Universitat Internacional de Catalunya
Facultat d'Odontologia

Tesi doctoral

Relació entre la prehipertensió arterial i la malaltia periodontal.

Neus Lanau Solé

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uic barcelona

Al Jaume i al Pau,

“Hapiness can be found even in the darkest of times, if one only remembers to turn on the light”

Albus Dumbledore

Agraïments

En primer lloc m'agradaria agrair la feina als meus directors, al Dr. Javier Mareque per encendre la guspira d'aquesta tesi i al Dr. Michel Zabalza per la seva incommensurable ajuda, les correccions a les tantes de la nit i la seva comprensió i ànims en moments de flaquesa.

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Índex

ÍNDEX

Resum i Abstract

RESUM

La hipertensió arterial i la periodontitis són dues de les malalties més freqüents a nivell mundial, i recentment s'està posant de manifest la relació que tenen entre elles i el gran nombre de pacients que pateixen ambdues malalties. Malgrat totes les mesures anti-hipertensives que existeixen, un gran nombre de pacients amb pressió arterial alta estan sense diagnosticar i molts dels diagnosticats no aconsegueixen arribar als valors de pressió arterial recomanats.

L'objectiu d'aquesta tesi doctoral és aprofundir en el coneixement de la relació entre la pressió arterial alta i la periodontitis, i més concretament si el tractament periodontal no-invasiu pot ajudar en el control de la pressió arterial en individus prehipertensos amb periodontitis.

En aquesta tesi s'ha analitzat la prevalença d'individus amb hipertensió i prehipertensió arterial entre els pacients amb patologia periodontal mitjançant un estudi descriptiu transversal. També s'ha estudiat l'efecte del tractament periodontal no invasiu en els valors de pressió arterial en un grup d'individus prehipertensos amb periodontitis durant un període de seguiment de sis mesos.

Els resultats indiquen una alta prevalença de pacients prehipertensos (67.5%) i hipertensos (15%) d'entre els pacients amb periodontitis estudiats. En l'estudi de cohorts prospectiu de pacients prehipertensos amb periodontitis es van trobar diferències estadísticament significatives en els valors de pressió arterial abans i després del tractament periodontal, sense haver dut a terme cap altre tipus d'intervenció ni farmacològica ni de canvis d'estil de vida. El tractament va causar una reducció passades 4 - 6 setmanes, de 4.7 mmHg de pressió arterial sistòlica i 3.4 mmHg de pressió arterial distòlica. Aquesta reducció es va mantenir passats 6 mesos amb una reducció de 5.2 mmHg de pressió arterial sistòlica i 3.7 mmHg de pressió arterial diastòlica.

Tenint en compte les limitacions i la necessitat de confirmar els resultats amb estudis amb mostres més grans i durant més temps de seguiment, es posa de manifest el benefici que

el tractament periodontal pot tenir en el control de la pressió arterial en individus prehipertensos amb periodontitis. També és rellevant el paper que els dentistes podem tenir a nivell de prevenció i detecció precoç de pacients amb la pressió arterial alta i normal-alta sense diagnosticar, i així derivar-los a l'especialista mèdic que correspongui per a un diagnòstic de certesa. Finalment, són importants els beneficis que poden causar els tractaments periodontals en el control de la pressió arterial, i així millorar el risc cardiovascular d'aquests pacients.

ABSTRACT

Arterial hypertension and periodontitis are two of the most common diseases worldwide, and recently, the relationship between them and the large number of patients that suffer both diseases is being highlighted. Despite all anti-hypertensive measures that exist, an important number of patients with high blood pressure are not diagnosed and a lot of those diagnosed fail to achieve the recommended blood pressure values.

The aim of this doctoral thesis is to deepen the understanding of the relationship between high blood pressure and periodontitis, and more specifically if non-invasive periodontal treatment can help in blood pressure control of prehypertensive patients with periodontitis.

In this thesis, the prevalence of individuals with arterial hypertension and prehypertension among patients with periodontal disease has been analysed, through a cross-sectional descriptive study. Moreover, the effect of non-invasive periodontal treatment on blood pressure values has also been studied in a group of prehypertensive individuals with periodontitis during a six-month follow-up period.

The results show a high prevalence of prehypertensive (67.5%) and hypertensive patients (15%) among the periodontitis patients studied. In the prospective cohort study of prehypertensive patients with periodontitis, statistically significant differences were observed in blood pressure values before and after periodontal treatment without any other type of pharmacological intervention of lifestyle changes. The treatment caused a reduction after 4-6 weeks of 4.7mmHg in systolic blood pressure and 3.4 mmHg in diastolic blood pressure. This reduction was maintained after 6 months, with a reduction of 5.2mmHg in systolic blood pressure and 3.7 mmHg in diastolic blood pressure.

Taking into account the limitations and the necessity of confirming the results with studies with larger samples and for a longer follow-up period, the benefit that periodontal treatment can have in the control of blood pressure in prehypertensive individuals with periodontitis is highlighted. The role that dentists can play in terms of prevention and

early detection of undiagnosed patients with high and normal-high blood pressure is also relevant, this referring them to the appropriate medical specialist for a correct diagnosis. Finally, the benefits that periodontal treatments can cause in the control of blood pressure are important, helping improve the cardiovascular risk of these patients.

Llistat de figures i taules i llistat d'abreviatures

LLISTAT DE FIGURES I TAULES

LLISTAT D'ABREVIATURES

HTA: hipertensió arterial

PA: pressió arterial

PAS: pressió arterial sistòlica

PAD: pressió arterial diastòlica

mmHg: mil·límetres de mercuri

MAPA: monitoratge ambulatori de la pressió arterial

FRCV: factor de risc cardiovascular

PPD: profunditat de sondatge, de l'anglès *Periodontal probing depth*

BOP: sagant al sondatge, de l'anglès *Bleeding on probing*

CAL: pèrdua d'inserció clínica, de l'anglès *Clinical attachment loss*

RBL: pèrdua d'os radiogràfica, de l'anglès *Radiographic bone loss*

HbA1c: hemoglobina glicosilada

SD: desviació estàndard, de l'anglès *Standard deviation*

p: p-valor

Introducció

1. INTRODUCCIÓ

1.1 Hipertensió arterial

1.1.1. Definició

La hipertensió arterial (HTA), també coneguda com a pressió arterial (PA) alta, és una malaltia crònica no transmissible en la qual les artèries tenen la pressió constantment elevada. Com més pressió hi ha en aquests vasos sanguinis, el cor ha de treballar més intensament per poder bombejar la sang.[3]

La pressió arterial es mesura en mil·límetres de mercuri (mmHg) i es registra amb dos valors. El primer i més alt és la pressió arterial sistòlica (PAS), que és la pressió més alta que tenen els vasos sanguinis quan el cor es contrau. El segon i més baix és la pressió arterial diastòlica (PAD), que és la pressió més baixa als vasos sanguinis entre pulsacions quan el cor es relaxa.[3]

Segons la Guia de la Societat Europea de Cardiologia del 2018[1], la hipertensió arterial en adults es defineix com a PAS ≥140 mmHg i/o PAD ≥90 mmHg. Aquests valors estan basats en l'evidència científica de diversos assaigs clínics aleatoritzats.

1.1.2. Diagnòstic i classificació

Per al diagnòstic de la hipertensió és necessari que apareguin mesures repetides a la consulta o bé un diagnòstic fora de la consulta amb un monitoratge ambulatori durant 24 hores (MAPA) si econòmicament és viable.[1,4] Aquest monitoratge fora de la consulta és ideal per a casos d'HTA de "bata blanca", que són els casos en els quals el pacient té uns valors alts de PA a la consulta però no a casa. La prevalença és molt variada segons els estudis, però podria estar al voltant d'un 30%.[1,5]

Per al diagnòstic a la consulta, s'ha de tenir en compte la mitjana de dues o tres mesures realitzades en mínim dues visites diferents.[5] La mesura de la pressió arterial s'ha de realitzar amb un esfigmomanòmetre correctament validat.[6] Es demana als pacients que no parlin durant la presa de registres i que no facin exercici ni fumin ni prenguin cafeïna

els 30 minuts previs a la visita. Quan els pacients han arribat a la consulta les mesures es poden prendre després de 5 minuts de repòs. Idealment s'han de prendre als dos braços i si hi ha diferències importants entre ells s'ha d'agafar la mesura més alta. Entre mesura i mesura s'ha d'esperar un interval de dos minuts i el pacient ha d'estar assegut amb l'esquena amb suport, els peus plans al terra i amb l'avantbraç recolzat i el braç a nivell del cor.[1]

L'HTA pot ser essencial o primària (el 90 % dels casos) o secundària, que podria ser deguda a alguns tipus de fàrmacs, consum d'alcohol o drogues, HTA d'origen renal o com a conseqüència d'altres malalties sistèmiques, metabòliques o immunitàries, com per exemple l'hipertiroïdisme.[7,8]

Segons la Societat Europea de Cardiologia [1] es pot establir una classificació de diferents grups segons els valors de pressió arterial a la consulta (Taula 1). Una pressió arterial òptima estaria considerada PAS <120 mmHg i una PAD <80 mmHg. La pressió considerada normal seria una PAS entre 120-129 mmHg i/o una PAD entre 80-84 mmHg. Es considera ja una pressió normal-alta (també anomenada prèviament prehipertensió) valors de PAS entre 130-139 mmHg i/o PAD entre 85-89 mmHg. La hipertensió es divideix en tres grups: grau 1 (PAS 140-159 mmHg i/o PAD 90-99 mmHg), grau 2 (PAS 160-179 mmHg i/o PAD 100-109 mmHg) i grau 3 (PAS ≥180 mmHg i/o PAD ≥110 mmHg). També es poden trobar casos d'hipertensió sistòlica aïllada amb valors PAS ≥140 mmHg però PAD <90 mmHg o hipertensió diastòlica aïllada amb valors de PAS <140 mmHg i PAD>90 mmHg.

Grup	PA Sistòlica (mmHg)		PA Diastòlica (mmHg)
Òptima	<120	i	<80
Normal	120-129	i/o	80-84
Normal-alta	130-139	i/o	85-89
Hipertensió grau 1	140-159	i/o	90-99
Hipertensió grau 2	160-179	i/o	100-109

Hipertensió grau 3	≥ 180	i/o	≥ 110
HTA sistòlica aïllada	≥ 140	i	< 90
HTA diastòlica aïllada	<140	I	> 90

Taula 1. Classificació graus hipertensió segons la Societat Europea de Cardiologia (ESC guideline)

Els objectius dels tractaments aniran enfocats a reduir els valors de PA per sota dels 140/90 mmHg en tots el pacients i idealment s'haurien d'arribar a nivells per sota dels 130/80 mmHg sobretot en pacients menors de 65 anys i diabètics.

Aquesta classificació té algunes petites diferències amb la classificació de l'Associació Americana de Cardiologia[9,10], on els valors són més restrictius, i això té conseqüències en les classificacions que agafen els diversos estudis d'investigació. Es considera una pressió arterial normal valors PAS <120 mmHg i PAD <80 mmHg. Ja es considera una pressió arterial elevada valors de PAS 120-129 mmHg i PAD >80 mmHg. La hipertensió es divideix en dos grups: Estadi 1 (PAS 130-139 mmHg i/o PAD 80-89 mmHg) i Estadi 2 (PAS ≥140 mmHg i/o PAD ≥90 mmHg). En aquest cas, els objectius del tractament van encaminats a aconseguir valors de pressió arterial menors a 130/80 mmHg.

En aquest treball farem sempre referència a la Classificació Europea[1] però farem servir indistintament els termes prehipertensió i pressió normal-alta.

1.1.3. Prehipertensió: importància de la prevenció

La prehipertensió o pressió normal-alta està associada amb tres vegades més possibilitats de desenvolupar HTA.[11] També s'ha associat a un pitjor perfil de risc cardiovascular, major prevalença de desordres metabòlics i mortalitat cardiovascular. [12–17] Hi ha estudis que apunten que 4 de cada 5 pacients d'entre 40 i 49 anys amb prehipertensió desenvoluparan hipertensió en els propers 10 anys.[18,19] En aquest context, és de gran importància implementar estratègies de prevenció, per poder intervenir i evitar o retardar que aquests individus prehipertensos esdevinguin hipertensos en el futur.

Inicialment, és molt important implementar i recomanar canvis en l'estil de vida d'aquests pacients i canviar tots aquells factors de risc modificables.[20–23] Posteriorment, s'ha

d'avaluar la possibilitat d'iniciar o no un tractament farmacològic, encara que en aquest punt hi ha controvèrsia a la literatura.[18,24–26]

1.1.4. Prevalença i impacte sanitari actual

La pressió arterial és un dels factors de risc cardiovascular més important i està associat amb un augment de la mortalitat i morbilitat cardiovascular.[27,28] La PA alta afecta entre un 30 i un 45% de tota la població adulta mundial. L'any 2010 hi havia 1.39 bilions de persones hipertenses,[29,30] i és la primera causa de mort prematura al món (10.4 milions de morts a l'any).[1,11] Aquesta tant alta prevalença fa que sigui un problema de salut pública global, ja que s'estima que un terç de la població serà hipertensa al 2025,[1,31] degut a l'envelliment de la població, el sedentarisme i l'obesitat, entre d'altres. A més, malgrat totes les estratègies de prevenció i tractament, està estimat que entre el 15 i 50% de població està sense diagnosticar [32] i que aproximadament el 70% dels pacients hipertensos no aconsegueixen reduir els valors de pressió arterial fins als òptims.[33]

Pel que fa la població espanyola, s'estima que gairebé 13 milions de persones són hipertenses, de les quals gairebé 5 milions no estan diagnosticades i desconeixen que tenen aquesta patologia. A més, es calcula que només el 30% dels pacients estan controlats i han aconseguit arribar a valors de pressió òptims.[8]

A Catalunya, i amb dades del 2020 del Departament de Salut,[34] gairebé el 25% de la població major de 15 anys té pressió arterial elevada. Aquest percentatge augmenta fins al 61% en els majors de 65 anys i també és més elevat en les persones amb menys recursos econòmics i en les que tenen un nivell d'estudis més baix.

1.1.5. Etiologia i factors de risc

L'etiologia de l'HTA és multifactorial i de fet no se sap exactament quins en són els desencadenants exactes.[35] Existeixen factors metabòlics, factors de risc conductuals i factors genètics. Entre el primer grup, un dels factors és l'augment en la rigidesa de les parets arterials, fet que apareix amb l'edat. També hi tenen a veure molts altres factors, com canvis hemodinàmics i mecànics de la circulació, canvis en la regulació hormonal, disfunció endotelial i estrès oxidatiu.[35,36] És important també el paper que juguen les

inflamacions locals i sistèmiques, ja que les cèl·lules del propi sistema immunitari poden promoure la pujada de la PA mitjançant efectes renals o a la funció vascular.[32,37]

Com a factors de risc conductual, i per tant, modificables; es podrien tenir en compte el consum de menjar amb massa sal i grasses saturades i no menjar suficient fruites i verdures, l'abús d'alcohol, el sedentarisme, la inactivitat física i elevats nivells d'estrès.[3] El component genètic (història familiar prèvia d'HTA) és un dels altres factors a tenir en compte. Estudis recents s'han identificat més de 500 loci que podrien estar relacionats amb la regulació de la PA.[38,39]

Els factors de risc cardiovascular tradicionals inclouen l'HTA, el tabaquisme, l'obesitat, el sedentarisme, la dislipèmia, la diabetis mellitus, l'edat (homes majors de 55 anys i dones majors de 65 anys) i antecedents familiar de malaltia cardiovascular.[1,5] Aquests factors es relacionen entre sí i influencien la PA, i és molt estrany que aparegui HTA aïllada, sense la presència de cap altre factor de risc cardiovascular. Actualment, s'estan posant en rellevància factors de risc cardiovascular nous, com poden ser el nivell d'altres lipoproteïnes, inflamacions sistèmiques diverses a través de la identificació de marcadors sistèmics d'inflamació,[40] l'estrès, malalties autoimmunes, malaltia renal crònica, desordres psiquiàtrics majors, apnea obstructiva del son [1] o la periodontitis.[41]

Està demostrat que com més alta és la PA, hi ha més risc de malalties cardiovasculars, com per exemple infart de miocardi, ictus o malaltia renal, independentment d'altres factors de risc.[5,42,43] Per a pacients entre 40 i 70 anys està descrit que cada increment de 20 mmHg de PAS o 10 mmHg de PAD dobla el risc de patir una malaltia cardiovascular.[5]

1.1.6. Tractament

L'objectiu principal del tractament de l'HTA és disminuir la mortalitat i morbiditat cardiovascular.[44,45] Està descrit en diversos assaigs clínics aleatoritzats que la reducció dels valors de PA està associada a una reducció d'entre el 35 i 40% d'ictus, d'aproximadament el 20% d'infarts de miocardi i de més del 50% d'angines cardíaques.[5]

Els objectius de tractament segons la Societat Europea de Cardiologia,[1] per norma general, són els següents:

- El primer objectiu de tractament és aconseguir valors de pressió arterial menors a 140/90mmHg en tots els pacients i, si el tractament és ben tolerat, s'hauria d'intentar arribar a valors menors de 130/80mmHg en la majoria de pacients.
- En pacients menors de 65 anys en tractament amb fàrmacs antihipertensius, es recomana que s'aconsegueixin uns valors de pressió arterial sistòlica entre 120-129 mmHg.
- En pacients majors de 65 anys que reben tractament per reduir la PA, es recomanen valors PAS entre 130-139 mmHg.
- Respecte la pressió arterial diastòlica es recomana a tots el pacients, independentment del seu nivell de risc i comorbiditats, considerar nivells per sota dels 80mmHg.

