AUCTORES
Globalize your Research

International Journal of Clinical Case Reports and Reviews

Christopher Turner *

Open Access

Review Article

Diabetes Mellitus and its Sixth Complication Explained

Christopher Turner

Specialist in Restorative Dentistry (Rtd) Bath UK.

***Corresponding Author:** Christopher Turner, Specialist in Restorative Dentistry (Rtd) Bath UK.

Received Date: March 04, 2025 | **Accepted Date:** March 07, 2025 | **Published Date:** March 24, 2025

Citation: Christopher Turner, (2025), Diabetes Mellitus and its Sixth Complication Explained, *International Journal of Clinical Case Reports and Reviews*, 24(4); **DOI:10.31579/2690-4861/730**

Abstract:

In 1999 Löe described periodontal disease (PD) as the sixth complication of diabetes mellitus (DM) because this latter group of patients has a 3 – 4 times greater risk of developing PD when compared with non-diabetics. This rises to 10 times for smokers.

DM and PD are inter-related, one disease affecting the other and vice versa. The exact mechanism is unclear but may be related to inflammation, blood markers for which are raised in both diseases.

From the medical point of view there are five complications of DM namely cardiac, vascular, renal, ophthalmic and neurological that can be visualised as a simple hub called DM with spokes for the above complications.

However, the research evidence has shown that the severity of all these five complications is worse when patients have active, uncontrolled PD. When PD is treated, there is an improvement in glycaemic control.

These results have led to the conclusion that PD is not a separate complication of DM but a co-morbidity factor acting by: modifying the severity of another disease and modulating the severity of diabetic complications in the manner of a rheostat. A new model is proposed together with a system for doctors and dentists to work together.

There are likely to be wide variations in outcomes depending on both the bacteriological load from mature dental plaque and individual immune responses.

More focussed research is required.

Key words: diabetes; periodontitis; co-morbidity; professional co-operation

Case Presentation

The concept that periodontal disease was the sixth complication of diabetes mellitus (DM) dates back to a paper by the distinguished Scandinavian periodontist Professor Harald Loë in 1999 when he attempted to inform doctors about the increased risk that people living with diabetes had of developing periodontal disease (PD) [1]. In fact, the first description of this was much earlier by Williams in his paper entitled 'Diabetic Periodontoclasia' published in 1928 and forgotten [2]. Nearly 100 years later as dentists we still have difficulty persuading too many doctors about this connection. We now know that this risk is about 3-4 times greater than for non-diabetics, rising to 10 times for diabetics who smoke [3].

