

The oral-brain axis

Neesha Patel¹

Dementia is at the forefront of global public health challenges, with approximately 10 million new cases diagnosed worldwide every year, according to World Health Organization (WHO). As a clinical syndrome, it is characterised by a gradual deterioration of cognitive skills including language, spatial perception, memory, orientation, learning capacity and mathematical reasoning affecting the older generation (WHO, 2022).

In 2019, an estimated 57 million people worldwide were living with dementia, of which Alzheimer's and other types of dementia are the most common forms (Livingston et al, 2020).

This number is expected to triple by 2050, highlighting the increasing burden of dementia and related disorders (Livingston et al, 2020).

Studies show a strong association between periodontal disease and dementia, with both conditions sharing common inflammatory markers and biological pathways. Understanding this link is crucial as both diseases disproportionately affect older adults, increasing their susceptibility to systemic and cognitive decline.

More importantly, since periodontal disease is largely preventable and can be managed through early intervention and oral health management, addressing this may offer a modifiable pathway to mitigate dementia risk or its progression rate.

This article will explore the potential connection between dementia and periodontal disease and outline the common inflammatory and microbiological processes that underline these disorders by examining epidemiological and clinical evidence supporting the associations. Practical implications for dental professionals in promoting periodontal care to support systemic and cognitive health will also be discussed.

Pathophysiology: a shared inflammatory pathway

Periodontal disease is a chronic oral biofilm-mediated infection, which leads to a progressive destruction of the periodontium and even tooth loss if left untreated.

While the oral health impact of periodontitis is well-established in dentistry, its systematic effects are gaining significant focus due to emerging evidence linking chronic oral infections to a range of systemic health conditions.

Of particular significance is the emerging concept of oral-brain axis that describes the bidirectional link between periodontal health and the brain, where dysbiosis or imbalances in oral microbiota can influence brain functions and vice versa (Narengaowa et al, 2021).

Biological pathways linking shared-inflammatory response between periodontitis and neurodegenerative conditions like dementia is central to this understanding.

¹ Dr Neesha Patel
BSC HONS BDS MFGDP
MCLINDENT PERIO
MRD RCS (EDIN)
Neesha is a specialist periodontist
and clinical director at Pure
Periodontics in London.