Pel que fa als tipus de tractament, en primer lloc s'estableixen modificacions en l'estil de vida, i depenent del grau d'hipertensió es considera començar amb tractament farmacològic.

Dins de les modificacions higiènico-dietètiques, s'inclouen totes aquelles accions encaminades a canviar el major nombre de factors de risc modificables. Ens referim a reduir el consum de sal, moderar el consum d'alcohol, augmentar el consum de fruites i verdures, reduir el pes corporal si s'escau i mantenir el pes ideal, controlar els nivells d'estrès i incloure exercici físic de manera regular. També és molt important la reducció de l'hàbit tabàquic. [1,36,46] En molts casos el principal problema és la falta d'adherència i compliment de totes aquestes mesures per part dels pacients.

La necessitat de tractament farmacològic depèn dels nivells de PA, del risc cardiovascular de cada pacient i de la presència d'altres malalties cardiovasculars, diabetis o malaltia renal entre d'altres.[1,46]

En casos de pressió normal-alta o prehipertensió, la teràpia d'elecció són les modificacions de l'estil de vida i només es recomana començar amb fàrmacs

antihipertensius si el nivell de risc cardiovascular és molt alt degut a una malaltia cardiovascular prèvia.[1]

En els casos de Grau 1 d'hipertensió sense altres factors de risc cardiovascular (FRCV), es recomana començar amb tractament farmacològic si els canvis en l'estil de vida no han tingut cap efecte reduint els valors de PA durant un màxim de 6 mesos de marge de temps.[1,46] En el cas que aquests pacients tinguin altres FRCV, s'ha d'iniciar el tractament farmacològic en un termini màxim de 6 setmanes si les mesures de canvi d'estil de vida no han tingut cap efecte. [46,47]

Els pacients amb Grau 2 d'HTA i amb Grau 1 d'alt risc, el tractament farmacològic s'ha d'instaurar de forma ràpida. El tractament farmacològic ha de ser immediat en casos de PAS >180mmHg i PAD >110 mmHg que es registrin de forma persistent.[46,47]

Existeixen múltiples fàrmacs antihipertensius (inhibidors de l'enzim conversos de l'angiotensina, diürètics, antagonistes del calci, antagonistes del receptor de l'angiotensina, blocadors beta, antialdoesterònics) i es poden receptar individualment o en teràpia combinada depenent del cas particular de cada pacient. [1,5,9,36,46,48]

1.2. Periodontitis

1.2.1. Definició

Les malalties periodontals, la gingivitis i la periodontitis, són malalties cròniques multifactorials causades per bacteris que afecten els teixits de suport de les dents. [49]

La gingivitis és la forma més lleu de malaltia periodontal. Es caracteritza per la presència d'inflamació de les genives però sense pèrdua òssia, i per tant és reversible.[50]

La forma més greu és la periodontitis. Comporta la destrucció tant de la geniva com de l'os de suport de les dents. Això es manifesta amb la pèrdua d'inserció clínica i l'aparició de bosses periodontals, el sagnat gingival i la pèrdua radiogràfica d'os alveolar. [50,51] En cas de no realitzar els tractaments oportuns pot arribar a comportar la pèrdua de peces dentals.[50,52]

1.2.2. Diagnòstic i classificació

Per a poder diagnosticar les malalties periodontals s'han de tenir en compte diversos factors: la profunditat de sondatge (en anglès *Periodontal Probing Depth* -PPD-), el sagnat al sondatge (en anglès *Bleeding on Probing* -BOP-), la pèrdua d'inserció clínica (en anglès *Clinical Attachment Loss* -CAL-), la pèrdua d'os radiogràfica (en anglès *Radiographic Bone Loss* -RBL-) i el número de dents perdudes degut a causes periodontals. [51]

Segons la nova classificació dervidada del *"2017 World Workshop of the Classification of Periodontal and Peri-Implant Diseases and Conditions"* [2,53,54] es pot establir:

- Salut periodontal clínica: absència d'inflamació (entenent-la com a menys d'un 10% de localitzacions amb BOP), absència de CAL i absència de pèrdua òssia derivades d'una periodontitis prèvia.

- Gingivitis: presència d'inflamació gingival (expressada com a més d'un 10% de localitzacions amb BOP) però amb absència de CAL deguda a una periodontitis prèvia. La gingivitis pot ser localitzada (sagnat a 10-30% de les localitzacions) o generalitzada (BOP > 30% de les localitzacions).

- Periodontitis: pèrdua de teixit periodontal avaluada segons la pèrdua d'os radiogràfica i el CAL interdental mitjançant el sondatge periodontal. Es defineix com a un cas de periodontitis en un context clínic si hi ha presència de CAL interdental detectable en dues o més dents adjacents i si hi ha presència de CAL major o igual a 3mm amb profunditat de sondatge major o igual a 3mm detectable a dues o més dents adjacents, sempre i quan sigui un CAL produït per causes periodontals.

Addicionalment, cada cas de periodontitis es pot classificar segons l'estadi (gravetat de la periodontitis) i el grau (progressió esperada, característiques biològiques i factors de risc) de la malaltia (Taules 2 i 3). Pel que fa al grau, sempre s'ha d'assumir un grau B de progressió moderada i buscar evidència per canviar a progressió lenta o ràpida.

Estadi de periodontitis		**Estadi I**	**Estadi II**	**Estadi III**	**Estadi IV**
Gravetat	CAL interproximal màxim	1-2 mm	3-4 mm	≥ 5 mm	≥ 5 mm
	RBL	Terç coronal (<15%)	Terç coronal (15-33%)	Terç mig o apical	Terç mig o apical
	Pèrdua dentaria per periodontitis	0	0	≤ 4 dents	≥ 5 dents
Complexitat	Local	PPD màxima ≤ 4mm RBL horitzontal	PPD màxima ≤ 5mm RBL horitzontal	PPD ≥ 6mm RBL vertical ≥3mm Lesió furca II o III Defecte cresta òssia moderat	Addicionalment a complexitat III necessari rehabilitació complexa*
Extensió i distribució		Localitzada (< 30% de dents afectades), generalitzada (>30% dents) o patró molar/incisiu			

*Necessitat de rehabilitació complexa degut a disfunció masticatòria, trauma oclusal secundari que provoca mobilitat dental tipus 2 o 3, defecte de cresta greu, col·lapse oclusal, migracions o ventaments dentals, menys de 20 dents residuals (10 parelles d'antagonistes).

CAL = pèrdua d'inserció clínica, RBL = pèrdua òssia radiogràfica, PPD = profunditat de sondatge.

Taula 2. Característiques per definir els estadis de la periodontitis. Adaptada de Tonetti, Greenwell i Kornman.[2]

Grau de periodontitis – taxa progressió			**Grau A: lenta**	**Grau B: moderada**	**Grau C: ràpida**
Criteris primaris	Evidencia directa progressió	RBL o CAL	No pèrdua en 5 anys	Pèrdua < 2mm en 5 anys	Pèrdua ≥ 2mm en 5 anys
	Evidencia indirecta progressió	Relació Biofilm-destrucció	Molt biofilm amb destrucció baixa	Destrucció en consonància amb dipòsits biofilm	Destrucció exagerada pel biofilm dipositat
Modificadors	Factors risc	Tabaquisme	No fumadors	< 10 cigarrets/dia	≥ 10 cigarrets/dia
		Diabetis	No diabètic	Diabètics HbA1c <7%	Diabètics HbA1c ≥7%

HbA1c = Hemoglobina glicosilada

Taula 3. Característiques per definir els graus de periodontitis. Adaptada de Tonetti, Greenwell i Kornman.[2]

1.2.3. Prevalença i impacte a la societat actual

La prevalença de les malalties periodontals és molt elevada a nivell global i és una de les malalties cròniques no transmissibles més freqüent.[52] Es calcula que entre un 20 i un 50% de la població mundial pateix periodontitis.[49]

Una de les conseqüències de la periodontitis és la pèrdua de peces dentals. Això provoca una discapacitat funcional en els pacients, tant masticatòria com fonatòria i estètica.[50] Aquest fet pot comportar una disminució de la qualitat de vida de totes aquelles persones que pateixen periodontitis. [52]

La periodontitis no només afecta la boca i els teixits de suport de les dents, sinó que també té impacte en la salut general global. La periodontitis està relacionada amb malalties sistèmiques com la diabetis, les malalties cardiovasculars, la hipertensió arterial i també

amb problemes durant l'embaràs. També pot causar disfunció endotelial, canvis en la regulació metabòlica i inflamació sistèmica.[55]

1.2.4. Etiologia i factors de risc

L'etiologia de la periodontitis és multifactorial. El factor iniciador principal són els bacteris de la placa dental acumulats i organitzats en biofilms. La destrucció dels teixits ossis de suport és deguda a la resposta immune de l'hoste a nivell cel·lular. [50,56] Els leucòcits que es troben a les genives produeixen mediadors de la inflamació, citocines i metal·loproteases, que són les que realment destrueixen els teixits. Aquest fet es relaciona amb una inflamació sistèmica crònica a l'hoste.[57]

Entre els factors de risc de la periodontitis hi ha l'edat avançada, sexe masculí, hàbit tabàquic, factors genètics, la presència de bacteris específics (*Porphyromonas gingivalis, Tannerella forsythia i Fusobacterium nucleatum*), nivell socioeconòmic baix, estrès i factors cardio-metabòlics. En aquests factors s'inclouen la diabetis, l'obesitat i la hipertensió arterial.[56,58]

1.2.5. Tractament

El tractament de les malalties periodontals inclou, en primer lloc, el control del biofilm i placa supragingival amb la realització d'una bona higiene bucodental professional, per exemple amb ultrasons. En segon lloc, és tant o més important la recomanació i explicació de pautes d'higiene i hàbits dentals al pacient perquè sigui capaç de controlar la inflamació. És necessari que els pacients adoptin una bona tècnica de raspallat (ja sigui amb raspall manual o elèctric) i una bona higiene interproximal (amb fil dental o bé raspalls interdentals).També és igual d'important l'assessorament en la modificació dels factors de risc que poden influenciar negativament el resultat del tractament, com ara el tabaquisme o la diabetis. En aquesta fase es poden recomanar agents antisèptics en forma de pastes dentífriques o col·lutoris. En casos de gingivitis aquest serà el tractament estàndard. En casos de periodontitis aquesta és només la primera fase del tractament.[50]

La segona fase del tractament en casos de periodontitis depèn del grau i l'estadi de la malaltia. L'objectiu principal és reduir al màxim el biofilm i el càlcul subgingival. Aquest és l'anomenat tractament periodontal no quirúrgic i es coneix amb el nom de raspat i allisat radicular. Es pot fer amb mètodes ultrasònics i/o amb mètodes manuals amb curetes periodontals. En aquesta fase pot ser necessària l'ajuda d'agents químics coadjuvants, d'antibiòtics locals o fins i tot sistèmics.[50]

Entre 4 i 6 setmanes després d'haver realitzat el raspat i allisat radicular es duu a terme l'anomenada reavaluació periodontal, on s'avalua l'efectivitat del tractament. Si ha estat suficientment efectiu el pacient passaria a una fase de manteniment periodontal, i així estabilitzar la progressió de la malaltia. La freqüència d'aquests manteniments ha de ser regular (trimestral o semestral, per exemple) i depèn de l'èxit, característiques i factors de risc de cada pacient. En cadascuna d'aquestes visites s'avaluarà l'estat del pacient i si és necessari realitzar algun tractament complementari en alguna zona en particular o en tota la boca. En el cas que el tractament no hagi estat efectiu, i depenent de les característiques de cada cas, es pot realitzar tractament periodontal quirúrgic amb l'objectiu d'acabar d'eliminar el biofilm i càlcul subgingival (cirurgies resectives o d'accés) o amb l'objectiu de regenerar depèn de quina lesió òssia o gingival (cirurgies regeneratives).[50]

El tractament de la periodontitis beneficia no només de l'estat de salut bucodental, sinó que també pot produir una millora en l'estat de salut general i en la qualitat de vida dels pacients. Un tractament periodontal exitós pot tenir efectes positius en el control de la diabetis, en el control de malalties cardiovasculars i també pot ajudar a reduir les complicacions durant l'embaràs.[59,60] Aquest fet es contempla degut a una reducció de la càrrega bacteriana i possible bacterièmia sistèmica i també a la disminució dels marcadors sistèmics de la inflamació.

1.3. Relació entre la hipertensió arterial i la periodontitis

Com hem vist, la hipertensió arterial i la periodontitis són dues de les malalties més freqüents en l'actualitat.[1,31,52] A més, són molts els pacients que pateixen ambdues malalties a la vegada. Totes dues comparteixen factors de risc i es poden establir

paral·lelismes a nivell etiopatogènic.[56,61,62] L'evidència científica recent estableix una relació causal entre la hipertensió i la periodontitis.[55,63–65] Els pacients amb periodontitis moderada o severa tendeixen a tenir valors de pressió arterial més alts, i tenen entre un 30 i un 70% més probabilitats de tenir hipertensió.[63,66,67] De fet, en algunes guies mèdiques recents[41] s'ha inclòs la periodontitis com un factor de risc cardiovascular.

Malgrat això, els mecanismes exactes de la relació entre ambdues malalties no estan del tot clars. Els més plausibles són:

- La inflamació sistèmica que pot estar augmentada degut a la inflamació local gingival i el dany que això provoca a l'endoteli vascular.[67–69]
- La bacterièmia oral i disbiosi de les bactèries periodontals, que poden passar al torrent sanguini.[68]
- Aquesta bacterièmia oral pot influenciar a la producció d'òxid nítric, fet que pot produir anormalitats metabòliques que ajudin a pujar els nivell de PA.[67–69]
- L'estrès oxidatiu que produeix la periodontitis tant a nivell local com sistèmic pot tenir efecte en la funció endotelial produint canvis vasculars, augmentant la rigidesa arterial.[70–72]
- Predisposició genètica comuna per ambdues malalties.[68,73]

Més important encara, alguns estudis recents han arribat a la conclusió que el tractament periodontal pot arribar a reduir els valors de pressió arterial dels pacients.[40,74–79]

En aquest context és rellevant plantejar el rol que els dentistes i els tractaments dentals poden tenir en el context de salut pública i en la prevenció, diagnòstic i control de la pressió arterial.

Hipòtesi

2. HIPÒTESI

2.1. Preguntes d'investigació

- Quin paper poden tenir els dentistes en la prevenció, diagnòstic i control de la hipertensió i prehipertensió arterial?
- Quina prevalença de prehipertensió i hipertensió arterial hi ha en pacients amb periodontitis?
- Hi ha una relació entre la prehipertensió arterial i la periodontitis?
- Quin benefici pot suposar el tractament periodontal en els nivells de pressió arterial en individus amb prehipertensió arterial?
- La disminució dels nivells de pressió arterial té una relació directa amb l'èxit del tractament periodontal?

Objectius

3. OBJECTIUS

3.1. Objectiu principal

Conèixer quins efectes positius pot tenir el tractament periodontal no invasiu en el control de la pressió arterial en individus amb pressió arterial alta i periodontitis sense cap altre tipus d'actuació o canvi a nivell d'estil de vida ni cap teràpia farmacològica.

