparison of *Prevotella intermedia* strains possessing different virulence *in vivo*. Virulence. 2022 Dec;13(1):1133-1145.
4. Zou P, Cao P, Liu J, Li P, Luan Q. Comparisons of the killing effect of direct current partially mediated by reactive oxygen species on *Porphyromonas gingivalis* and *Prevotella intermedia* in planktonic state and biofilm state – an *in vitro* study. J Dent Sci. 2022 Jan;17(1):459-467.
5. Cong S, Tong Q, Peng Q, Shen T, Zhu X, Xu Y, *et al*. *In vitro* antibacterial activity of diosgenin on Porphyromonas gingivalis and Prevotella intermedia. Mol Med Rep. 2020 Dec;22(6):5392-5398.
6. Fischer RG, Lira Junior R, Retamal-Valdes B, Figueiredo LC, Malheiros Z, Stewart B, *et al*. Periodontal disease and its impact on general health in Latin America. Section V: Treatment of periodontitis. Braz Oral Res. 2020 Apr 9;34(supp1 1):e026.
7. Guo R, Liu H, Li X, Yang Q, Jia L, Zheng Y, *et al*. Subgingival microbial changes during the first 3 months of fixed appliance treatment in female adult Patients.

Curr Microbiol. 2019 Feb;76(2):213-221.
8. Byrne DP, Manandhar SP, Potempa J, Smalley JW. Breakdown of albumin and haem albumin by the cysteine protease interpain A, an albuminase of Prevotella intermedia. BMC Microbiol. 2015 Sep 24;15:185.
9. Ruan Y, Shen L, Zou Y, Qi Z, Yin J, Jiang J, *et al*. Comparative genome analysis of Prevotella intermedia strain isolated from infected root canal reveals features related to pathogenicity and adaptation. BMC Genomics. 2015 Feb 25;16(1):122.
10. Du Q, Ma X. [Research progress of correlation between periodontal pathogens and systemic diseases]. Nan Fang Yi Ke Da Xue Xue Bao. 2020 May 30;40(5):759-764.
11. Fteita D, Könönen E, Gürsoy M, Söderling E, Gürsoy UK. Does estradiol have an impact on the dipeptidyl peptidase IV enzyme activity of the Prevotella intermedia group bacteria? Anaerobe. 2015 Dec;36:14-8.
12. Moghimi M, Bakhtiari R, Mehrabadi JF, Jamshidi N, Jamshidi N, Siyadatpanah A, *et al*. Interaction of human oral cancer and the expression of virulence genes of dental pathogenic bacteria. Microb Pathog. 2020 Dec;149:104464.
13. Doke M, Fukamachi H, Morisaki H, Arimoto T, Kataoka H, Kuwata H. Nucleases from Prevotella intermedia can degrade neutrophil extracellular traps. Mol Oral Microbiol. 2017 Aug;32(4):288-300.
14. Zhang Y, Zhen M, Zhan Y, Song Y, Zhang Q, Wang J. Population-Genomic Insights into Variation in *Prevotella intermedia* and *Prevotella nigrescens* Isolates and Its Association with Periodontal Disease. Front Cell Infect Microbiol. 2017 Sep 21;7:409.
15. Liljestrand JM, Paju S, Pietiäinen M, Buhlin K, Persson GR, Nieminen MS, *et al*. Immunologic burden links periodontitis to acute coronary syndrome. Athero-sclerosis. 2018 Jan;268:177-184.
16. Sahrmann P, Gilli F, Wiedemeier DB, Attin T, Schmidlin PR, Karygianni L. The Microbiome of Peri-Implantitis: A Systematic Review and Meta-Analysis. Microorganisms. 2020 May 1;8(5):661.
17. Ito T, Mori G, Oda Y, Hirano T, Sasaki H, Honma S, *et al*. Clinical evaluation of periodontal pathogen levels by real-time polymerase chain reaction in peri-implantitis patients. Int J Implant Dent. 2021 Oct 6;7(1):105.
18. Bakhareva VY, Margaryan EG, Selifanova EI, Makeeva IM. Issledovanie mikroflory I opredelenie kachestvennogo sostava parodontopatogenov metodom PTsR u patient s kariesom dementia I naruzhnoi tservikal'noi rezorbtsiei [Research on microflora and the qualitative composition of periodontal pathogens by PCR method in patients with root caries and external cervical resorption]. Stomatologiia (Mosk). 2021;100(6):19-23.