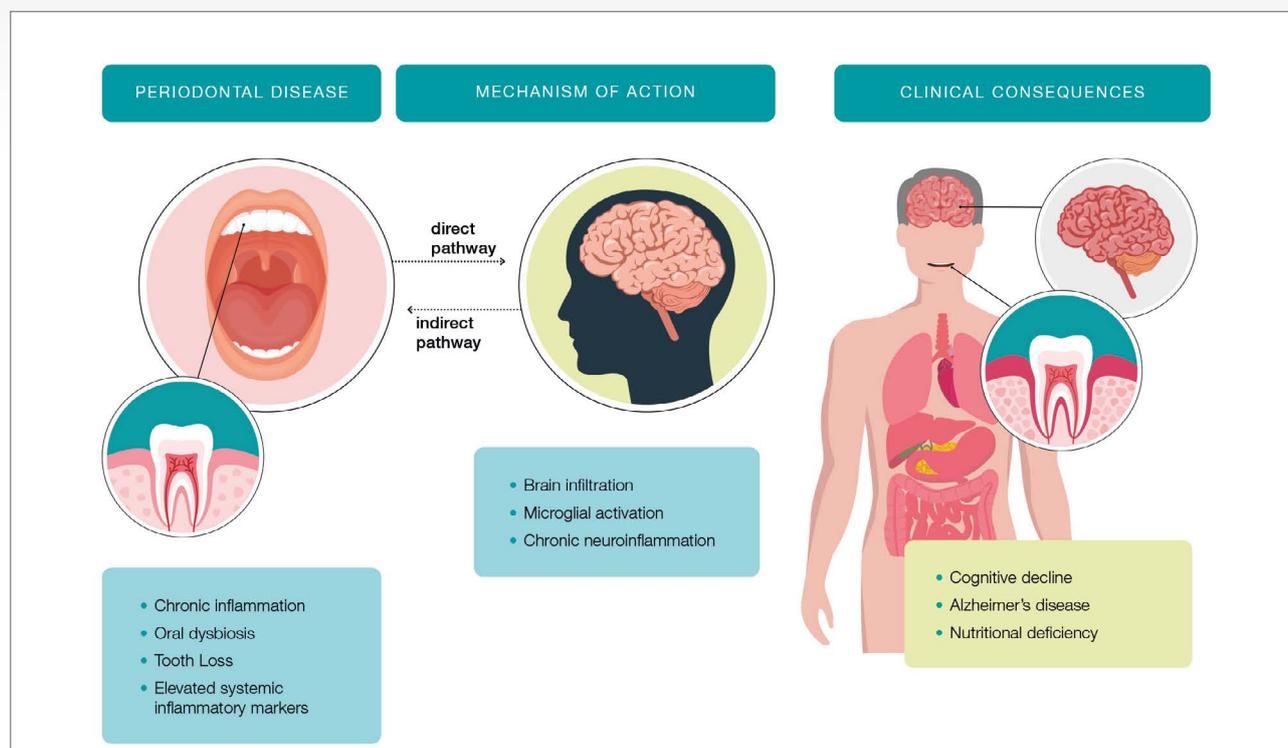


Figure 1: Dementia and periodontal health

Research shows pro-inflammatory cytokines which are characteristic of periodontal disease such as interleukin- 1β (IL- 1β), interleukin-6 (IL-6), and tumour necrosis factor-alpha (TNF- α), are released into the bloodstream in adults with compromised periodontal health (Singhrao et al, 2014). This activates pathways that contribute to a pro-inflammatory environment in the brain and is linked to a range of cognitive dysfunctions including Alzheimer's disease (Seyedmoalemi and Saied-Moallemi, 2025).

Similarly, Alzheimer's disease is now understood to have significant inflammatory and microbial components with evidence of periodontal pathogens such as *Porphyromonas gingivalis* in the brains of individuals with Alzheimer's disease (Kanagasingam et al, 2020).

While the precise role of *P. gingivalis* in the development of Alzheimer's and its underlying mechanisms are still being established, these findings support the relation between chronic oral infections and the development of neurodegenerative processes.

Evidence also suggests Herpes simplex virus type 1 (HSV-1) may contribute to the pathogenesis of Alzheimer's disease through mechanisms such as oxidative stress, dysfunction of

the mitochondria and initiation of chronic inflammatory response. Moreover, HSV-1 may act synergistically with periodontal pathogens, further exacerbating cognitive decline (Teixeira et al, 2017).

Microbial mechanism and neuroinflammation

Microbial mechanism exploring the role of oral pathogens provide insight into the direct and indirect biological pathways linking periodontal disease and dementia.

Emerging evidence highlights the spread of periodontal pathogens from the oral cavity to the central nervous systems, crossing the blood-brain barrier through hematogenous spread (via the bloodstream), and through neural pathways (via cranial nerves) (Li et al, 2022).

Once in the brain, these pathogens can directly affect the brain tissue, triggering an immune response, releasing neurotoxic mediators, causing inflammation and damaging neurons.

A number of reviews have identified neuroinflammation induced by periodontal pathogens such as *P. gingivalis* as a factor for the development and progression of Alzheimer's disease (Olsen, 2021; Shawkatova et al, 2025).

Studies also highlight wider systemic inflammation triggered by periodontal infections as indirect mechanisms that exacerbate neurodegenerative conditions (Seyedmoalemi and Saied-Moallemi, 2025). For example, chronic periodontitis causes elevation of key inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6) in the bloodstream (Shen et al, 2019).

Such pro-inflammatory cytokines, which are commonly found in periodontal disease, can prime the brain's immune cells (ie microglia), making them more reactive to inflammatory stimuli. This makes the cells more susceptible to aggravated neurodegeneration and subsequent dementia, even in the absence of direct bacterial invasion of the brain (Teixeira et al, 2017).