3.2. Objectius secundaris

- Establir quines accions poden dur a terme els dentistes i quins beneficis poden tenir els tractaments dentals periodontals en el diagnòstic, control i prevenció de la pressió arterial alta.
- Conèixer quina és la prevalença d'individus normotensos, prehipertensos i hipertensos entre els pacients que tenen periodontitis.
- Intentar establir la relació entre la prehipertensió arterial i la periodontitis
- Si existeix, quantificar la disminució dels valors de pressió arterial després del tractament periodontal comparada amb els valors de pressió arterial previs al tractament periodontal.
- Si existeix, veure si hi ha una relació directament proporcional entre la disminució dels valors de pressió arterial i la millora dels valors periodontals. És a dir, si a més milloria periodontal i ha més disminució de la pressió arterial.

Metodologia

4. METODOLOGIA

Aquesta tesi doctoral consta de tres articles cadascun dels quals vol abordar una visió de la relació que té la malaltia periodontal amb la pressió arterial alta. La metodologia emprada en cada cas està descrita detalladament a l'apartat de material i mètodes de cada article.

Resultats

5. RESULTATS

5.1 Coherència i complementarietat dels tres articles

El primer article és una revisió sistemàtica de la literatura que té com a objectiu revisar el publicat fins a mitjans del 2020 respecte la relació entre la hipertensió i la periodontitis i l'efecte que poden tenir els tractaments periodontals no invasius en els valors de pressió arterial i així contextualitzar l'estat de la qüestió fins al moment.

En el segon article, i veient a la literatura l'alta prevalença de la prehipertensió, vam voler analitzar la prevalença d'hipertensió, prehipertensió i normotensió en pacients amb periodontitis en el nostre àmbit d'actuació amb un estudi descriptiu *cross-sectional* de prevalença.

El tercer article i més rellevant, és el resultat d'un estudi de cohorts prospectiu, en el que es monitoritzen els valors de pressió arterial en pacients prehipertensos amb periodontitis abans i després del tractament periodontal no invasiu de raspats i durant un temps de seguiment de 6 mesos. L'objectiu és avaluar si el tractament periodontal té un efecte positiu en els valors de pressió arterial i quantificar-lo, sense cap altra modificació en hàbits, estil de vida del pacient o tractament farmacològic antihipertensiu.

5.2 Articles originals

5.2.1 Primer article

Títol: Does Periodontal Treatment Help in Arterial Hypertension Control? A Systematic Review of Literature.

Referència: Lanau N, Mareque-Bueno J, Zabalza M. Does Periodontal Treatment Help in Arterial Hypertension Control? A Systematic Review of Literature. Eur J Dent. 2021 Feb;15(1):168-173. doi: 10.1055/s-0040-1718244. Epub 2020 Oct 8. PMID: 33032337; PMCID: PMC7902101.

Revista: European Journal of Dentistry publicada per l'editorial Thieme.

Quartil (SJR Scopus): Q1 al 2021 publicació formal (Q2 al 2020, moment de la publicació online)

Factor impacte (SJR 2021): 0.622 (Revista 27 de 109 de la categoria d'Odontologia a Scopus)

Citescore 2021: 4.3

Contribucions a l'article: com a primera autora, contribució en el disseny de la revisió, la recollida de dades, l'anàlisi i interpretació de les dades i la redacció de l'article.

DOES PERIODONTAL TREATMENT HELP IN ARTERIAL HYPERTENSION CONTROL? A SYSTEMATIC REVIEW OF LITERATURE

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ABSTRACT

Arterial hypertension and periodontal diseases are two of the pathologies with more prevalence worldwide. In the last few years, several scientific evidence has demonstrated the relationship between both diseases. As well as the etiopathogenic and causal relationship, some recent publications have pointed out that the therapeutic approach of periodontitis could have positive effects on the control of arterial hypertension.

The aim of this systematic review is to determine whether there is a decrease or better control of blood pressure after performing non-surgical periodontal treatment in patients with periodontitis.

A thorough search in PubMed, Scopus and ISI Web of Science databases with the keywords "periodontal disease' OR 'periodontitis' OR 'periodontal' AND 'blood pressure' OR 'hypertension' OR 'arterial hypertension" was conducted. The quality of the reported information was assessed following the Prisma statement for systematic reviews.

Eight articles were considered for this systematic review. Five of the studies showed statistically significant reduction in systolic blood pressure values.

Despite the limitations of the review, non-surgical treatment of periodontal disease seems to reduce systolic blood pressure values. Further research with larger and longer-term clinical trials are needed in order to demonstrate this potential positive effect.

Key words: periodontitis, hypertension, blood pressure, periodontal disease, periodontal therapy

INTRODUCTION

Arterial hypertension is one of the most important and better studied cardiovascular risk factor and is associated with an increased risk of cardiovascular morbidity and mortality.[1]

Arterial hypertension affects 30 to 45% of the adult population and is the leading cause of premature death in the world.2 Its high prevalence is a global public health problem, it is estimated that by 2025 a third of the world's population could be hypertensive.[2]

In this scenario, the identification of hypertensive subjects and the control of their blood pressure measurements, in order to avoid cardiovascular events, is an unquestionable health goal.

The etiopathogenic mechanisms that trigger the onset of arterial hypertension are varied, multifactorial and not fully known; they include hemodynamic mechanical changes and stiffness in the arterial wall, autonomic and neurohormonal dysregulations, endothelial dysfunction, oxidative stress and local and systemic inflammation.[3]

Periodontal diseases, gingivitis and periodontitis, are very prevalent multifactorial inflammatory pathologies caused by bacteria that affect periodontal tissues. The prevalence of periodontitis is estimated to be between 20 and 50% of the worldwide population.[4] Among its etiopathogenic mechanisms there is a chronic inflammation response catalysed by different mediators.[5,6]

The etiopathogenic parallels and the high prevalence of both diseases in the same patients has raised the search for the relationship between both pathologies and the exclusion of confounding factors such as age, gender, smoking, educational level, socioeconomic status, obesity and diabetes. In recent years, there has been numerous scientific evidence that supports this relationship more solidly.[5,7,8,9] Its relationship has also been taken into account in different scientific societies and has been mentioned in dental and medical guides which address the management of high blood pressure.[5,10]

Beyond the etiopathogenic and causal relationship, it is of great importance the publication of some papers in which it is exposed that therapeutic approach of periodontal disease could have effects on the control of blood pressure measurements.[10] Although the evidence is very limited, it is a very important concept since many of the hypertensive patients are not treated or do not reach recommended blood pressure goals, or are poorly controlled despite various medical and

pharmacological treatments. Arterial hypertension is a modifiable risk factor, and any progress or improvement in its control affects individual cardiovascular risk.

These findings highlight the relevant role that dentists and dental treatments can play in the management of arterial hypertension either in the field of primary prevention through the identification of untreated patients or as secondary prevention, implementing oral treatments for the management and control of high blood pressure.

The aim of this review is to determine if there is a decrease or better control of blood pressure after performing non-surgical periodontal treatment in patients with periodontitis.

MATERIAL AND METHODS

Primary outcome

The primary outcome of this systematic review is to determine changes in BP measurements following periodontal therapy.

Inclusion/exclusion criteria

The eligibility criteria was defined according to PECO strategy. This acronym represents the patient (P), exposition (E), comparison (C), and outcome (O) characteristics of the eligible question.

The inclusion criteria considered original intervention articles, published in peer-reviewed journals, including all kinds of longitudinal studies (randomized clinical trials, cohort studies and case-control studies) that included adult patients with periodontal pathology (P), which evaluated exposed (E) and nonexposed patients to periodontal therapy (C), assessed the association between changes in BP and periodontal therapy (O). The search strategy was limited to articles published in English and studies conducted in humans. The exclusion criteria were case reports, reviews, descriptive studies, opinion articles, technical articles and case series. Individuals under 16 years old and pregnant women were also excluded.

Search strategy and study selection

A comprehensive search of the PubMed, Scopus and ISI Web of Science databases from its inception through November 2019 was conducted in order to identify studies that evaluated the

relationship between arterial hypertension and periodontitis, and more specifically studies that evaluated the changes in blood pressure after conducting non-surgical periodontal treatment.
We queried MeSH terms and the article text for the following search terms: ('periodontal disease') OR ('periodontitis') OR ('periodontal') AND ('blood pressure') OR ('hypertension') OR ('arterial hypertension').

The articles resulting from this search were screened manually, first based on the title, then the abstract and finally the complete manuscript, to determine their appropriateness for inclusion in the literature review. References cited in the included articles were also reviewed to identify additional published articles not identified by the database search.

Data extraction

Selected publications were independently reviewed by two investigators (MZ and NL). The extracted data included information about the study design characteristics, group and patients' characteristics (periodontal status and blood pressure assessment), the exact nonsurgical procedure and the reported results. Disagreements between the authors were resolved through consensus. Quality assessment of all included articles was performed independently by a reviewer as part of the data extraction process.
The quality of the reported information included in each article was assessed following the Prisma statement[11] for the improvement of the publication of systematic reviews (Appendix 1).

Definitions of periodontitis and hypertension.

Diagnosis of arterial hypertension

Hypertension was defined as Systolic Blood Pressure (SBP) ≥140 mmHg and/or Diastolic Blood Pressure (DBP) ≥90 mmHg or the use of anti-hypertensive medications.[2]

Diagnosis of periodontitis

Following the guidelines of the 2017 World Workshop on the Classification of Periodontal and Peri-implant diseases and conditions[12,13,14] in the context of clinical care, a patient is a "periodontitis case" if:

- Interdental CAL (Clinical Attachment Loss) is detectable at ≥ 2 non-adjacent teeth, or
- Buccal or oral CAL ≥3mm with pocketing ≥3mm is detectable at ≥2 teeth but the observed CAL cannot be ascribed to non-periodontitis-related causes.

RESULTS

Studies included

The study selection process for inclusion in the review was summarized in figure 1 (diagram flow). The database search strategy identified 395 potentially eligible references. After screening titles and abstracts, 52 full-text articles were reviewed in their entirety. Forty four articles were excluded because no periodontal intervention was performed or were focused only on the metabolic syndrome. Three additional articles were included after review of references. Eventually 8 studies were included in the literature research (Table 1).

Description of the Study Characteristics

The 8 studies included in this review had variable design, quality and no meta-analysis was performed because of the heterogeneity of the identified studies. The population of the studies varied from 40 to 125 patients depending on the article. Moreover the type of studies were different: 5 randomized clinical trials [15–19], one interventional prospective cohort study 10, one clinical intervention trial [20] and one pilot intervention study [21]. There were also different types of periodontal treatment compared. While some authors compared basic periodontal therapy (dental hygiene) and intensive periodontal treatment (scaling and root planing),[19] some others compared intensive periodontal treatment with or without administration of antibiotics, both local antimicrobials [15] and systemic [16,20]. There was another group of studies that had an intervention group where periodontal intensive treatment was performed and a control group that received no treatment until the end of the study [17,18]. Finally, there were two studies that only had one group of patients that received non-surgical periodontal treatment, dental hygiene or scaling and root planing according to need. [10,21]

DISCUSSION

The relationship between periodontal disease and arterial hypertension seems quite evident and there is significant scientific evidence that points to this direction. However, the association between basic or intensive periodontal therapy and the improvement in blood pressure levels is not entirely clear.

First, the studies that address this issue have different and varied results. The consistency and magnitude of the association is not clear in all of them because different results and conclusions

arise; from the significant decrease in blood pressure measurements after an intensive periodontal treatment to the invariability in blood pressure levels. Moreover, the groups are not homogenous, the measurements of blood pressure are different among studies and the follow-up is diverse.

Three of the included studies compared two groups of patients depending on whether periodontal treatment was performed with or without antibiotic therapy [15,16,17] both systemic or locally delivered in periodontal pockets. The first one, by D'Aiuto et al.[15] is a randomized clinical trial in which 40 patients with periodontal chronic disease defined as fifty per cent of dentition with periodontal probing pocket depths ≥ 4mm and with radiographic documentation of alveolar bone loss, were distributed in two groups. The first one received standard periodontal therapy (scaling and root planing session) and the second one received the same therapy to which small doses of local antibiotic therapy (minocycline microspheres) were added. The follow-up was performed 1, 2 and 6 months after the intervention. A decrease in SBP was detected at 2 months in the antibiotic therapy group with a mean difference of 7±3mmHg (CI 95% 1-12 p=0.0211). Moreover, this decrease was more important in smokers. However, the reduction was not maintained at 6 months nor did occur in DBP.

Bizzarro S et al.[16] also performed a randomized controlled clinical trial comparing two groups of patients (n=110). One group received basic periodontal therapy (scaling and root planing) and the second one received the same therapy with administration of systemic antibiotics (amoxicillin 375mg and metronidazole 250mg both 3 times daily for 7 days). Periodontitis was defined as CAL of at least ≥3mm in ≥2 non-adjacent teeth and patients were included if they had ≥30% alveolar bone loss at ≥2 teeth per quadrant and presence of ≥2 teeth per quadrant with periodontal pockets ≥5mm with at least ≥3mm of CAL and at least 50% of all sites in the mouth with bleeding on probing (BOP). The follow-up was performed 3, 6 and 12 months from baseline. A decrease in SBP was observed in both groups 12 months after treatment ($p<0.05$) but with no statistically difference between them (reduction of 2.7mmHg in control group and 5.4mmHg in the antibiotic group). No changes in DBP were observed.

In 2017 Jockel-Schneider et al.[20] performed a clinical intervention trial with 55 patients also comparing periodontal treatment (scaling and root planing) with or without administration of systemic antibiotic (amoxicillin 500mg and metronidazole 400 mg three times daily for 7 days). The periodontal parameters stated in order to be elected were: appearance of periodontal

pockets ≥6mm at a minimum of four teeth. Follow up was performed at 12 months. No changes in SBP or DBP statistically significant were observed in any group of patients.

There is another group of studies from the included that compare the BP levels between groups of patients with no periodontal treatment (or only a dental hygiene) and periodontal treatment (scaling and root planing).[18,19,20] The first one by Taylor B et al.[17] is a randomized controlled prospective trial with 125 patients comparing no periodontal treatment with scaling and root planing. Periodontitis parameters for the inclusion were six or more sites with ≥5mm PPD and ≥2mm attachment loss at teeth other than third molars. The duration of the study was 3 months and no changes in blood pressure were observed. The second study by Hada et al.[18] was also a randomized clinical trial with 55 patients. The control group did not receive periodontal therapy and the experimental group had two sessions of scaling and root planing. Periodontal parameters for the inclusion were: patients with at least 14 teeth (excluding third molars) and advanced chronic gingivitis and mild-to-moderate chronic periodontitis (at least four teeth with CAL ≤4mm at a minimum of one site). Follow up was performed 1, 3 and 6 months after the intervention. At 6 months, a statistically significant reduction of 7,1mmHg in SBP in the intervention group was observed ($p<0.05$). The third study by Zhou QB et al.[19] is a randomized clinical trial with 107 patients that compared BP levels in two groups of patients: the first one received a dental hygiene and the second one received periodontal treatment (scaling and root planing). Patients with moderate to severe periodontitis were included considered as the presence of at least two sites between adjacent teeth with ≥4mm attachment level and at least two such sites with ≥5mm pockets. Follow up was performed 1, 3 and 6 months after the intervention. At 6 months BP levels were markedly reduced in the treatment group. They observed an absolute difference of 12.57 mmHg in SBP and 9.65 mmHg in DBP (95% confidence interval: 10.45 to 14.69 and 7.06 to 12.24; $p<0.05$).

Finally, there are two studies of the included that only have one group, the treatment group with no control group.[10,21] The first one, by Vidal et al.[10] is an interventional prospective cohort study of 26 patients that had periodontal treatment, a dental hygiene or scaling and root planing according to its need. The periodontal parameters in this study were the diagnosis of generalized advanced chronic periodontitis. Follow up was done 3 and 6 months after the intervention. After six months a significant reduction in SBP and DBP was observed, 12.5mmHg and 10.0 mmHg respectively. The last study included in the review was done by Houcken et al,[21] a pilot

intervention study of 45 patients with only one treatment group (scaling and root planing was performed). The follow up was done 6 months after the intervention, where a significant reduction in SBP was observed (from 119.8 ±14.6 mmHg to 116.9±15.1 mmHg, p=0.04).