19. Soleimani M, Zolfaghari MR. Development and Comparison of in-house line probe assay (LiPA) and SYBR Green Real-time PCR Regarding the Detection of Periodontal Pathogens. Avicenna J Med Biotechnol. 2019 Jan-Mar;11(1):80-87.
20. Jepsen K, Falk W, Brune F, Fimmers R, Jepsen S, Bekeredjian-Ding I. Prevalence and antibiotic susceptibility trends of periodontal pathogens in the subgingival microbiota of German periodontitis patients: A retrospective surveillance study. J Clin Periodontol. 2021 Sep;48(9):1216-1227.
21. Arweiler NB, Marx VK, Laugisch O, Sculean A, Auschill TM. Clinical evaluation of a newly developed chairside test to determine periodontal pathogens. J Periodontol. 2020 Mar;91(3):387-395.
22. Baumgartner D, Johannsen B, Specht M, Lüddecke J, Rombach M, Hin S, *et al*. Oral Disk: A chair-side compatible molecular platform using whole saliva for monitoring oral health at the dental practice. Biosensors (Basel). 2021 Oct 28;11(11):423.
23. Gujar AN, Al-Hazmi A, Raj AT, Patil S. Microbial profile in different orthodontic appliances by checkerboard DNA-DNA hybridization: An *in-vivo* study. Am J Orthod Dentofacial Orthop. 2020 Jan;157(1):49-58.
24. Lombardo L, Palone M, Scapoli L, Siciliani G, Carinci F. Short-term variation in the subgingival microbiota in two groups of patients treated with clear aligners and vestibular fixed appliances: A longitudinal study. Orthod Craniofac Res. 2021 May;24(2):251-260.
25. Jung WS, Kim K, Cho S, Ahn SJ. Adhesion of periodontal pathogens to self-ligating orthodontic brackets: An in-vivo prospective study. Am J Orthod Dentofacial Orthop. 2016 Sep;150(3):467-75.
26. Butera A, Gallo S, Pascadopoli M, Maiorani C, Milone A, Alovisi M, *et al*. Paraprobiotics in Non-Surgical Periodontal Therapy: Clinical and Microbiological Aspects in a 6-Month Follow-Up Domiciliary Protocol for Oral Hygiene. Microorganisms. 2022 Feb 1;10(2):337.
27. Hagihara M, Kato H, Shibata Y, Sakanashi D, Asai N, Suematsu H, *et al*. *In vivo* pharmacodynamics of lascufloxacin and levofloxacin against Streptococcus pneumoniae and Prevotella intermedia in a pneumonia mixed-infection mouse model. Anaerobe. 2021 Jun;69:102346.
28. Theodoro LH, Assem NZ, Longo M, Alves MLF, Duque C, Stipp RN, *et al*. Treatment of periodontitis in smokers with multiple sessions of antimicrobial photodynamic therapy or systemic antibiotics: A randomized clinical trial. Photodiagnosis Photodyn Ther. 2018 Jun;22:217-222.
29. Cláudio MM, Nuernberg MAA, Rodrigues JVS, Belizário LCG, Batista JA, Duque C, *et al*. Effects of multiple sessions of antimicrobial photodynamic therapy (aPDT) in the treatment of periodontitis in patients with uncompensated type 2 diabetes: A randomized controlled clinical study. Photodiagnosis Photodyn Ther. 2021 Sep;35:102451.
30. McCawley TK, McCawley MN, Rams TE. The immediate effect of Nd: YAG laser monotherapy on subgingival periodontal pathogens: A pilot clinical study. J Periodontal Implant Sci. 2022 Feb;52(1):77-87.
31. Villafuerte KRV, Martinez CJH, Nobre AVV, Maia LP, Tirapelli C. What are microbiological effects of the adjunctive use of probiotics in the treatment of periodontal diseases? A systematic review. Benefit Microbes. 2021 Aug 30;12(4):1-13.