Epidemiological evidence

A number of longitudinal and cross-sectional studies have identified associations between periodontal disease and cognitive decline.

Elevated levels of periodontal disease antibodies have been detected in individuals years before the onset of cognitive symptoms, indicating that periodontal destruction may precede and subsequently contribute to the risk of dementia onset and progression (Sparks et al, 2012).

In addition, a recent systematic review has identified a strong association between periodontal disease severity and dementia with a higher Alzheimer's dementia risks in adults with severe periodontitis (Kim and Han, 2025).

The risk increasing effect of periodontal disease is found to be high even among individuals with otherwise healthy behaviours, including those who never smoked or consumed alcohol, highlighting the importance of early periodontal intervention in management of dementia risk (Choi et al, 2019).

Other studies identify tooth loss, which is a marker of periodontal disease severity, and its association to dementia risk. A dose-dependent relation between tooth loss and cognitive decline has been established with a 1.1% increased dementia risk and 1.4% increase in cognitive decline for each tooth lost (Qi et al, 2021).

Although, the exact reason for this association is unclear, tooth loss may indicate a history of chronic oral inflammation and infection, which contributes to a sustained systemic inflammatory burden over time.

In addition, tooth loss also affects diet, nutrition and social engagement, all of which are recognised risks for cognitive decline (Cerutti-Kopplin et al, 201). Therefore, preserving periodontal health may serve as important mediating factor

for reducing dementia risk.

Moreover, preventive periodontal care may also decrease mortality risks in older adults with dementia, highlighting the broader benefits of oral health care in ageing populations (Cho et al, 2024).

Clinical and public health implications

The growing body of evidence linking periodontal disease and dementia care has significant implication for both public health practice and clinical dentistry.

With an increasingly ageing population and growing rates of dementia globally and in the UK, delivering timely intervention by identifying modifiable risk factors remains critical. Therefore, addressing periodontal health and offering timely support and treatment could offer practical strategies for supporting healthy ageing and reducing the risk of dementia onset and progression.

Preventive therapy for periodontal care, including routine oral hygiene assessment, regular scale and polishing and effective home care routine remains critical for management of periodontal disease.

These treatment approaches not only improve oral health, but they can also lead to reduction of systemic inflammation and microbiological load associated to dementia related cognitive decline. Furthermore, reduction in periodontal disease risk and severity, along with the retention of natural dentition, may also facilitate adequate nutrition intake essential for managing general health and wellbeing in older adults.

A shared-responsibility strategy involving multidisciplinary care remains critical. As oral health is often identified as low priority in the boarder management of dementia and deferred until issues arise, difficulties in accessing preventive and timely care is common. This reactive approach can increase the risk of avoidable oral issues, discomfort and functional decline.

Collaborative strategies involving dental professionals along with general practitioners, carers and memory clinic team are essential for a more proactive management of oral health.

In individuals with dementia, tailored preventive strategies can support ongoing oral function, reduce dental pain and minimise risks of acute dental issues that are more difficult to manage in more advanced disease stages.

Equally, early identification of at-risk patients and offering timely periodontal care management may offer useful long-term benefits for both oral and cognitive health in patients.

Conclusion

The link between periodontal disease and dementia is a significant area of scientific investigation and clinical interest that bridges oral and neurological health. The shared inflammatory and microbiological pathways underscore the importance of offering comprehensive solutions to manage systemic inflammation through oral health care.

As the evidence base exploring the dementia-oral health nexus continues to emerge, it is important for the dental team to recognise periodontal diseases as a systemic inflammatory disorder with neurocognitive implications.

Dental care professionals are uniquely positioned to identify early signs of cognitive decline, deliver tailored care and support multidisciplinary collaboration to manage oral health in patients.

By prioritising preventive oral health care strategies, dental practitioners can contribute to meaningful efforts to reduce the disease burden of dementia in individuals and the society.