With all the studies reviewed we can conclude that periodontal treatment could have positive effects in blood pressure measurements, specifically in systolic blood pressure. Five of the studies showed statistically significant reduction in SBP values.[15,17,18,19,21] However, while in some articles19 questions about changes in lifestyle or habits were asked in the follow up visits, in other ones,16 confounders such as smoking habits, diet or physical activity were not taken into account; or even smoking patients were not included in the research.[18] Moreover, the periodontal parameters of inclusion and exclusion criteria were different in the studies, either because of the different definitions of periodontal diseases considered, or because in some studies the most severe forms of periodontitis were not included.[18] Furthermore, different evaluation methods of hypertension were performed. From our point of view all these different criteria may have affected the results due to a potential bias. The lack of publications and clinical studies that address this association, their heterogeneity, the role of inflammation in this process as bias, the variability that can occur in blood pressure measurements and the different guidelines in the treatment of periodontal disease must be taken into account when analysing these two diseases.

Our study has several limitations, which are also inherent to many systematic reviews. The retrospective nature of our review, incorporating data from published studies and not on individual patients, limits the availability of information on some issues, such as different clinical end points, comorbidities or concomitant therapies. No meta-analysis was performed, which was probably because of the heterogeneity of the identified studies.

Finally, the results observed forces us to reflect and ask ourselves new questions and challenges, as whether periodontal disease is a marker or mediator or some patients may have a genetic or metabolic susceptibility[22] that might also play a part, as well as whether it affects only the systolic blood pressure by some unknown mechanism or the periodontal treatment really has an initial effect on the blood pressure but not maintained over time.

CONCLUSIONS

Hypertension is an important modifiable cardiovascular risk factor and therefore all measures aimed at identifying and controlling its development and progression are a global public health priority.

Although there are few publications that address this topic, non-surgical treatment of periodontal disease could have a positive effect in the reduction of systolic blood pressure values. To our knowledge this is the first systematic review that points in this direction.

Further research with larger and longer-term clinical trials are needed in order to demonstrate this association. Periodontitis could influence the prevalence of hypertension and periodontal interventions could play an important role in the prevention of cardiovascular diseases.

DISCLOSURE

The authors declare no conflict of interest nor sources of funding.

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Authors contributions

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in all the parts of the realization of the manuscript.

Figure and table Legends.

Figure 1. Prisma diagram flow of the selection process

Table 1. Results of literature research

Figure 1

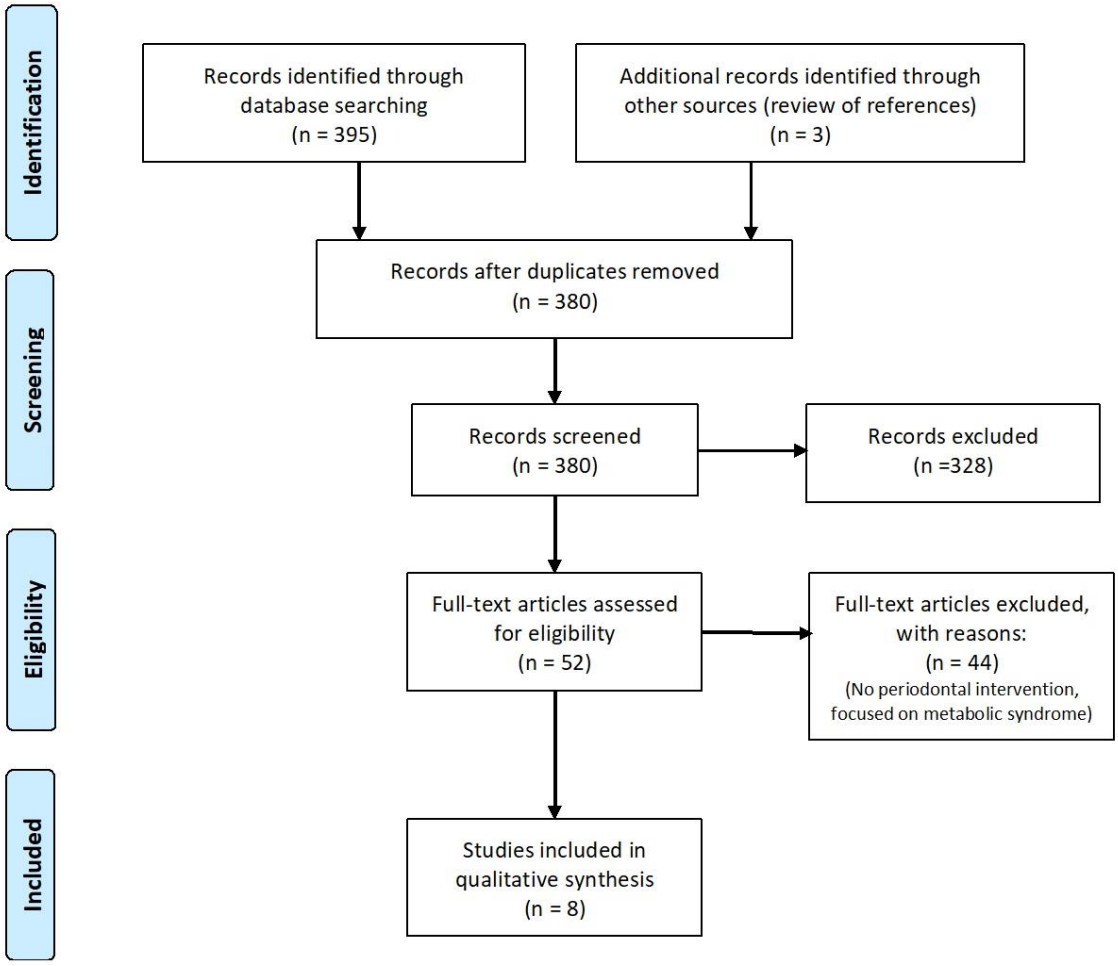
Identification
Screening
Eligibility
Included
Records identified through database searching (n = 395)
Additional records identified through other sources (review of references) (n = 3)
Records after duplicates removed (n = 380)
Records screened (n = 380)
Records excluded (n =328)
Full-text articles assessed for eligibility (n = 52)
Full-text articles excluded, with reasons: (n = 44) (No periodontal intervention, focused on metabolic syndrome)
Studies included in qualitative synthesis (n = 8)

Table 1. Results of literature research

Autor, year, country	Type of study	N	Periodontal intervention	Follow-up	Reduction BP	Results
D'Aiuto 2006 UK 15	Randomized single-blind interventional trial	40	Group A: scaling and root planing Group B: scaling and root planing + local antimicrobial	1,2,6 months	Group B decrease SBP 7±3mmHg at 2 months (p=0.0211) No stable at 6 months	Intensive periodontal treatment reduces systolic BP
Taylor B et al. 2010 Australia 17	Randomized controlled prospective trial	125	Group A: Intervention group (periodontal treatment) Group B: no treatment until end of study (3 months)	3 months	No changes in BP	BP levels did not change significantly in any of participants during study
Vidal et al. 2013 Brazil 10	Interventional prospective cohort study	26	Only one group, no control group Non - surgical treatment (dental hygiene or scaling and root planing according to need)	3,6 months	Reduction SBP 12.5mmHg and DBP 10.0mmHg after 6 months	Periodontal therapy significantly reduced levels of BP in refractory hypertensive patients.
Hada et al 2015 India 18	Randomized trial	55	Control group: no periodontal treatment Experimental group: scaling and root planing	1,3,6 months	Reduction SBP 7.1 mmHg treatment group in 6 months with no change in lifestyle (p<0.05)	Scaling and root planing is effective in reducing significantly systolic BP
Houcken et al. 2016 Holland 21	Pilot intervention study	45	Only one group. Non-surgical periodontal treatment	3,6 months	Decrease SBP 2.9mmHg after 6 months (p=0.04)	Peripheral systolic blood pressure significantly reduced after treatment
Bizzarro S et al 2017 Holland 16	Randomized controlled clinical trial	110	Group A: basic periodontal therapy Group B: basic periodontal therapy + antibiotics	3,6,12 months	Decrease SBP 2.7mmHg in group A and 5.4mmHg in group B at 12 months (p<0.05)	Systolic BP decreased in both groups with no statistically difference between them. No changes in DBP.
Jockel-Schneider et al 2017 Germany 20	Clinical intervention trial	55	Group A: scaling and root planing + antibiotic Group B: scaling and root planing	12 months	No changes statistically significant from baseline to 12 months	Peripheral blood systolic pressure was unchanged
Zhou et al 2017 China 19	Randomized clinical trial	107	Group A: dental hygiene Group B: Scaling and root planing	1,3,6 months	Reduction SBP 12.57mmHg and DBP 9.65mmHg in group B after 6 months (p<0.05)	Systolic BP and diastolic BP outcomes markedly reduced after treatment

5.2.2 Segon article

Títol: Prevalence of high blood pressure in periodontal patients: a pilot study

Referència: article acceptat per un Special Issue "Relationship between cardiovascular diseases and oral health" amb la publicació programada pel quart trimestre del 2023. (Carta d'acceptació a l'Annex 2)

Revista: Dental and Medical Problems publicada per la Facultat de Medicina de Wroclaw.

Quartil (SJR Scopus): Q2 Medicina General

Factor impacte (SJR 2021): 0.345 (Revista 313 de 826 de la categoria de Medicina General a Scopus)

Citescore 2021: 2.0

Contribucions a l'article: com a primera autora, contribució en el disseny de l'estudi, la recollida de dades, l'anàlisi i interpretació de les dades i la redacció de l'article.

Prevalence of high blood pressure in periodontal patients: a pilot study

Background

Arterial hypertension and periodontal diseases are two pathologies with high prevalence worldwide. Recent evidence suggests a possible causal relationship. Patients with moderate or severe periodontitis tend to present higher blood pressure measurements and have 30 to 70% higher possibilities to present hypertension.

Objectives

The aim of this cross-sectional pilot study is to determine the prevalence of high blood pressure in patients with periodontitis.

Material and methods

40 patients with diagnosed periodontitis and need for non-surgical periodontal treatment were included in this study. Demographic, periodontal and clinical characteristics including blood pressure measurements were registered.

Results

15% of the patients were classified as hypertensive (n=6), 67.5% as high normal (n=27) and 17.5% as normotensive (n=7). Recent studies have estimated that the prevalence of high normal blood pressure is between 30 and 50% in the general population. These findings suggest that patients with periodontal disease are more likely to present higher blood pressure levels than patients with healthy periodontal tissues.

Conclusions

High normal blood pressure is associated with three times more likelihood of developing hypertension so an early detection and prevention is a necessary public health strategy. Despite the limitations of this pilot study, it points out the role that dentists may play in the process of prevention, diagnosis and control of these patients to improve their health and cardiovascular risk.

INTRODUCTION

Arterial hypertension is one of the most important preventable cardiovascular risk factors which is associated with higher rates of vascular mortality and morbidity. [1]

High blood pressure (BP) affects about 30-40% of the adult worldwide population [2]. It is estimated that 1.39 billion people had hypertension in 2010 [3] and is the leading cause of premature death in the world (10.4 million deaths per year). [4]

Due to the ageing population and its high prevalence, the global burden complications of high BP continue to rise. In this scenario, the control of BP and identification of hypertensive patients is an essential public health goal.

The etiopathogenesis of hypertension involves multiple mechanisms such as environmental and pathophysiological factors including: autonomic and neurohormonal dysregulations, endothelial dysfunction, oxidative stress, mechanical changes, stiffness in the arterial wall and local and systemic inflammations. [5,6]

Periodontal diseases (gingivitis and periodontitis) are multifactorial inflammatory diseases caused by bacteria that affect soft and hard periodontal tissues and affects 20-50% of the world population.[7] It is a multifactorial disease and one of its etiological mechanisms is a chronic inflammation response catalysed by multiple mediators. [8,9]

Moreover, the high prevalence of hypertension and periodontitis and their etiological similarities have increased the search of relationship between them.[10] Recent articles suggest a possible causal relationship.[11] Patients with moderate or severe periodontitis tend to present higher BP measurements and the possibility to present hypertension is 30 to 70% higher.[12,13,14] Furthermore, recent evidence suggests that the treatment of periodontitis could benefit BP levels. [11,15]

All these data emphasise the importance of oral inflammation in high blood pressure and the prevention and early detection role that dentists and dental treatments can play in the management of high blood pressure. High BP is a manageable risk factor and its control affects directly the cardiovascular risk of the patients.

The aim of this study is to determine the prevalence of high blood pressure in patients with periodontitis in our clinical practice.

MATERIAL AND METHODS

Definition of hypertension and high normal blood pressure

Hypertension is defined as systolic blood pressure (SBP) **≥** 140 mmHg and/or diastolic blood pressure (DBP) **≥** 90 mmHg in adults older than 18 years old [2] diagnosed in the office or clinic. There are 3 grades of hypertension: grade 1 hypertension (SBP 140-159 mmHg and/or DBP 90-99 mmHg), grade 2 hypertension (SBP 160-179 mmHg and/or DBP 100-109 mmHg) and grade 3 hypertension (SBP ≥180 mmHg and/or DBP ≥110 mmHg).

Ideally it should be diagnosed with more than one office visit (2-3 visits at 1-4 week intervals) and if possible the diagnosis should be confirmed by out-of-office blood pressure measurements. This protocol is to prevent white coat hypertension, defined as elevated BP in the clinic but not in out-of-office. These patients represent 10-30% of the population and usually are at intermediate cardiovascular risk between normotensive and sustained hypertensives.[3,16]

Prehypertension, renamed as high-normal blood pressure in 2018 ESC guidelines[2] is defined as SBP 130-139 mmHg and/or DBP **≥** 85-89 mmHg. In this classification[2] normal blood pressure is defined as SBP between 120-129 mmHg and/or DBP 80-84 mmHg. Finally, the optimal blood pressure values are defined as SBP < 120 mmHg and DBP <80mmHg.

Definition of periodontitis

According to the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions [17,18], in the context of clinical care, a patent is considered a "periodontitis case" if:

- Interdental CAL (clinical attachment loss) is detectable at 2 or more adjacent teeth.
- Presence of buccal or oral CAL **≥** 3mm with pocketing **≥** 3mm detectable at 2 or more adjacent teeth (this CAL cannot be caused by non-periodontitis causes).

Inclusion and exclusion criteria

The patients included were adults with periodontitis that needed non-surgical treatment, patients with 10 or more teeth and patients with full capacity of giving consent to the study.

The patients excluded were pregnant and breastfeeding women, patients with acute localized periodontitis, patients that received periodontal treatment in the last 6 months and patients with other severe concomitant diseases.

Patient information

After a screening of 50 patients, only 40 met the inclusion criteria. These 40 patients were treated in our periodontology department during the years 2018-2021; diagnosed with periodontitis to receive non-surgical periodontal treatment. All the participants gave written consent to this study and to the use of the data. This study was approved by the Ethics Committee of Hospital Universitario Dexeus – Grupo Quironsalud with code 2018/ODI-2018-01.

At an initial evaluation 3 type of data were recorded:

1. Demographic characteristics: sex, age, heigh, weight and body mase index (BMI). According to BMI, the standard weight status categories are the following: underweight (values below 18.5 kg/m^2), healthy weight (values between 18.5 and 24.9 kg/m^2), overweight (values between 25 and 29.9 kg/m^2) and obesity (values >30 kg/m^2). [19]

2. Periodontal characteristics:

- Periodontogram with all the periodontal data (periodontal pocketing, clinical attachment level, bleeding on probing, dental mobility, furcation lesions, number of teeth present and plaque index)

- Dental habits questionnaire: frequency and type of toothbrush, interdental hygiene (dental floss, interproximal brushes or none) and frequency, if bleeding on brushing and the regularity of dental appointments.

3. Clinical characteristics:

- Blood pressure measurements (systolic and diastolic blood pressure and heart rate): as the ESC guidelines recommend, blood pressure measurements were taken with a validated electronic upper-arm cuff (Boso Medicus Family 4 Bosch+Sohn GMBH U.CO. KG, Jungingen, Germany) and with a cuff that fits the arm size of the patients by a trained operator. BP measurements were taken after 5 minutes of rest and in both arms. If there was consistent difference between them, the arm with the higher BP was used. Three measurements were taken at 2 minute intervals and the average of the last 2 measurements was used. The position of the patient was with the back supported, fit feet flat on the floor, with the arm bare and resting and mid-arm at heart level. The patient was asked not to talk during and between the measurements and not to smoke, drink coffee or exercise the previous 30 min to the visit. [3] In order to perform the study, BP

measurements were taken in the two first visits of the patients. The results presented are the average of the first and the second visit BP measurements.

- Cardiovascular risk factors: diagnosed hypertension (or antihypertensive medication prescribed) diabetes mellitus, dislipemia, family background and systemic diseases.