32. Kang MS, Park GY. *In vitro* Evaluation of the Effect of Oral Probiotic *Weissella cibaria* on the Formation of Multi-Species Oral Biofilms on Dental Implant Surfaces. Microorganisms. 2021 Nov 30;9(12):2482.
33. Kawai T, Ohshima T, Tanaka T, Ikawa S, Tani A, Inazumi N, *et al*. *Limosilactobacillus* (*Lactobacillus*) *fermentum* ALAL020, a Probiotic Candidate Bacterium, Produces a Cyclic Dipeptide That Suppresses the Periodontal Pathogens *Porphyromonas gingivalis* and *Prevotella intermedia*. Front Cell Infect Microbiol. 2022 Mar 7;12:804334.
34. de Faveri M, Pupio GC, Koo H, Bueno-Silva B, de Oliveira KM, Figueiredo LC, *et al*. The effect of Brazilian propolis type-3 against oral microbiota and volatile sulfur compounds in subjects with morning

breath malodor. Clin Oral Investing. 2022 Feb;26(2):1531-1541.
35. Escalante-Herrera A, Chaves M, Villamil JC, Roa NS. *In vitro* assessment of the antimicrobial activity of tetracycline hydrochloride diluted in three different vehicles against *Porphyromonas gingivalis*, *Prevotella intermedia*, and *Fusobacterium nucleatum*. J Indian Soc Periodontol. 2022 Mar-Apr;26(2):104-109.
36. Calniceanu H, Stratul SI, Rusu D, Jianu A, Boariu M, Nica L, *et al*. Changes in clinical and microbiological parameters of the periodontium during initial stages of orthodontic movement in patients with treated severe periodontitis: A longitudinal site-level analysis. Exp Ther Med. 2020 Dec;20(6):199.
37. Kim K, Jung WS, Cho S, Ahn SJ. Changes in salivary periodontal pathogens after orthodontic treatment: An *in vivo* prospective study. Angle Orthod. 2016 Nov;86(6):998-1003.
38. Kamran MA. Clinical, microbiological and immunological outcomes with photodynamic therapy as an adjunct to full-mouth scaling in patients undergoing fixed orthodontic treatment. Photodiagnosis Photodyn Ther. 2020 Mar;29:101585.
39. Rinčić G, Gaćina P, Virović Jukić L, Rinčić N, Božić D, Badovinac A. Association between periodontitis and liver disease. Acta Clin Croat. 2022 Feb;60(3):510-518.
40. Piekut T, Hurła M, Banaszek N, Szejn P, Dorszewska J, Kozubski W, *et al*. Infectious agents and Alzheimer's disease. J Integr Neurosci. 2022 Mar 28;21(2):73.
41. Hodovana OI, Skybchyk OV, Solomenchuk TM, Rumynska TM. Assessment of the microbial content of periodontal pockets in patients with chronic generalized periodontitis and coronary artery disease. Wiad Lek. 2021;74(10 pt 1):2428-2432.
42. Balle C, Esra R, Havyarimana E, Jaumdally SZ, Lennard K, Konstantinus IN, *et al*. Relationship between the Oral and Vaginal Microbiota of South African Adolescents with High Prevalence of Bacterial Vaginosis. Micro-organisms. 2020 Jul 4;8(7):1004.
43. Zhang L, Liu Y, Zheng HJ, Zhang CP. The Oral Microbiota May Have Influence on Oral Cancer. Front Cell Infect Microbiol. 2020 Jan 15;9:476.
44. Lopes MP, Cruz ÁA, Xavier MT, Stöcker A, Carvalho-Filho P, Miranda PM, *et al*. Prevotella intermedia and periodontitis are associated with severe asthma. J Periodontol. 2020 Jan;91(1):46.
45. Dong T, Xu S, Chen ZY, Liang YJ, Meng XQ, Niu CG, *et al*. *Prevotella intermedia* Aggravates Subclinical Hypothyroidism. J Dent Res. 2023 Jul;102(7):814-824.

How to Cite This Article
Villarreal RDS, Meester I, Yamada JR, Quevedo TDJM, Najera RIS, Gutierrez RC, Leon EDCV, Soto JMS. Prevotella intermedia, an orthodontic point of view. International Journal of Applied Dental Sciences. 2023;9(3):186-190.