References

Cerutti-Kopplin D, Feine J, Padilha DM, de Souza RF, Ahmadi M, Rompré P, Booij L, Emami E (2016) Tooth loss increases the risk of diminished cognitive function: a systematic review and meta-analysis. *JDR Clin Transl Res* 1(1): 10-19

Cho HA, Kim BR, Shin H (2024) Association of periodontal disease treatment with mortality in patients with dementia: a population-based retrospective cohort study (2002-2018). *Sci Rep* 14: 5243

Choi S, Kim K, Chang J, Kim SM, Kim SJ, Cho HJ, Park SM (2019) Association of chronic periodontitis with Alzheimer's disease or vascular dementia. *J Am Geriatr Soc* 67: 1234-1239

Kanagasingham S, Chukkapalli SS, Welbury R, Singhrao SK (2020) Porphyromonas gingivalis is a strong risk factor for Alzheimer's disease. *J Alzheimers Dis Rep* 4(1): 501-511

Kim DH, Han GS (2025) Periodontitis as a risk factor for dementia: a systematic review and meta-analysis. *J Evid Based Dent Pract* 25(2): 102094

Livingston G, Huntley J, Sommerlad A, Ames D, Ballard C, Banerjee S, Brayne C, Burns A, Cohen-Mansfield J, Cooper C, Costafreda SG, Dias A, Fox N, Gitlin LN, Howard R, Kales HC, Kivimäki M, Larson EB, Ogunniyi A, Orgeta V, Ritchie K, Rockwood K, Sampson EL, Samus Q, Schneider LS, Selbæk G, Teri L, Mukadam N (2020) Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *Lancet* 5(12): e661-e712

Li X, Kiprowska M, Kansara T, Kansara P, Li P (2022) Neuroinflammation: a distal consequence of periodontitis. *J*

Dent Res 101(12): 1441-1449

Narengaowa, Kong W, Lan F, Awan UF, Qing H, Ni J (2021) The oral-gut-brain axis: the influence of microbes in Alzheimer's disease. *Front Cell Neurosci* 15: 633735

Olsen I (2021) Porphyromonas gingivalis-induced neuroinflammation in Alzheimer's disease. *Front Neurosci* 15: 691016

Seyedmoalemi MA, Saied-Moallemi Z (2025) Association between periodontitis and Alzheimer's disease: a narrative review. *IBRO Neurosci Rep* 18: 360-365

Shawkatova I, Durmanova V, Javor J (2025) Alzheimer's disease and Porphyromonas gingivalis: exploring the links. *Life* 15: 96

Shen X, Niu L, Wang Y, et al (2019) Inflammatory markers in Alzheimer's disease and mild cognitive impairment: a meta-analysis and systematic review of 170 studies. *J Neurol Neurosurg Psychiatry* 90: 590-598

Singhrao SK, Harding A, Simmons T, Robinson S, Kesavalu L, Crean S (2014) Oral inflammation, tooth loss, risk factors, and association with progression of Alzheimer's disease. *J Alzheimers Dis* 42(3): 723-737

Sparks Stein P, Steffen MJ, Smith C, Jicha G, Ebersole JL, Abner E, Dawson D 3rd (2012) Serum antibodies to periodontal pathogens are a risk factor for Alzheimer's disease. *Alzheimers Dement* 8(3): 196-203

Teixeira FB, Saito MT, Matheus FC, Prediger RD, Yamada ES, Maia CSF, Lima RR (2017) Periodontitis and Alzheimer's disease: a possible comorbidity between oral chronic inflammatory condition and neuroinflammation. *Front Aging Neurosci* 9: 327

Qi X, Zhu Z, Plassman BL, Wu B (2021) Dose-response meta-analysis on tooth loss with the risk of cognitive impairment and dementia. *J Am Med Dir Assoc* 22(10): 2039-2045

WHO (2025) Dementia. World Health Organization. Available at: www.who.int/news-room/fact-sheets/detail/dementia (Accessed: 23 July 2025)

WHO (2022) International Classification of Diseases 11th Revision (ICD-11). World Health Organization. Available at: <https://www.who.int/standards/classifications/classification-of-diseases> (Accessed: 23 July 2025)

This article first appeared in Clinical Dentistry and has been reprinted with permission. Patel N. (2025) The oral-brain axis. Clinical Dentistry 5(9): 69-72