- Toxic habits: smoking habit (number of cigarettes or years after quitting), alcohol consumption (number of drinks).

- Healthy habits: physical activity, healthy diet, consumption of sugar drinks.

All the data was recorded by hand and then converted to an electronic data sheet. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement was followed during the whole process. [20]

Data analysis

As a descriptive study, data analysis was performed with SPSS.

BP level was described as a quantitative variable expressed with mmHg. Mean and standard deviation were calculated and follow a normal distribution.

The rest of the important variables are categorical. Gender is dicotomical (male and female). Age was taken as a quantitative variable but it was discretized in three groups (patients under 35 years old, patients between 36 and 59, patients older than 60). Smoking habit is also a dicotomical variable being only smoker or non-smoker the two options. Patients who were ex-smokers were included in the non-smoker group. Body Mase Index was calculated as a quantitative variable, but it was discretized in two groups: values between 18.5 and 25 kg/m^2 were categorized as healthy weight and values over 25 kg/m^2 were categorized as overweight and obesity.

RESULTS

40 Caucasian patients were included in the study, 19 men (47.5%) and 21 women (52.5%). The mean age was 47.7 years old (47.88 for men and 47.7 for women). (Table 1)

Among these 40 patients, 6 had hypertension (15%). Two of them were taking medication but were included in this group because the BP measurements were high and were referred to the

specialist for a check-up. The other 4 went to the doctor after our appointment to receive a correct diagnosis. Most of the patients, 27, were classified as high normal blood pressure (67.5%) and 7 of the total (17.5%) presented BP measurements classified as normal. Hypertensive patients had a mean age of 54.3 years old and 3 of them were men (50%) and 3 were women (50%). High normal blood pressure patients had a mean age of 45.9 years old and 15 of them were men (55.5%) and 12 of them were women (44.5%). The normotensive patients had a mean age of 48.7 years old and one of them was a man (14.3%) and 6 of them were women (85.7%). Mean blood pressure measurements of the patients in the hypertensive group were SBP 140.58 mmHg with standard deviation 10.74 mmHg and DBP 91.16 ±6.7mmHg. Mean BP values of the high normal blood pressure patients were SBP 126.9±6.5 mmHg and DBP 85.83±6 mmHg. Mean BP values for the normotensive patients were SBP 111.43 ±7.28 mmHg and DBP 73.14 ±3.93mmHg. (Figure 1)

Three patients presented other cardiovascular risk factors: one had diabetes (in the high normal blood pressure group) and two had hypercholesterolemia (one in the normotensive group and one in the hypertension group). In addition, 18 patients presented a Body Mase Index above 25kg/m^2, which is considered overweight or obesity (45% of the patients). Four of these patients were hypertensive (66.6% of the total of this subgroup), 11 were in the high-normal blood pressure group (40.7% of this group) and 3 of them were in the normal blood pressure group (42.85% of the normotensive patients).

50% of the patients (n=20) were smokers and 50% (n=20) of the patients were non-smokers, of these, 9 of them were ex-smokers. The smoker patients, 13 of them (65%) smoke more than 10 cigarettes a day. Regarding the BP groups, 2 of the smokers were in the hypertensive group (33.33% of the hypertensive patients were smokers), 16 of the smokers were in the High normal blood pressure group (59.2% of the prehypertensive patients were smokers) and 2 of the smokers were in the normotensive group (28.57% of the normotensive patients were smokers).

Regarding alcohol consumption, 3 patients declared more than two alcoholic drinks per day (7.5%), 32 declared occasional alcohol consumption (for example: weekends and holidays) (80%) and 5 patients declared no alcohol consumption at all (12.5%). The 3 patients that declared alcohol consumption, one was in hypertensive group, another in the normotensive group and the last one in the high normal blood pressure group.

Evaluating physical activity (considering physical activity more than 3 workouts a week) 9 patients declared regular physical activity (22.5% of total patients), 32 patients declared

occasional physical activity (80%) and 12 declared no physical activity at all (30%). Of these 12 sedentary patients, 25% were in the hypertensive group (n=3), 58.3% were in the high normal blood pressure group (n=7) and 16.7% were in the normal blood pressure group (n=2).

The majority of the patients (92.5% n=37) declared having a healthy diet based on Mediterranean diet with no abuse of carbonated and sugared drinks or trash food.

Regarding oral hygiene habits, 50% of the patients used an electric toothbrush (n=20), 35% used a manual toothbrush (n=14) and 15% of them (n=6) used both toothbrushes. The average time of toothbrushing per day was 2.125. Only 37.5% (n=15) performed interproximal hygiene whether with dental floss or interproximal toothbrushes with an average of 1.4 uses per day. There were no differences between groups.

DISCUSSION

Recent studies show that the prevalence of high normal blood pressure of the overall population is 30-50%. [21–24] . Patients with periodontal disease tend to present hypertension but also patients in early steps like high normal blood pressure.

In our study only patients with periodontitis were included and 67.5% of them had high normal blood pressure. The relationship between periodontal disease and arterial hypertension is well documented but not with prehypertensive states. This finding may suggest that patients with periodontal disease are more likely to present high normal blood pressure than patients with healthy periodontal tissues.

High normal blood pressure is associated with three times more likelihood of developing hypertension.[4] Moreover, there has been found an strong association between this status, coronary artery disease and cardiovascular mortality.[21,24] High normal blood pressure is also associated with worse cardiovascular risk profile and high prevalence of metabolic disorders.[25] Thus it is very important and necessary to implement early detection, prevention and treatment strategies not only for hypertension patients but also for previous states. [23,24]

Some of these risk factors are sex (men are more likely to present hypertension than women), age (older people have higher risk), heart rate (> 80 beats/min), smoking habit, diabetes, hypercholesterolemia, overweight or obesity, early-onset of menopause or family history of cardiovascular diseases or hypertension. [23]

Patients with high normal blood pressure usually have lifestyle modifications prescribed because the majority (69%) do not qualify for drug therapy[26]. These modifications include salt reduction, healthy diet and healthy drinks, moderation of alcohol consumption, weight reduction, smoking cessation, having regular physical activity and reducing stress. Taking into account these findings, it could be a good preventive strategy to check the oral and periodontal status of these patients and have periodontal treatment performed if necessary. Moreover, dentists may have an important role in the management and follow-up of these patients. During the realization of this study, four patients had repeatedly high levels of BP and they had no knowledge of their status. These patients were referred to general doctors for a check-up and in all four cases hypertension was diagnosed and pharmacologically treated.

This pilot observational study has some limitations, the most important is the number of patients included. The low number of hypertensive and normotensive patients may have been sources of potential bias. In addition, there is no control group of healthy periodontal patients. It is also important to notice the possible overestimation of BP levels due to white coat hypertension. It would be interesting to take 24-hour blood pressure measurements of the patients in order to confirm the diagnostics.

Our results may suggest the importance of detecting this subgroup of patients who are probably underdiagnosed because they do not meet strict criteria for hypertension. These types of patients have more cardiovascular risk factors and can benefit from early preventive actions.

Further and thorough research with a larger population and prospective clinical trials is necessary in order to confirm these findings. Additional investigation is needed to establish if periodontal treatment could benefit patients with high normal blood pressure to control the BP levels.

CONCLUSIONS

This descriptive and observational study suggests the high prevalence of high normal blood pressure in patients with periodontal disease in our environment, and highlights the importance of the dentist in the process of prevention, diagnosis, control and treatment of this state prior to established arterial hypertension, to improve their health and cardiovascular risk.

Declarations:

- Ethics approval: Ethics Committee of Hospital Universitario Dexeus – Grupo Quironsalud with code 2018/ODI-2018-01.
- The authors declare no conflict of interest.

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Table 1. Prevalence of hypertension and high normal blood pressure in patients with periodontitis

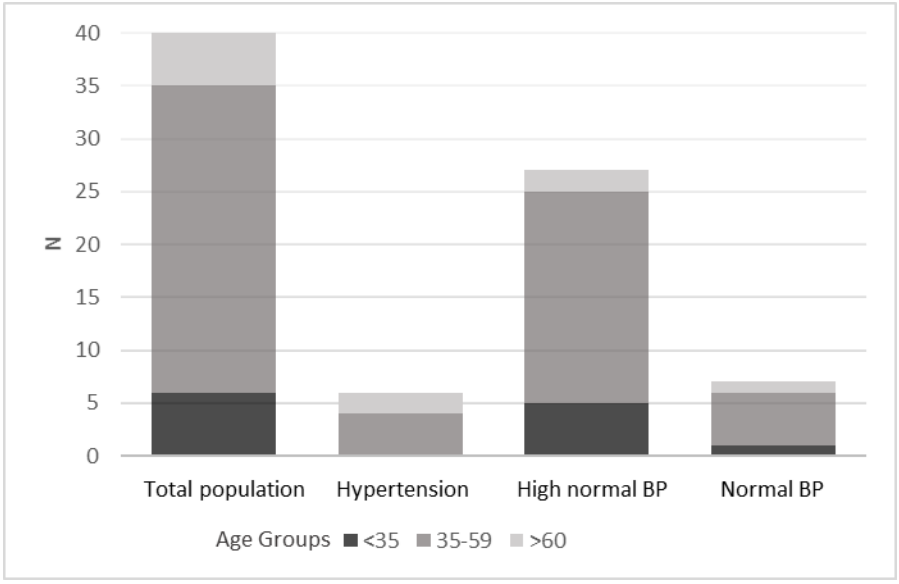
	Total population (%) (n=40)	**Hypertension (15%) (n= 6)**	**High normal (67.5%) (n=27)**	**Normal BP (17.5%) (n=7)**
Gender				
Male	19 (47.5%)	3 (50%)	15 (55.56%)	1 (14.29%)
Female	21 (52.5%)	3 (50%)	12 (44.44%)	6 (85.71%)
Age				
<35	6 (15%)	0 (0%)	5 (18.6%)	1 (14.28%)
35-59	29 (72.5%)	4 (66.7%)	20 (74%)	5 (71.43%)
>60	5 (15.5%)	2 (33.3%)	2 (7.4%)	1 (14.28%)
BP levels				
SBP (mmHg)	126.25 (±11.07 SD)	140.58 (±10.74 SD)	126.9 (±6.5 SD)	111.42 (±7.28 SD)
DBP (mmHg)	84.41 (±7.96 SD)	91.16 (±6.7 SD)	85.83 (±6 SD)	73.14 (±3.93 SD)
Smokers				
Yes	20 (50%)	2 (33.3%)	16 (59.26%)	2 (28.57%)
No	20 (50%)	4 (66.7%)	11 (40.74%)	5 (71.43%)
BMI				
18.5-25 (healthy weight)	22 (55%)	2 (33.3%)	16 (59.26%)	4 (57.14%)
>25 (overweight or obesity)	18 (45%)	4 (66.7%)	11 (40.74%)	3 (42.86%)

BP=blood pressure

SD=standard deviation

BMI=body mass index

Figure 1. Distribution of patients regarding age and blood pressure values



5.2.3. Tercer article

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Impact of non-surgical periodontal treatment on blood pressure: a prospective cohort study.

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Supplementary material: 1 figure and 2 tables

Impact of non-surgical periodontal treatment on blood pressure: a prospective cohort study.

ABSTRACT

Objectives. Arterial hypertension and periodontitis are two of the most common diseases worldwide and recent evidence supports a causal relationship between them. Despite all anti-hypertensive strategies, an important number of patients are undiagnosed and a large number of the diagnosed fail to achieve optimal blood pressure (BP) measurements. Some studies point out that periodontal treatment could have positive effects on BP levels. The aim of this study is to determine if non-surgical periodontal treatment can help BP level control in prehypertensive patients with periodontitis.

Material and Methods. 35 patients were included in the study and received non-surgical periodontal treatment according to necessity. Clinical data, periodontal data and BP measurements were taken at baseline, periodontal re-evaluation visit (4-6 weeks after treatment) and 6-month follow-up.

Results. Periodontal treatment caused a statistically significant reduction ($P<0.05$) of systolic blood pressure (SBP) and diastolic blood pressure (DBP) at re-evaluation visit of 4.7 ($p=0.016$) and 3.4 mmHg ($p=0.015$) respectively. The effect was maintained at 6-month follow-up visit with a reduction of SBP and DBP of 5.2 ($p=0.007$) and 3.7 ($p=0.003$) mmHg respectively.

Conclusions. Despite the limitations of this study, it suggests that non-surgical periodontal treatment can be effective in lowering BP levels in patients with prehypertension and periodontitis. Moreover, it highlights the importance of dentists in prevention, detection and control of this important cardiovascular risk factor.

Key words: periodontitis, hypertension, prehypertension, blood pressure

INTRODUCTION

Arterial hypertension is one of the most prevalent cardiovascular risk factors [1]. It is estimated to affect 1.4 billion people (>30% of world population) and cause around 10 million deaths per year worldwide, representing the first cause of premature death [2]. In this context, early detection of hypertensive patients and their medical control are essential in order to prevent cardiovascular events.

In addition, and despite all the anti-hypertensive strategies it is estimated that 15-50% of people are undiagnosed [3] and around 70% of the diagnosed patients fail to achieve optimal blood pressure (BP) measurements [4].

The concept of prehypertension or high normal pressure encompasses patients who have systolic blood pressure (SBP) values between 130-139 mmHg and/or diastolic blood pressure (DBP) values between 80-89 mmHg [2]. This condition is associated with three more times probabilities of developing hypertension [1]. Moreover, it has been linked with worse cardiovascular risk profile, higher prevalence of metabolic disorders and cardiovascular mortality [5–7].

Periodontal diseases, gingivitis and periodontitis, are one of the most prevalent chronic multifactorial inflammatory diseases worldwide 8. It is estimated that 20-50% of the population is affected [1,8]. Periodontal diseases are caused by bacteria and not only affect support tissues around teeth, but can also cause endothelial dysfunction, metabolic dysregulation and systemic inflammation [9]. Likewise observational and experimental evidence suggests the importance of systemic inflammation in the development and progression of hypertension [3].

Recent evidence supports a causal relationship between hypertension and periodontitis [9,10]. Regarding this relationship, is important to take into account, for example, the genetic predisposition of both diseases [11,12] and the effect that local inflammation of periodontal tissues has into systemic inflammation and vascular endothelium [11,13,14.] Patients with moderate or severe periodontitis tend to present higher BP measurements and have 30-70% more probability to develop hypertension [10,13,15] . In some recent medical guides 16 periodontitis is now being considered as a cardiovascular risk factor. Moreover, some studies conclude that periodontal treatment helps reducing BP measurements [16–23].

Therefore, with this interventional prospective cohort study, we aimed to investigate if non-surgical periodontal treatment could have a positive effect in blood pressure levels, in patients with periodontitis and pre-hypertension.

MATERIAL AND METHODS

The participants in our study were consecutive patients from general dental practice in Barcelona, Spain, enrolled between January 2021 and March 2022. This study was approved by the Ethics Committee of Hospital Universitario Dexeus Grupo Quironsalud with code 2018/ODI-2018-01. Written consent to participate in the study was given by all patients.

Adult patients aged 18 or older, diagnosed with prehypertension were enrolled into the study if they also presented with moderate to severe periodontitis. Moreover, patients must have 10 or more teeth and full capacity to understand, authorize and sign informed consent. Exclusion criteria included acute and major chronic inflammatory/immune disorders, chronic diseases and malignancies (within the last 5 years) as assessed by the examining clinician. Patients who had received treatment with medications known to affect periodontal status and patients using systemic or local immunosuppression within the previous 6 months were excluded, as were patients with any cause of secondary hypertension; meaning patients with hypertension caused by medications, alcohol or drug consumption or hypertension caused by other systemic, metabolic or immune diseases such as hypertiroidism. Moreover, patients with necrotizing periodontitis, patients who had periodontal treatment in the previous 6 months and breastfeeding and pregnant women were also excluded.

Definition of periodontitis

Regarding the Classification of Periodontal and Peri-implant Diseases and Conditions [24] established in 2017 in the American Academy of Periodontology and the European Federation of Periodontology World Workshop, a patient is considered a "periodontitis case" in the context of clinical care if:

- Interdental CAL (clinical attachment loss) is detectable at two or more adjacent teeth.
- Presence of buccal or oral CAL ≥ 3mm with pocketing ≥ 3mm detectable at 2 or more adjacent teeth (CAL only caused by periodontitis causes).