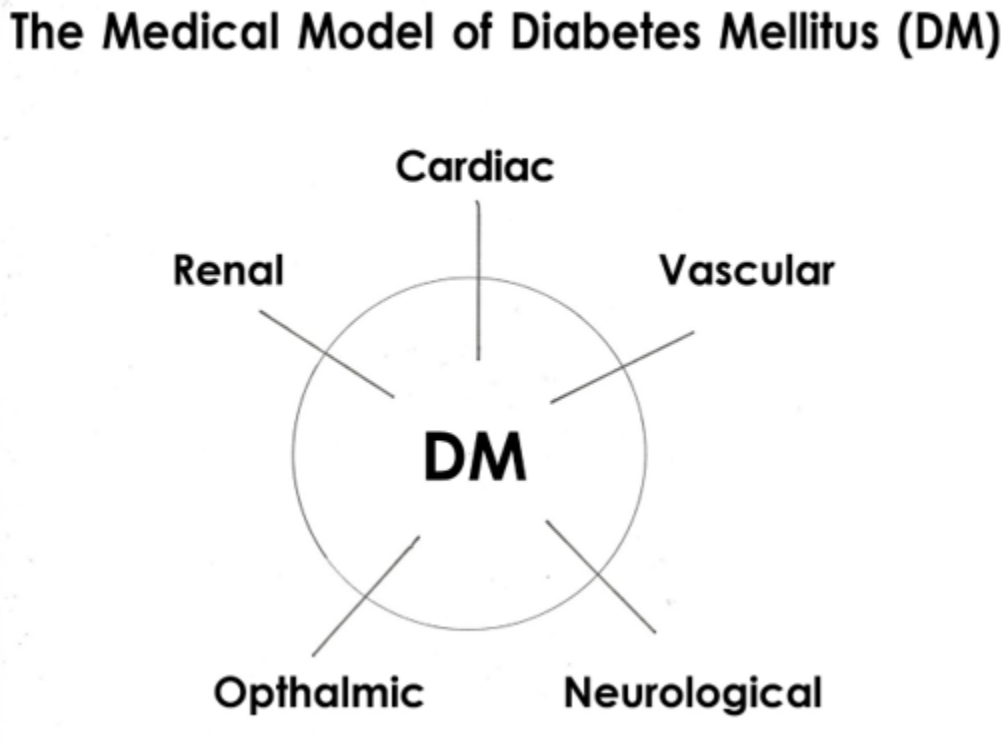
Pathophysiology

From the medical point of view there are five complications of diabetes mellitus namely, cardiac, vascular, renal, ophthalmic and neurological. We can visualise this simply as a hub called diabetes mellitus with spokes for the above complications (Figure 1).

Where does periodontitis fit in? Is it another spoke? Decidedly not. The evidence is overwhelming that diabetes and periodontitis are interrelated, one disease affecting the other and vice versa [4,5], so the model relationship has to have both diabetes and periodontitis at a much larger hub with an inter-relationship (Figure 2). More importantly, the research evidence has shown that the severity of all these five diabetic complications doctors have to deal with is worse when patients have active, uncontrolled periodontitis. Also, when periodontitis is treated, there is an improvement in glycaemic control [6].

The relationship between DM and PD may be inflammatory in origin. There is a common pathogenesis involving an enhanced inflammatory response at both local and systemic levels7. This is caused by the chronic

effects of hyperglycaemia and the formation of advanced glycation end-products that promote the inflammatory response [7]. Levels of C-reactive protein4, tissue necrosis factor [7], and cytokines [8] are raised in both diseases. Polysaccharides in Gram negative bacteria in mature dental plaque are known to stimulate the production of cytokines. Toxic products from these organisms initiate tissue breakdown and increased osteoclastic bone resorption in the periodontium [9]. Osteoclastic activity also increases along with enhanced glycation levels and poor glycaemic control [10], thus stimulating further bone resorption and diminished bone formation in a vicious circle and contributing to the enhanced levels of periodontitis and alveolar bone loss seen in people living with diabetes.



When dental plaque is left, after seven to ten days gingival inflammation ensues and this is the precursor of periodontitis [11].

PD may be thought of as an infection. However, it is not in the true medical sense of the word because it does not meet Koch's postulates for a single recoverable infective agent. PD is a chronic hyper sensitivity reaction to antigens in mature dental plaque.

Research has shown that when the severity of diabetic complications is compared to periodontal status that for:

Cardiac and Vascular: Poor oral health is associated with atherosclerotic cardiovascular disease. This interaction raises cardiac morbidity fourfold and is associated with chronic infection mediators which may lead to the initiation of endothelial dysfunction [12].

Nephropathy: People on dialysis are at greater risk of developing PD [13]. With severe Periodontitis there is a 2.6 times greater risk of macroglobinaemia and a 4.9 times risk of end stage renal disease [14]. Periodontal management may contribute to the prevention of renal disease [15]. Patients should be screened for periodontitis before acceptance onto dialysis programmes [16].

Neuropathy; Is a microvascular complication associated with xerostomia in 40 per cent of people living with diabetes mellitus [17]. The increased risk of caries goes without saying. There is an inverse relationship between salivary flow and glycated haemoglobin (HbA1c) levels that may be due o disturbances in glycaemic control [18].

Retinopathy: There are few studies of this complication together with PD using different criteria [19,20]. However, an increase in the severity of diabetic retinopathy is associated with the components of periodontal disease [21].

How might this affect the medical model? It is clear that periodontitis is influencing diabetic's individual responses. It is both

a. modifyng the severity of another disease
b. and modulating the severity of diabetic complications in the manner of a rheostat, the greater the level of periodontal disease, the worse the complications at one end of the spectrum, while when PD is successfully treated glycaemic control improves at the other.

This is a new concept and means that PD should not be regarded as a complication of DM but a co-morbidity factor. Therefore, for optimum treatment of people living with diabetes there has to be both medical and dental contemporaneous input into their care. When both are treated together there may be a synergistic effect [22].

It is expected that there will be wide variations in individual patient responses depending upon the bacteriological load from their plaque, and their immune response.