Moreover, each periodontitis case can be classified regarding stage (severity of periodontitis, from I to IV) and grade (expected progression, biological characteristics and risk factors). The stage takes into account the severity (CAL, radiographic bone loss and tooth loss), complexity (PPD and type of bone loss horizontal or vertical) and extent and distribution. Regarding grade, a moderate progression is always assumed and evidence must be found to change grade into slow or rapid rate of progression[24].

Definition of Hypertension and Prehypertension

According to the 2018 ESC guidelines [2] optimal blood pressure values are defined as SBP < 120 mmHg and DBP <80mmHg. Hypertension is defined as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg diagnosed in a medical office. High-normal blood pressure (formerly prehypertension) is defined as SBP 130-139 mmHg and/or DBP ≥ 85-89 mmHg [2]. These patients were the target of our study.

Sample size

A calculated minimum of 37 patients were necessary to recognize a statistically significant difference of 5 mmHg in BP between visits, accepting an alpha risk of 0.05 and a beta risk of 0.2 in a two-sided test. The standard deviation was assumed to be 10 and a drop-out rate of 15% was anticipated. A final sample size of 35 patients was enrolled.

Study dynamics and patient information

This study consists of three visits: baseline, periodontal re-evaluation (4-6 weeks after the treatment), and follow-up at 6 months. During all the study STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology) [25] was followed.

The data collected were the following:

a) Socio-demographic data: age, sex, ethnicity, height, weight and body mase index (BMI).

b) Periodontal data:

- Dental habits questionnaire: frequency and type of brushing, type of interdental hygiene (interproximal brushes, dental floss or none) and frequency, presence of bleeding while brushing and regularity of dental appointments. (Supplementary material table 1)
- Electronic Periodontogram recording probing pocket depth (PPD), clinical attachment level (CAL) and bleeding on probing (BOP). Third molars if present were excluded of the data analysis.

c) Clinical data:

- Cardiovascular risk factors: diabetes mellitus, dislipemia, systemic diseases and family background.
- Toxic habits: smoking (number of cigarettes per day), alcohol consumption (number of drinks per day/week).
- Healthy habits: healthy diet, consumption of carbonated and sugared drinks, physical activity. (Supplementary material table 2)

In all visits patients were asked if there had been any change of habits whether it was an improvement of dental hygiene or any lifestyle change such as smoking reduction, increase of physical activity, diet changes or weight changes.

Blood pressure measurements

Blood pressure measurements (SBP, DBP and heart rate) were obtained by a trained operator, with a validated electronic upper-arm cuff (Boso Medicus Family 4 Bosch+Sohn GMBH U.CO. KG, Jungingen, Germany) according to the ESC guidelines[2]. Patients were asked not to talk during the measurements and not to exercise, smoke or consume caffeine the previous 30 minutes to the appointment. When the patients arrived, measurements were taken after 5 minutes of rest and in both arms. If there were important differences between them, the arm with higher values was used. Measurements were taken three times at 2-minute intervals, the first one was discarded and the mean of the other two was used. The patients were with back support, feet flat on the floor, with the arm bare resting and with mid-arm at heart level. To perform the study and in order to include the patients, BP measurements were taken in the first two visits to the clinic. The baseline BP measurements presented are the average of the first and the second visit measurements.

Periodontal examination and treatment

Periodontal treatment consisted of non-surgical periodontal treatment (scaling and root planing), divided in two half-mouth sessions separated 7-10 days between them. Patients were locally anesthetized with articaine 4% epinephrine 1:100.000 (Septodont) or mepivacaine 3% (Septodont) if necessary. Treatment was performed first with H3 ultrasound tip (Acteon Satelec) and then with Gracey curettes (Bontempi – American Eagle). Irrigation with oxygen peroxide was performed at the end of each session. Patients were given postoperative and dental hygiene instructions and were asked to rinse with Chlorhexidine 0.12% + CPC 0.05% (Dentaid) 2 times a day during 2 weeks following the treatment. Data was recorded by hand, checked for errors and then converted to an electronic data sheet.

Data analysis

Variable description

SBP and DBP levels were described as quantitative variables expressed in mmHg. PPD and CAL were assessed at 6 points sites around each tooth, and were described as quantitative variables

expressed in mm. For analysis purposes the mean of all sites was calculated for each patient in each visit. BOP was described as a categorical variable (presence or absence of bleeding) and assessed for each tooth. For analysis purposes the percentage of BOP was calculated for each patient in each visit. BMI was calculated as a quantitative variable but was classified in 4 groups: underweight (values <18.5), healthy weight (18.5-24.9), overweight (25-29.9) and obesity (>30).

Statistical analysis

Statistical analysis was performed with python scipy.stats. Shapiro-Wilk test was used to assess if variables were normally distributed. Paired samples T-student test was used to compare BP levels and PPD and CAL values before and after non-surgical periodontal treatment. Normally distributed variables were reported as mean ± SD. Wilcoxon signed-rank test vas used to compare BOP percentages before and after non-surgical periodontal treatment. Relationship between the decrease of BP levels and the amount of periodontal improvement was assessed with Pearson or Spearman Correlation as needed. P <0.05 was considered statistically significant.

RESULTS

After a screening of 56 patients, 38 meet the inclusion criteria for adults with prehypertension and periodontal disease. Three patients did not reach the 6-month time point and were lost to follow-up. Finally, 35 patients (17 females and 18 males) finished the 6-month follow-up and were included in the study (Figure 1). Baseline characteristics of the patients included are shown in Table 1.

Effects of periodontal treatment on blood pressure

There were statistically significant differences (P<0.05) of BP values before and after non-surgical periodontal treatment. (Figure 2).

Periodontal treatment caused a significant reduction at the re-evaluation visit of SBP (figure 3a) and DBP (figure 3b) by 4.7 and 3.4 mmHg, respectively. The effect was maintained over time and is reflected in the six-month follow-up visit with a reduction of the SBP (figure 3c) and DBP (figure 3d) by 5.2 and 3.7 mmHg, respectively.

Effects of periodontal treatment on periodontal health

The dental treatment produced a substantial improvement in periodontal parameters of all participants when compared to baseline. The analysed variables: PPD, CAL and BOP had statistically significant reduction during follow-up. (Table 2)

There is a reduction in the mean values of PPD, CAL and BOP percentages as well as the mean values of SBP and DBP between baseline and re-evaluation visit (Supplementary material figure 1) and between baseline and 6-month follow-up visit (Figure 4). However, there was no direct relationship between the amount of periodontal improvement and the amount BP levels improvement. No relevant changes in clinical data (toxic and healthy habits) were observed between visits. An important number of patients (82.8%) had an improvement of dental hygiene habits at 6 month-follow up (Supplementary material table 1). Age, sex, smoking habit, alcohol consumption, type of diet, physical activity and changes in dental hygiene habits had no statistically significant impact in the improvement of BP levels.

DISCUSSION

Recent studies suggest a causal link between periodontitis and high blood pressure [9,10,13,16,26] confirming that patients with severe periodontitis tend to have higher blood pressure levels than patients with healthy periodontal tissues. Moreover, evidence suggests that periodontal treatment can improve blood pressure levels [18–23,27].

The present study found a statistically significant reduction in SBP and DBP both in the periodontal re-evaluation visit (4-6 weeks after the treatment) that was maintained at 6-month follow-up visit. Despite the heterogeneity in groups, follow-up protocols and types of study our findings are in line with recent studies regarding the effect of non-surgical periodontal treatment in BP levels. BP reductions described in literature are highly variable from no decrease at all 28, not statistically significant [29] or reductions of 11.1 mmHg [9].

In 2006 D'Aiuto [18] found reduction in SBP after periodontal treatment combined with antimicrobials of 7±3 mmHg at 2 months but this reduction was not stable at 6-month follow-up. Vidal et al in 2013 [19] described a reduction both in SBP and DBP of 12.5 mmHg and 10.0 mmHg respectively 6 months after non-surgical periodontal treatment. In 2015 Hada et al [20] found a reduction in SBP of 7.1 mmHg at 6 months. In 2016, Houcken et al [21] described a decrease in SBP of 2.9 mmHg at 6 months. Similar results were found by Bizzarro et al [22] in 2017, which

described a reduction of 2.7 mmHg at 12 months in patients that received non-surgical periodontal treatment that increased to 5.4 mmHg reduction when treatment combined with antibiotics.

In 2017, Zhou et al [23] described a reduction in SBP and DBP of 12.57mmHg and 9.65 mmHg respectively at 6 months following scaling and root planing periodontal treatment. Similar results were published by Czesnikiewicz-Guzik M et al [9] in 2019, which found a reduction in SBP of 11.1mmHg and DBP of 8.3 mmHg 2 months after periodontal treatment. In this last case, BP measurements were taken with a 24-hour Ambulatory Blood Pressure Monitoring (ABPM). While this measurement method is more reliable in diagnosing high blood pressure, some evidence suggests 11 that studies using ABPM show the greatest reduction both in SBP and DBP. Our findings are also consistent with recent large cross-sectional survey of 11753 participants that showed that periodontal health is associated with better SBP profile by about 3 mmHg and with lower odds of anti-hypertensive treatment failure [30].

The prevalence of high normal blood pressure is estimated to be 30-50% of overall population [6,7,31,32] and is associated with 3 times more likelihood of developing hypertension in the future[1]. Therefore, any strategy focused on diagnosing and lowering BP levels on these patients is an important preventive public health goal. The study published by Kawabata et al [27] suggests that the presence of periodontitis can be a risk factor for developing hypertension in patients with prehypertension.

The exact mechanisms that link high BP and periodontitis remain unclear. Different factors are described in the literature. The most important pathomechanism seems to be systemic inflammation that may be exacerbated by local gingival inflammation, and secondary damage to the vascular endothelium [11]. Moreover, the bacteraemia and oral pathogens dysbiosis that occur in periodontal diseases has an important role. Oral bacteria can influence nitric oxide production and this may produce metabolic abnormalities that contribute to BP levels rising [11.] Furthermore, recent evidence demonstrates common genetic predisposition factors for both diseases [11], which can explain the frequent coexistence of them.

This study has not found a proportional relationship between the rate of improvement of periodontal values (PPD, CAL, BOP) and the rate of BP level improvement (SBP and DBP). This

may be explained by the fact that performing non-surgical periodontal treatment in patients with periodontitis, decreases by itself gingival and systemic inflammation.
This simple periodontal treatment that patients need is already a benefit for the individual cardiovascular risk profile of patients. An improvement of only 5mmHg in SBP can reduce stroke mortality by 14% and cardiovascular disease mortality by 9% [26].

Our clinical study has its limitations. The low number of patients included needs to be confirmed in a large cohort of prehypertensive patients. Moreover, there may be an overestimation of BP levels due to white coat hypertension. Ambulatory 24-h BP monitoring would be a very useful tool to confirm diagnostics. Also, a longer follow-up of 12 months would be needed to allow for therapeutic recommendations and conclusions. Finally, it should be considered that the decrease in BP may be due to the result of general healthy instructions and oral hygiene improvement apart from periodontal treatment.

Findings of this study suggest the importance and impact of periodontal treatment in BP levels in patients with prehypertension. Moreover, the importance of early detection of this subgroup of patients, who are usually underdiagnosed because they do not meet the strict criteria for hypertension.

Likewise, and just as important as the clinical findings, our study emphasizes the figure of the dentist in the context of public health. The role of professionals in dental clinics is fundamental in the primary and secondary prevention of arterial hypertension. The implementation of BP screening programs in patients with periodontitis and practical circuits where to refer affected patients is essential. Finally, the clinical practice of the dentist can be fundamental in the non-pharmacological control of this cardiovascular risk factor.

CONCLUSIONS

This study shows that non-surgical periodontal treatment can be effective in lowering BP levels in patients with prehypertension and periodontitis, without any antihypertensive medication. It also highlights the importance of dentists in prevention, detection and control of high blood pressure and cardiovascular risk

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TABLES

Table 1. Baseline characteristics of the participants in the study.

	Total participants (n=35)	Male (n=18) 51.4%	Female (n=17) 48.6%
Age mean (years)	45.42(28-65)	45.42 (30-65)	45.42 (28-58)
Smoking, n (%)			
Current	17 (48.6%)	10	7
Never	7 (20%)	2	5
Past	11 (31.4%)	6	5
BMI, n (%)			
· Underweight	1 (2.9%)	0	1
· Healthy weight	18 (51.4%)	11	7
· Overweight	11 (31.4%)	5	6
· Obesity	5 (14.3%)	2	3
DM2, n (%)	1 (2.9%)	1	0
Average SBP (mmHg)	129.6 ± 7.6	131.6 ± 5.6	127.4 ± 8.8
Average DBP (mmHg)	87.0 ± 5.0	86.2 ±5.5	87.9 ± 4.4
Heart rate (b.p.m)	70.5 ± 11.46	70.5 ± 11.7	70.5 ± 11.46
Mean PPD (mm)	4.14 ± 0.49	4.15 ± 0.52	4.13 ± 0.47
Mean CAL (mm)	4.51 ± 0.71	4.64 ±0.86	4.37 ±0.49

Table 2. Effects on blood pressure and periodontal changes (p-value calculated between baseline and periodontal re-evaluation and between baseline and 6-month follow-up).

Parameters	Baseline	Periodontal re-evaluation 4-6 weeks		6-month follow-up	
SBP (mmHg)	129.6 ± 7.6	124.9 ± 10.2	(p=0.016)*	124.4 ± 9.8	(p=0.007)*
DBP (mmHg)	87.0 ± 5.0	83.6 ± 7.5	(p=0.015)*	83.3 ± 6.1	(p=0.003)*
PPD (mm)	4.14 ± 0.49	3.44 ± 0.52	(p<0.001)*	3.41 ± 0.55	(p<0.001)*
CAL (mm)	4.51 ± 0.71	3.78 ± 0.78	(p<0.001)*	3.76 ± 0.81	(p<0.001)*
BOP (%)	96.2	43.4	(p<0.001)*	44.6	(p<0.001)*

p= p-value

*= statistically significant

FIGURE LEGENDS

Figure 1. Flow diagram of patient inclusion and exclusion.

Figure 2. SBP and DBP during 6-month follow-up period. a and b represent mean SBP and mean DBP respectively. Vertical bars represent standard deviation (SD). P-values were calculated with paired samples T-student test between baseline and re-evaluation visit and between baseline and 6-month follow-up visit.

Figure 3. Histogram of BP distribution. a and b represent changes in SBP and DBP distribution respectively between baseline and periodontal re-evaluation visit. c and d represent changes in SBP and DBP distribution respectively between baseline and 6-month follow-up visit. Vertical lines represent BP mean values of each visit.

Figure 4. Relationship between periodontal parameters (PPD (mm), CAL (mm), BOP (%)) and SBP and DBP (mmHg) measurements (left and right column respectively. Baseline values are presented in blue and 6-month follow-up values are presented in green.

Supplementary material Figure legends

Figure 1. Relationship between periodontal parameters (PPD (mm), CAL (mm), BOP) and SBP and DBP (mmHg) measurements. In blue baseline and in orange re-evaluation visit.

Figure 1. Flow diagram of patient inclusion and exclusion.

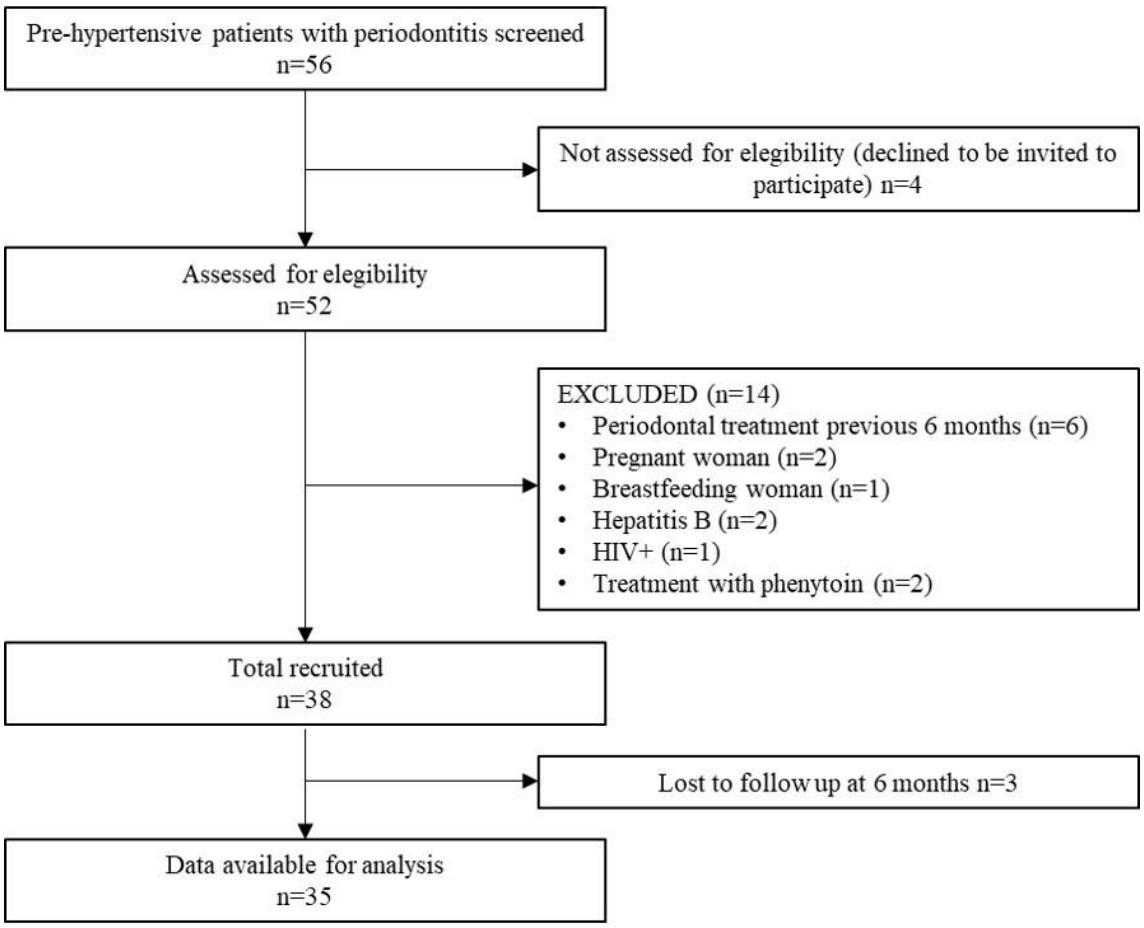
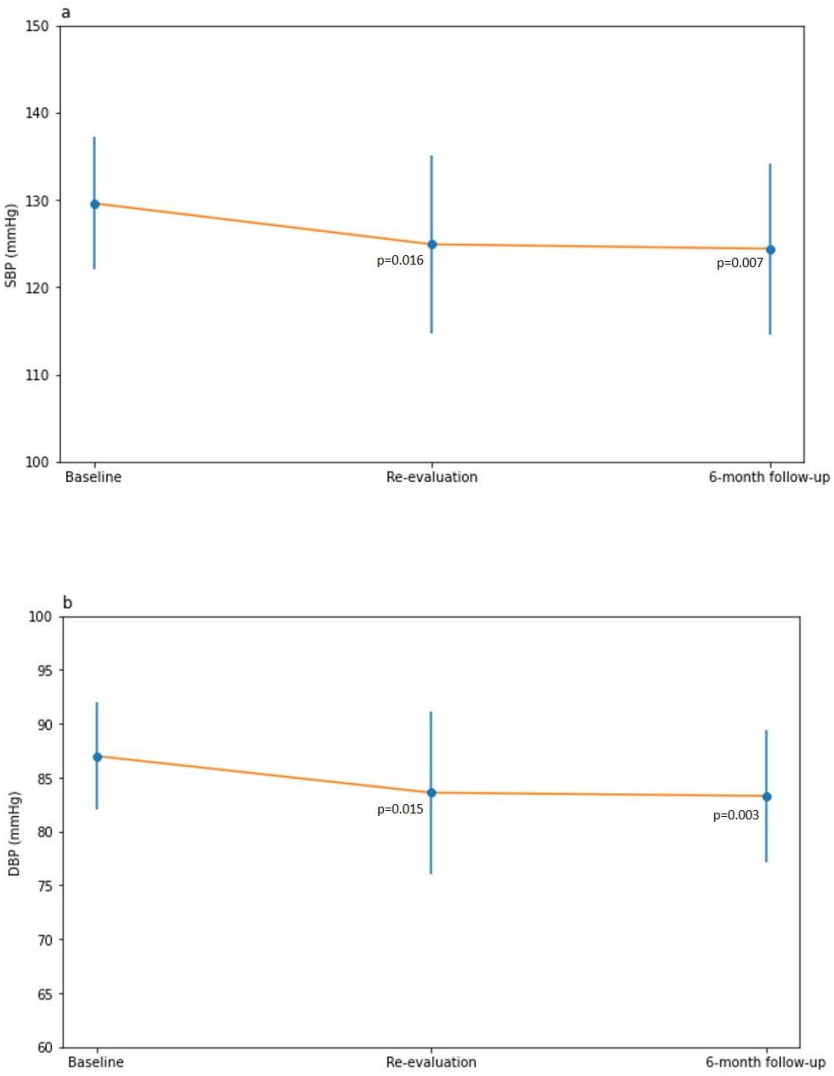


Figure 2. SBP and DBP during 6-month follow-up period. a and b represent mean SBP and mean DBP respectively. Vertical bars represent standard deviation (SD). P-values were calculated with paired samples T-student test between baseline and re-evaluation visit and between baseline and 6-month follow-up visit.



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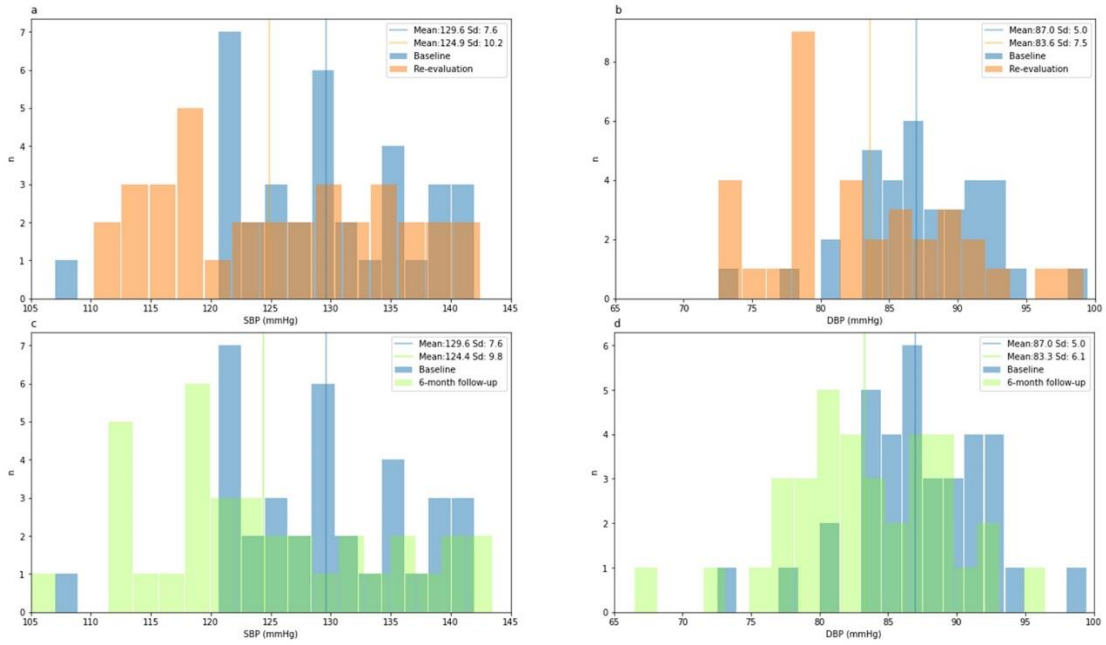

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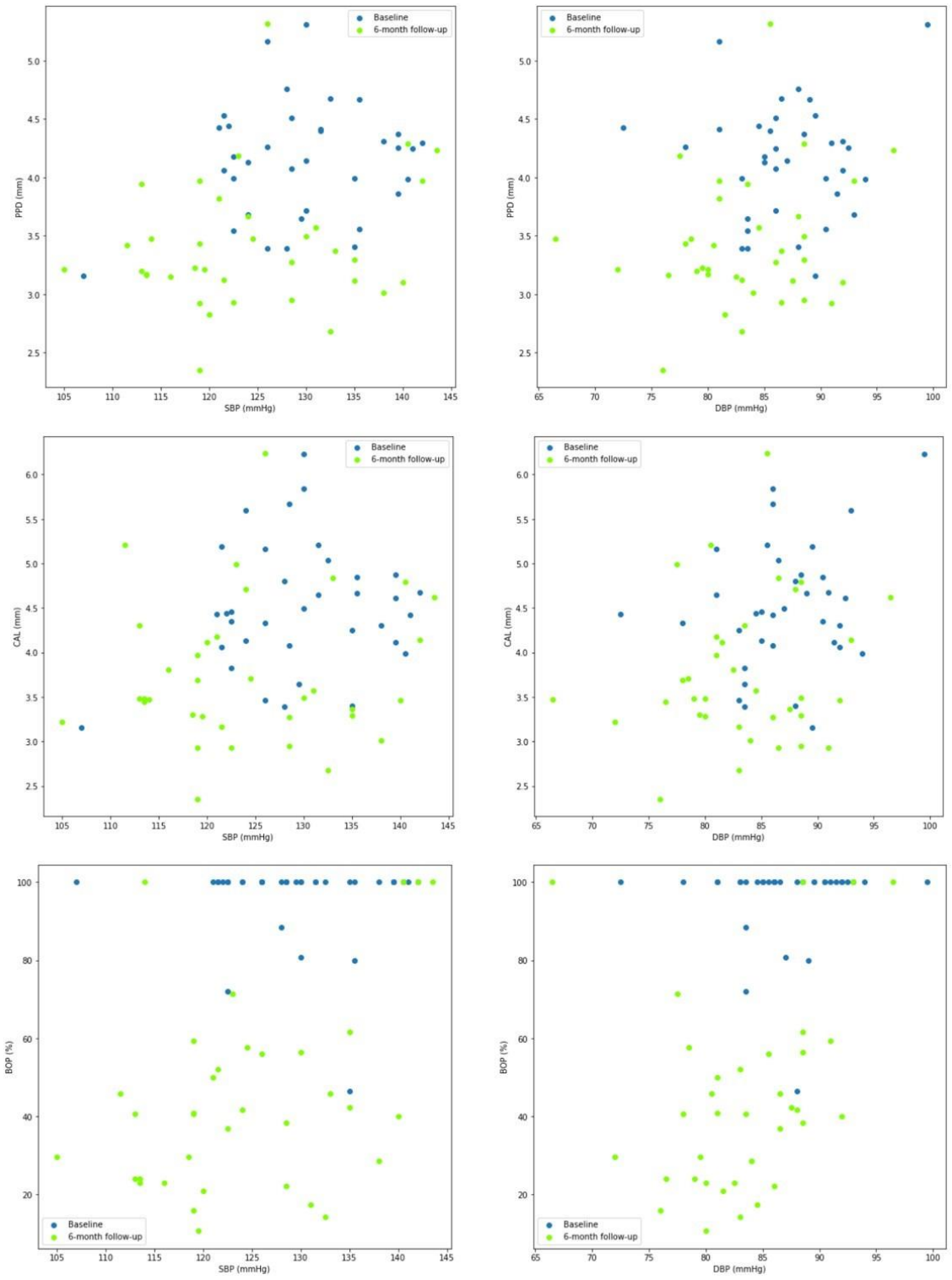


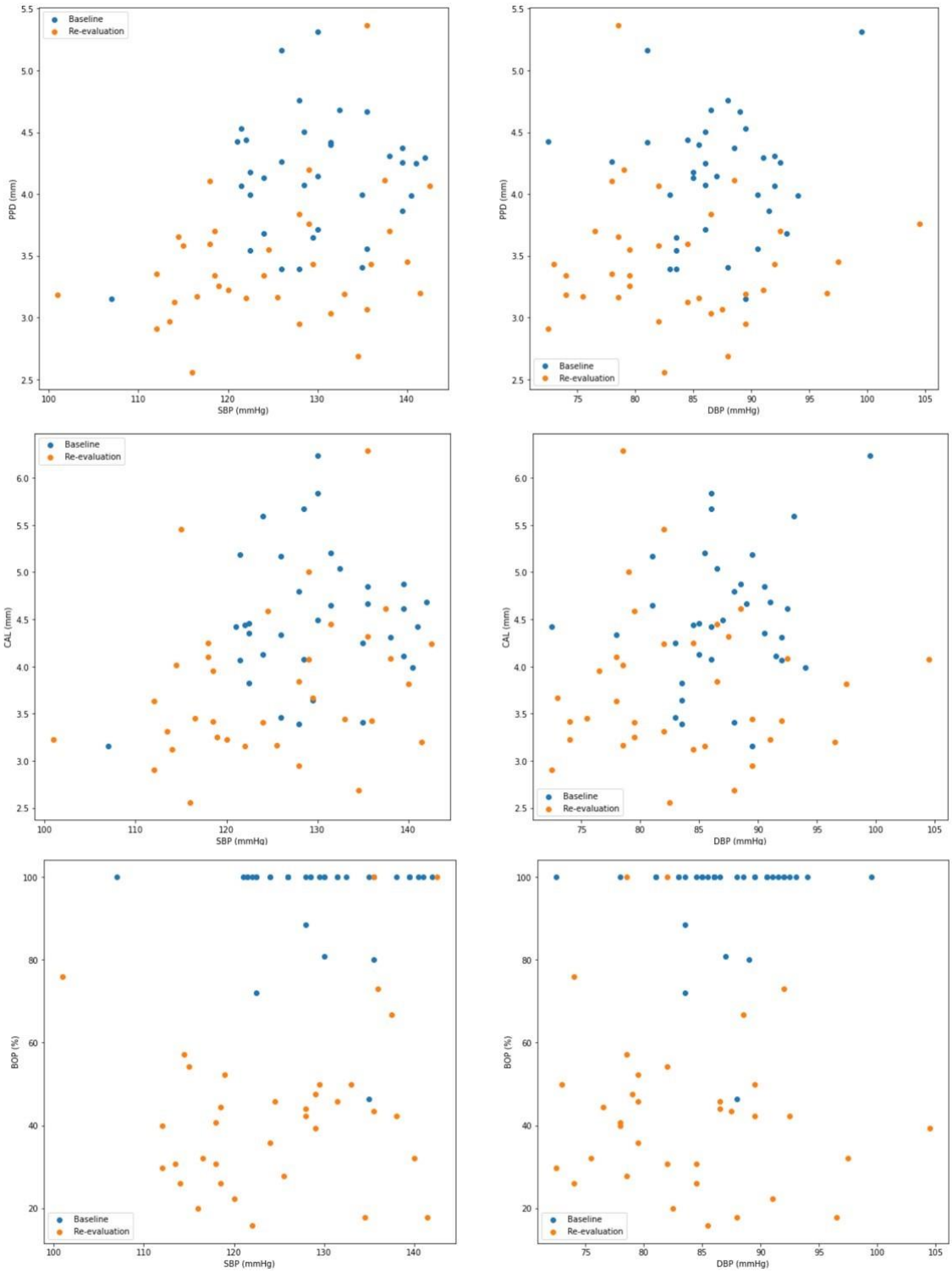
Supplementary material Table 1. Dental Habits Questionnaire at baseline and 6-month follow-up.

BASELINE	Total (n=35)	Male (n=18)	Female (n=17)
Type of brushing			
- Manual	17	8	9
- Electric	13	7	5
- Both	5	3	2
Frequency of brushing			
- 1/day	8	5	3
- 2/day	17	7	10
- 3/day	10	6	4
Interproximal hygiene			
- No	25	12	13
- Yes (1/day)	10	6	4
- Dental floss	7	4	3
- Interproximal brush	3	2	1
Bleeding while brushing			
- No	2	0	2
- Yes	28	16	12
- Occasionally	5	2	3
Regularity dental appointments			
- Yes	11	7	4
- No	24	11	13
6-MONTH FOLLOW-UP	Total (n=35)	Male (n=18)	Female (n=17)
Type of brushing			
- Manual	1	1	0
- Electric	25	12	13
- Both	9	5	4
Frequency of brushing			
- 1/day	4	3	1
- 2/day	13	6	7
- 3/day	18	9	9
Interproximal hygiene			
- No	2	1	1
- Yes (1/day)	33	17	16
- Dental floss	8	4	4
- Interproximal brush	25	13	12
Bleeding while brushing			
- No	26	12	14
- Yes	1	1	0
- Occasionally	8	5	3

Supplementary material Table 2. Clinical Data at baseline

	Total (n=35)	Male (n=18)	Female (n=17)
Cardiovascular risk factors and systemic diseases			
- Diabetes Mellitus	1	1	0
- Dislipemia	1	1	0
- Hypothyroidism	2	0	2
- Asthma	2	1	1
Toxic habits			
- Smoking	17	10	7
- <10 cigarettes/day	6	3	3
- 10-20 cigarettes/day	9	5	4
- >20 cigarettes/day	2	2	0
- Alcohol consumption			
- never	5	1	4
- occasionally	29	16	13
- every day	1	1	0
Healthy habits			
- Healthy/Mediterranean diet	32	16	16
- Regular carbonated/sugared drinks	5	4	1
- Physical activity			
- never	9	3	6
- occasionally	17	7	10
- 2-3 times a week	6	5	1
- Every day	3	3	0

Supplementary material Figure 1. Relationship between periodontal parameters (PPD (mm), CAL (mm), BOP) and SBP and DBP (mmHg) measurements. In blue baseline and in orange re-evaluation visit.