In summary, the new model shows dentists can help doctors and their diabetic patients but most of the former do not know that, they have not been taught that, and there are too many who see dentists trying to 'muscle in' on what is their treatment area. Dentists need to change that and achieve a paradigm shift in thinking with doctors to meet the calls for better interprofessional co-operation in care [23,24].

Defining risk factors for doctors.

The medical gold standard for diabetic monitoring is the serum level of HbA1c, a two to three month retrospective measure. This may be recorded as percentage levels that should be maintained below 6.5%, green on the

traffic light method that has been introduced [25,26]. There is an amber band for 6.5 to 8.5% and a red band for greater than 8.5%. More recently these values have been expressed in either mmol/mol or mmol/litre (Table 1). However, previously determined individual targets could be more appropriate for some people with diabetes, particularly those who are frail or lack awareness of hypoglycaemia [27].

percentage	< 6.5	6.5 – 8.5	8.5>
mmol/mol	< 48	48 – 69	69 >
mmol/L	< 7.8	7.8 – 10.9	10.9 >
Risk factor	Low, green	Moderate, amber	High, red

Table 1: HbA1c levels and medical risks

Defining risk factors for dentists.

Various indices of periodontal health have been described. The measure of choice is the World health Organisation's Community Periodontal Index of Treatment Need (CPITN) [28]. The mouth is divided into sextants, right and left molars and bicuspids, and incisors and canine teeth for each jaw. The maximum score for each sextant is recorded using the following general guidelines [25,26]:

0 Pockets less than 3.5mm depth, periodontal health.

1 Pockets less than 3.5mm with bleeding on probing (a sign of gingivitis and poor plaque control).

2 Pockets of less than 3.5mm. Presence of supra-gingival calculus indicating a need for professional mechanical plaque removal.

3 2*Pockets of less than 3.5mm. Presence of sub-gingival calculus indicating a need for professional mechanical plaque removal.

4 Pockets of 3.5 to 5.5mm (early or moderate periodontal breakdown).

5 Pockets of greater than 5.5mm (severe periodontal breakdown).

4* Root furcation involvement or severe periodontal breakdown with an increased risk that teeth will require extraction. The maximum sextant score gives a periodontal risk factor using the traffic light system,0,1,or 2, green, 2* or 3, amber, and 4 0r 4* as red (Table 2). A *pro forma* has been developed for people living with diabetes to record their results and share them with their respective professional advisors (Table 3)[25]. This form is freely downloadable at www.chooseabrush.com.

Highest sextant score	0 or 1 or 2	2* or 3	4 or 4*
Risk factor	Low, green	Moderate, amber	High, red

Table 2: Periodontal risk factor

Table 3:

MY DIABETES RESULTS FOR 20……..

NAME……DOB……

Doctors – HbA1c, this should be below 6.5%

Risk Factor: less than 6.5% low; 6.5-8.5%, medium; 8.5% or more high, or

Less than 48mmol/mol,low;48-70mmol/mol,medium; 70mmol/mol or more,high

Less than 7.8mmol/l, low; 7.8-10.9 mmol/L, medium: more than 10.9 mmol/L high

Date HbA1c…… Risk level……

Previous results

Date HbA1c…… Risk level……

Dentists: The Basic periodontal examination

Date…….. Highest score……..

Risk Factor 0,1,2 low; 2*-3 medium; 4 or 4* high

Previous results

Date…….. Highest score……..

Risk Factor 0,1,2 low; 2*-3 medium; 4 or 4* high

Notes. These numbers range from 0 to 4*. The maximum score in each sextant is recorded.

0	Pockets less than 3.5mm depth, periodontal health.
1	Pockets less than 3.5mm with bleeding on probing (a sign of gingivitis and poor plaque control).
2	Pockets of less than 3.5mm. Presence of supra-gingival calculus indicating a need for professional mechanical plaque removal.
	Pockets of less than 3.5mm. Presence of sub-gingival calculus indicating a need for professional mechanical plaque removal. 2*
3	Pockets of 3.5 to 5.5mm (early or moderate periodontal breakdown).
4	Pockets of greater than 5.5mm (severe periodontal breakdown).
4*	Root furcation involvement or severe periodontal breakdown with an increased risk that teeth will require extraction.

See www.chooseabrush.com to down load this form

Discussion

Doctors need to understand basic facts about periodontitis and record which of their patients is receiving dental care and advise those who are not that they are at greater risk of developing PD and that when PD is treated their blood sugar levels can be better controlled [29,30].

Dentists should revise their medical history questionnaire [31] to include questions about type 1 or type 2 DM. What medications are being taken because some type 2 diabetics do need insulin injections in addition to oral medication. and about hypo or hyper glycaemic episodes requiring hospitalisation. They may have a medical emergency to deal with.

However, the medical gold standard for diabetic monitoring is the glycated haemoglobin level, the HbA1c. So, the HbA1c level is a most important addition to the medical history. Each patient may know, or you may have to ask their doctor.

In our recent study, asking this question in general dental practice these are the results [32]:

Most patients, 84 per cent were type 2. Analysing their HbA1c results showed that 40 per cent were in the green zone, 20 per cent amber, 12 per cent red and 28 per cent did not know. The study also identified 9 per cent of patients who were not attending for annual review by their doctors. The importance here is that as the HbA1c increases, bringing PD under control becomes harder.

Fortunately, periodontitis is both a treatable and preventable disease with good clinical outcomes when detected at an early stage. Prevention depends on daily efficient and effective plaque control by patients33. When plaque is left in situ for 7 to 10 days inflammation results [11]. In relation to the other costs of care for the main diabetic complications, dental treatment is relatively cheap and can be cost-effective.

Where these is bone loss between teeth limited and gingivae the most efficient way to remove plaque is by using interdental brushes. These are made in a variety of diameters by different manufacturers some of whom have a limited size range [34]. For ideal results in individual prescription for the correct diameter brush for each space is essential as in one study every pattern of bone loss and therefore brush diameter requirement was individual [33].

When few sizes are suggested, plaque will always be left behind contributing to the bacteriological load, periodontal disease will continue and diabetic complications are less likely to be limited.

Conclusions

PD is not the sixth complication of DM. It modifies and modulates the severity of diabetic complications. This means that both diseases should be treated concurrently and that dentists and their teams have a very important role to play together with doctors.

The glycated haemoglobin results, HbA1c are essential for dentists. The higher the score the more difficult it is to control periodontal disease.

Risk results need to be shared between doctors and dentists. A form has been developed for patients themselves to show their respective professional advisors.

This can be downloaded at www.chooseabrush.com.

Dentists need to be more proactive, teach and work with doctors who may not know about the increased risk that their patients living with DM have for PD.

Declaration of interest

The author is the inventor of the Chooseabrush® method of interdental plaque control.

References.

1. Löe H. Periodontal disease. The sixth complication of diabetes mellitus. Diabetes Care 16: 329, 1999. Löe, H. (1993). Periodontal disease. The sixth complication of diabetes mellitus. *Diabetes Care, [online]* 16(1), pp.329–334.
2. Williams J. Diabetic periodontoclasia J Amer Dent Assoc 15: 523,1928. Manouchehr-Pour, M. and Bissada, N.F. (1983). Periodontal Disease in Juvenile and Adult Diabetic Patients: A Review of the Literature. The Journal of the American Dental Association, 107(5), pp.766–770.
3. Battancs e, Georghita D, Nyiraty S. et al. (2020). Periodontal disease in diabetes mellitus: A case-controlled study in smokers and non-smokers. Diabetes Ther Nov 11 (11), 2715.
4. Battancs, E., Gheorghita, D., Nyiraty, S., Lengyel, C., Eördegh, G. et al. (2020). Periodontal Disease in Diabetes Mellitus: A Case–Control Study in Smokers and Non-Smokers. Diabetes Therapy, 11(11), pp.2715–2728.
5. Southerland JH. Diabetes and periodontal infection – making the connection. Clin Diabetes 23: 171, 2009. Southerland, J.H., Taylor, G.W. and Offenbacher, S. (2005). Diabetes and Periodontal Infection: Making the Connection. Clinical Diabetes, [online] 23(4), pp.171–178.
6. Stöhr J Bidirectional association between periodontal disease and diabetes mellitus: a systematic review with meta-analysis of cohort studies Sci Rep 11: 136, 2021. Stöhr, J., Barbaresko, J. et al, (2021). Bidirectional association between periodontal disease and diabetes

mellitus: a systematic review and meta-analysis of cohort studies. Scientific Reports, 11(1).

7. Wang TF, Jen IA, Chou C. et al. (2014). Effects of periodontal therapy on the metabolic control of patients with type 2 diabetes and periodontal disease: a meta-analysis. Medicine (Baltimore) 28: 292, 2014. Wang, T.-F., Jen, I-An., Chou, C. and Lei, Y.-P. (2014). Effects of Periodontal Therapy on Metabolic Control in Patients with Type 2 Diabetes Mellitus and Periodontal Disease. Medicine, 93(28), p.e292.
8. Liu R, Bal HS, Desta T et al. (2006). Tumor necrosis factor-alpha mediates diabetes-enhanced apoptosis of matrix-producing cells and impairs diabetic healing. Am J Pathol 175: 1574, 2009.
9. Liu, R., Bal, H.S., Desta, T., Behl, Y. and Graves, D.T. (2006). Tumor necrosis factor-alpha mediates diabetes-enhanced apoptosis of matrix-producing cells and impairs diabetic healing. *The American Journal of Pathology*, [online] 168(3), pp.757–764.
10. Johnson Dr, O'Connor JC, Satpathy A, Freund GG. Cytokines in type II diabetes. Vitam Horm 74: 405, 2006. O'Connor, J.C., Sherry, C.L., Guest, C.B. and Freund, G.G. (2007). Type 2 diabetes impairs insulin receptor substrate-2-mediated phosphatidylinositol 3-kinase activity in primary macrophages to induce a state of cytokine resistance to IL-4 in association with overexpression of suppressor of cytokine signaling-3. *Journal of Immunology* (Baltimore, Md.: 1950), [online] 178(11), pp.6886–6893.
11. Wu YY, Xioa E, Graves DT. (2015). Diabetes mellitus related bone metabolism and periodontal disease. *Int J Oral Sci*. 7: 63-72.
12. Krakener JC, McKenna MJ, Buderer NF et al. (1995). Bone loss and bone turnover in diabetes. Diabetes 44|: 775, Krakauer, J.C., Mckenna, M.J., Fenn Buderer, N., Rao, D.S., Whitehouse, F.W. and Parfitt, A.M. (1995). *Bone Loss and Bone Turnover in Diabetes. Diabetes*, 44(7), pp.775–782.
13. Löe H, Thielade E, Jensen SB. (1965). Experimental gingivitis in man. Periodontol 36: 167, 1965. Löe, H., Theilade, E. and Jensen, S.B. Experimental Gingivitis in Man. *Journal of Periodontology*, 36(3), pp.177–187.
14. Khumaedi AI, Purnamasari D, Wijaya P, Soeroso Y. (2019). The relationship between diabetes, periodontal and cardiovascular disease. Diabetes Metab Syndr 13: 1675, Khumaedi, A.I., Purnamasari, D., Wijaya, I.P. and Soeroso, Y. (2019). The relationship of diabetes, periodontitis and cardiovascular disease. Diabetes & Metabolic Syndrome: *Clinical Research & Reviews*, 13(2), pp.1675–1678.
15. Nguyen ATM, Akhter R, Garde S et al. (2020). The association of periodontal disease with the complications of diabetes mellitus. A systematic review. *Diabetes Res Clin Pract.*165.108244.
16. Mahajan S, Bhaskar N, Kaur RK, Jain A. (2021). A Comparison of oral health status in diabetic and non-diabetic patients receiving haemodialysis – a systematic review and meta-analysis.Biabetes Metab Syndr 15: 102256. Mahajan, S., Bhaskar, N., Kaur, R.K. and Jain, A. (2021). A comparison of oral health status in diabetic and non-diabetic patients receiving hemodialysis – A systematic review and meta-analysis. Diabetes & Metabolic Syndrome: *Clinical Research & Reviews*, 15(5), p.102256.
17. Yoshioka M, Okamoto y, Murata M et al. (2020). Association between oral health status and diabetic nephrology- related indices in Japanese middle-aged men. J diabetes Res June 7,2020 Yoshioka, M., Okamoto, Y., Murata, M., Fukui, M., Yanagisawa, S., Shirayama, Y., Nagai, K. and Hinode, D. Association between Oral Health Status and Diabetic Nephropathy-Related Indices in Japanese Middle-Aged Men. *Journal of Diabetes Research.*
18. Bornakke WS, Anderson PF, Shannon C, Jivanescu A. (2015). Is there a relationship between oral health and diabetic neuropathy? Curr Diab Rep 11; 93, *Current Diabetes Reports*, 15(11).
19. Bornakke WS, Anderson PF, Shannon C, Jivanescu A. (2015). Is there a relationship between oral health and diabetic neuropathy? Curr Diab Rep 11; 93, Borgnakke, W.S., Anderson, P.F., Shannon, C. and Jivanescu, A. (2015). Is There a Relationship Between Oral Health and Diabetic Neuropathy? *Current Diabetes Reports*, 15(11).
20. Moore PA, Weyant RJ, Mongelluzzo MB et al. (2001). Type 1 diabetes, xerostomia and salivary flow rates. Oral Surg Oral Med Oral Path Oral Radiol Endodod 92: 281, 2001 Moore, P.A., Guggenheimer, J., Etzel, K.R., Weyant, R.J. and Orchard, T. (2001). Type 1 diabetes mellitus, xerostomia, and salivary flow rates. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics, [online] 92(3), pp.281–291.
21. Yamamoto Y, Morazumi T, Hirata T et al. (2020). Effect of periodontal disease on diabetic retinopathy in type 2 diabetic patients. A cross-sectional pilot study. J Clin Med 92:3234.
22. Alverenga MOP, Miranda GHN, Ferriera RO et al. Association between diabetic retinopathy and periodontitis. A systematic review. *Front Public Health* 8.550614.
23. Tandon A, Kamath YS, Gopalkrishna MB et al. (2021). The association between diabetic retinopathy and periodontal disease. *Saudi J Ophthalmol* 34: 167, 2021 Kamath, Y., Tandon, A., Gopalkrishna, P., Saokar, A., Prakash, S., Sarpangala, S. and Bhandary, S. (2020). The association between diabetic retinopathy and periodontal disease. Saudi Journal of Ophthalmology, 34(3), p.167.
24. Turner CH. (2023). Periodontal disease and diabetes mellitus. An update and case report. J Med Case Rep Case Series.
25. Siddiqi J, Zafar S, Sharma A, Quaranta A. (2020). Diabetes mellitus and periodontal disease: The call for inter-professional education and inter professional collaborative care. *J Interprof Care* 10:1, 2020. Siddiqi, A., Zafar, S., Sharma, A. and Quaranta, A. (2020). Diabetes mellitus and periodontal disease: The call for interprofessional education and interprofessional

collaborative care - A systematic review of the literature. *Journal of Interprofessional Care,* pp.1–9.

26. Turner CH. (2024). Interprofessional Co-operation and result sharing between doctors, and dentists for people living with diabetes mellitus. *ABC J Diab Endocrinol*, 9: 1-3.
27. Turner CH. (2022). Diabetes mellitus and periodontal disease: the profession's choices. *Brit Dent J,* 233: 537-538.
28. Turner CH, Bouloux P-M. (2023). Diabetes mellitus and periodontal disease: education, collaboration and information sharing between doctors, dentists and patients. *Br J Diabetes*, 23: 35-38.
29. Strain WD, Down S, Brown P, Puttana A et al. (2021). Diabetes and frailty. An expert concensus statement on the management of older adults with type 2 diabete Diabetes Ther, 12:1227-1247.
30. https://pubmed.ncbi.nlm.nih.gov/7836006/
31. https://www.bjd-abcd.com/bjdvd/index.php/bjd/article/view/1191
32. https://www.magonlinelibrary.com/doi/abs/10.12968/bjha.2022.16.1.18
33. Turner CH. (2024). An updated medical history form for people living with diabetes mellitus. Brit Dent J,
34. Goode SG, Turner CH. (2024). Diabetes mellitus and periodontal disease: A pilot investigation into patient awareness of glycated haemoglobin levels and periodontal screening scores and their associated risk factors in general dental practice. *Int J Diabetol Vascular Di*s Res, 11:287-290.
35. Turner CH. (2011). Implant maintenance. The Dentist, 62-64.
36. Turner CH. Interdental brushes and ISO standards Brit dent J 232:761,2022 Turner, C. (2022). Interdental brushes and ISO standards. British Dental Journal, [online] 232(11), pp.761–762.

DOI:10.31579/2690-4861/730