Discussió

6. DISCUSSIÓ

6.1. Resum dels resultats

6.1.1. Prevalença de la hipertensió i prehipertensió en individus amb periodontitis

En el nostre estudi observacional *cross-sectional* de pacients amb periodontitis es va descriure una prevalença d'individus amb hipertensió d'un 15% (n=6) i d'individus amb normotensió d'un 17.5% (n=7). La majoria dels pacients van ser inclosos en el grup de prehipertensió, un 67.5% (n=27). Els valors de pressió arterial mitjana en el grup de normotensos va ser PAS 111.42 mmHg (±7.28 SD) i PAD 73.14 mmHg (±3.93 SD). En el grup de prehipertensos PAS 126.9 mmHg (±6.5 SD) i PAD 85.83 mmHg (±6 SD). I en el grup d'hipertensos PAS 140.58 mmHg (±10.74 SD) i PAD 91.16 mmHg (±6.7 SD).

Com ha estat comentat anteriorment, s'estima que l'any 2025 un terç de la població mundial serà hipertensa.[1,31] A més, s'estima que la prevalença d'individus amb prehipertensió a la població mundial ronda entre el 30 i el 50%.[12,15,16,80]

Sabem que els individus que pateixen periodontitis tendeixen a tenir valors de pressió arterial més elevats, i tenen entre un 30 i un 50% més probabilitats de tenir hipertensió arterial.[63,66,67] A més, està descrit que la presència de periodontitis podria ser un factor de risc per a acabar desenvolupant hipertensió arterial en pacients que pateixen prehipertensió.[81]

Està descrit a la literatura que els pacients amb periodontitis tenen de mitjana valors de PAS entre 3.36 i 4.49mmHg més alts que els pacients sense periodontitis i valors mitjans de PAD entre 2.03 i 2.16 mmHg més alts que els pacients sense periodontitis. A més, els pacients amb BOP generalitzat, signe típic de la periodontitis, presenten de mitjana valors PAS 5mmHg més alts que els pacients amb les genives sanes i sense sagnat al sondatge.[63,74] Aquestes estimacions estan en consonància amb els resultats del nostre estudi.

Malgrat les limitacions de l'estudi, aquesta troballa posa de manifest el percentatge tant alt de pacients a la nostra societat amb valors de pressió arterial alta, tant hipertensió com prehipertensió i com la periodontitis pot ser un factor implicat en aquesta alta prevalença.

6.1.2. Efectes del tractament periodontal en la pressió arterial en pacients prehipertensos

En el nostre estudi de cohorts prospectiu, es van observar diferències estadísticament significatives ($p<0.05$) en els valors de PA abans i després del tractament periodontal no invasiu de raspats sense cap altra modificació en l'estil de vida del pacient ni cap tipus de medicació antihipertensiva. El tractament periodontal va causar una reducció de PAS de 4.7mmHg ($p=0.016$) i PAD de 3.4mmHg ($p=0.015$) a la visita de reavaluació periodontal, realitzada entre la setmana 4 i 6 després de la realització del tractament. Aquest efecte es va mantenir a la visita de control dels 6 mesos, amb una reducció de PAS de 5.2 mmHg ($p=0.007$) i PAD 3.7 mmHg ($p=0.003$).

El tractament periodontal també va suposar una reducció estadísticament significativa de tots els paràmetres periodontals analitzats (PPD, CAL i BOP). Tanmateix, no es va poder establir una relació directament proporcional entre la quantitat de millora dels paràmetres periodontals i la reducció de valors de pressió arterial. Aquest fet podria ser explicat degut a que la sola realització del tractament periodontal ja fa baixar els nivells de bacterièmia bucal i això pot reduir els nivells de producció d'òxid nítric, estabilitzant els sistemes metabòlics que regulen la PA. A més, al produir-se una reducció d'inflamació local periodontal, s'ajuda a reduir la inflamació sistèmica.

Malgrat l'heterogeneïtat de grups, seguiments i tipus d'estudi, els resultats del nostre estudi van amb consonància amb el resultats descrits en la literatura recentment. La disminució de la pressió arterial descrita després del tractament periodontal és molt variable, anant des de cap tipus de reducció,[82] a reduccions estadísticament no significatives [83] passant per disminucions entre 2.5 i 5 mmHg [40,77,78,84]; fins a reduccions força altes de fins a 12 mmHg.[55,75,76,79]

Tot i tenir en compte les limitacions de l'estudi, aquests resultats posen de manifest la importància que poden tenir els tractaments periodontals en el control de la pressió arterial alta especialment en individus que pateixen prehipertensió.

6.2. Implicacions clíniques

El fet que els dentistes a les clíniques dentals puguin dur a terme accions per detectar pacients en risc de patir hipertensió o prehipertensió per si sol ja és un fet important dins de la salut pública. Amb un equipament molt bàsic es poden realitzar medicions de la pressió arterial com a un fet rutinari en les visites dentals. D'aquesta manera es poden referir els pacients al seu especialista de referència per a un correcte diagnòstic i tractament si s'escau. A més, tots els consells de vida saludable, com el cessament de l'hàbit tabàquic, la pèrdua de pes, etc. que es puguin donar des d'una clínica dental són beneficiosos per als pacients; tant des del punt de vista de la salut bucodental com per a la salut general. És molt important tornar a donar rellevància i explicar als pacients l'estreta relació i també l'impacte que té la salut bucodental en la nostra salut global.

Per poder-ho dur a terme, és imprescindible que els dentistes estiguin ben formats en aquest aspecte. Per a poder tenir un punt de vista, no tant focalitzat només en les dents i la boca, sinó també en la salut global dels pacients. Aquest fet, que era innat fa anys quan els dentistes eren metges estomatòlegs, però que potser es va diluir una mica quan l'odontologia va esdevenir una carrera per si sola, s'està recuperant en l'odontologia contemporània.

En aquesta línia de treball, i durant la realització d'aquesta tesi doctoral, la Sociedad Española de Periodoncia (SEPA) conjuntament amb el Consejo General de Colegios Oficiales de Odontólogos y Estomatólogos, la Sociedad Española de Cardiología (SEC) i la Sociedad Española de Diabetes (SED); han publicat recentment (principis del 2023) una guia que recull la iniciativa "Promosalud".[58] Aquesta iniciativa posa de rellevància la relació que existeix entre la periodontitis i diferents patologies sistèmiques. Més concretament, la diabetis i la pressió arterial alta i les accions que es poden dur a terme des del punt de vista de prevenció a una clínica dental. Segons una enquesta del Consejo General de Dentistas, el 55% de la població espanyola entre 20 i 74 anys va anar al

dentista al menys una vegada durant l'any 2021. Aquest és un percentatge molt elevat i permetria arribar a pacients que potser no estan controlats a nivell sistèmic.

Aquesta iniciativa "Promosalud" proposa realitzar un cribratge del risc de patir diabetis o prediabetis i pressió arterial quan els pacients acudeixin a la clínica dental. Es tracta d'informar als pacients dels seus riscos i realitzar registres de la pressió arterial amb un tensiòmetre manual o digital homologat i també la medició de l'hemoglobina glicosilada. Aquests registres tindrien l'objectiu de cribratge i prevenció i no de diagnòstic, ja que els pacients amb risc elevat s'haurien de derivar al seu doctor o doctora de referència per a un correcte diagnòstic. De fet, en aquesta guia s'inclouen models de documentació d'interconsulta per poder referir als pacients correctament i amb la informació ben organitzada. Tanmateix, s'hauria de realitzar una difusió real per arribar als professionals de la salut i implantar-la a nivell de sanitat tant pública com privada.

D'altra banda i tant o més rellevant, és l'efecte que pot tenir el tractament periodontal no quirúrgic de raspats en la millora i disminució dels valors de pressió arterial en pacients prehipertensos. Amb un tractament tant senzill com els raspats, i que els pacients necessiten pel tractament de la periodontitis, es pot aconseguir una disminució dels valors de pressió arterial tant sistòlica com diastòlica. Està descrit a la literatura que una disminució de tan sols 5 mmHg de PAS pot reduir el risc de mortalitat cardiovascular un 9%.[85]

Aquest fet posa de manifest no només la importància que poden tenir els dentistes i les clíniques dentals en el cribratge i diagnòstic de la pressió arterial alta, sinó també el paper que pot tenir el tractament dental periodontal com a teràpia complementaria no farmacològica per la disminució de la pressió arterial.

Tot i que en algunes guies la periodontitis ja està considerada com un dels nous factors de risc cardiovascular, a la pràctica no existeix cap estratègia per realitzar accions concretes. La nostra proposta seria establir un circuit efectiu de derivació entre professionals sanitaris. No només des dels dentistes cap als metges de capçalera o cardiòlegs de referència, sinó també a la inversa. Seria una bona estratègia incloure el

tractament de la periodontitis com a part de les recomanacions de modificacions de l'estil de vida que es pauten als pacients amb PA alta.
Així doncs, seria convenient derivar al pacient a un dentista per poder establir l'estat de la salut bucodental i diagnosticar la presència o no de periodontitis. Per així poder realitzar el tractament periodontal de raspats si fos necessari.

6.3. Limitacions

En primer lloc, per a la realització de la revisió sistemàtica de la literatura hi van haver diverses limitacions pel que fa al disseny dels estudis revisats. En alguns no es preguntaven als pacients preguntes de canvis d'estil de vida en les visites de seguiment, i en d'altres no es tenien en compte factors de confusió com per exemple el tabaquisme o l'exercici físic. A més, els paràmetres periodontals d'inclusió i exclusió dels pacients i fins i tot la definició emprada de periodontitis no eren les mateixes en tots els articles. Finalment, tampoc eren homogenis en tots els articles els mètodes d'avaluació de la PA. Totes aquestes limitacions van fer que no es pogués dur a terme un metaanàlisi. Tanmateix, van fer que tinguéssim en compte tots aquests paràmetres per al disseny del nostre estudi de cohorts prospectiu.

Pel que fa a l'estudi observacional de prevalença, la grandària de la mostra seria el punt més feble, així com el petit nombre de pacients normotensos i hipertensos, que pot suposar una font potencial de biaix. A més, no es disposa d'un grup de control de pacients periodontalment sans per a poder comprar els resultats. També seria important destacar la possible estimació a l'alça dels valors de PA degut a la hipertensió arterial de bata blanca.

Respecte a l'estudi clínic de cohorts prospectiu, la limitació més rellevant és la grandària mostral. Els resultats s'haurien de contrastar en un estudi amb un nombre més elevat de pacients. A més, tampoc es pot menysprear l'efecte d'hipertensió clínica aïllada que pugui haver succeït. Una altra limitació és el marc temporal utilitzat, ja que també seria útil confirmar la baixada de pressió arterial sistòlica i diastòlica durant un període de temps més llarg, per veure si el tractament periodontal té influència més enllà dels sis mesos. Una altra opció de mesura dels valors de pressió arterial, i que hagués servit per

tenir una altra perspectiva, hagués estat utilitzar monitorització ambulatòria durant 24 hores. Finalment, cal també tenir en compte la possibilitat que la disminució de PAS i PAD observada puguin ser el resultat de les instruccions generals de vida saludable, i no només el resultat del tractament periodontal no quirúrgic.

Finalment, i com a limitació general en la realització de la tesi doctoral que ha fet que es patissin retrassos en el cronograma ha estat la COVID-19. Els nostres estudis clínics van coincidir en el temps amb la pandèmia. Durant un període llarg de temps vam estar sense poder atendre pacients a la consulta i després només atenent urgències dentals. Els tractaments periodontals no són una urgència dental com a tal, i això va fer que no es pugués dur a terme el reclutament de pacients que teníem programat, ni el seguiment pertinent d'alguns pacients que va desembocar a la no inclusió de tots aquells individus que van començar l'estudi.

6.4. Perspectives futures

Les aproximacions i investigacions futures haurien d'aprofundir en els mecanismes fisiopatològics compartits entre la hipertensió arterial i la malaltia periodontal. Per així arribar a conèixer quines són les claus o signes que ens permetin diferenciar els pacients que desenvoluparan aquestes patologies simultàniament.

Seran necessaris estudis que explorin els elements relacionats amb les dues malalties i així discernir els factors rellevants de la progressió d'ambdues, els factors genètics, biomarcadors sensibles, tècniques d'imatge, paràmetres analítics concrets i també el paper de les diferents opcions terapèutiques bucodentals i farmacològiques.

Tampoc podem deixar de banda que l'HTA i la malaltia periodontal son malalties complexes en les quals els factors ambientals juguen un paper determinant. Per tant, serà important establir col·laboracions específiques i efectives per estudiar la complexa interacció gen-ambient i la seva relació amb la susceptibilitat individual per presentar les malalties.

Un altre aspecte fonamental és el coneixement per part dels odontòlegs de la correcta utilització pràctica d'eines tant sensibles i específiques com l'esfigmomanòmetre, i així realitzar una correcta implementació rutinària a les clíniques dentals. Seria interessant poder establir un protocol realista i realitzable de detecció del risc de patir HTA per part dels dentistes a les clíniques dentals tant a nivell de sanitat pública com privada i un mecanisme de derivació efectiu al centre de salut de referència del pacient per a un diagnòstic de certesa.

Amb tota aquesta informació, els dentistes podrem estratificar pacients propensos a desenvolupar HTA o altres malalties de base inflamatòria i ser part fonamental en el cribratge de malalties tant prevalents i rellevants en l'àmbit de la salut pública.

Conclusions

7. CONCLUSIONS

- El tractament periodontal no invasiu beneficia el control de la pressió arterial en individus amb prehipertensió i periodontitis sense cap altre tipus d'actuació o canvi a nivell d'estil de vida ni cap teràpia farmacològica.
- La reducció de nivells de pressió arterial és estadísticament significativa en pacients amb prehipertensió arterial amb periodontitis:
    - 4.7 mmHg i 3.4 mmHg de pressió arterial sistòlica i pressió arterial diastòlica respectivament a la visita de reavaluació periodontal
    - 5.2mmHg i 3.7 mmHg de de pressió arterial sistòlica i pressió arterial diastòlica respectivament al control als 6 mesos.
- La millora dels valors de pressió arterial no és directament proporcional a la quantitat de millora dels valors periodontals.
- Els mecanismes que relacionen la pressió arterial alta i la periodontitis no estan clarament definits. El que sí és clar és, que els pacients amb periodontitis tenen valors de pressió arterial més alts que els individus amb les genives sanes. Hi ha una alta prevalença de pacients prehipertensos (67.5%) entre els pacients amb periodontitis.
- Els dentistes poden dur a terme estratègies de prevenció i diagnòstic senzilles a la consulta dental. Mitjançant recomanacions d'estil de vida saludable i amb programes de detecció precoç i mesura de la pressió arterial a les visites dentals rutinàries.
- Serà fonamental de cara al futur establir un protocol fàcil i eficaç de derivació entre especialistes i així ajudar a disminuir el risc cardiovascular d'aquests pacients.

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Annexos

9. ANNEXOS

9.1. Annex 1: Primer article original

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Does Periodontal Treatment Help in Arterial Hypertension Control? A Systematic Review of Literature

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Abstract

Arterial hypertension and periodontal diseases are two of the pathologies with more prevalence worldwide. In the last few years, several scientific evidences have demonstrated the relationship between both diseases. Besides the etiopathogenic and causal relationship, some recent publications have pointed out that the therapeutic approach of periodontitis could have positive effects on the control of arterial hypertension.

The aim of this systematic review is to determine whether there is a decrease in or better control of blood pressure after performing nonsurgical periodontal treatment in patients with periodontitis.

A thorough search in PubMed, Scopus, and ISI Web of Science databases with the keywords "'periodontal disease' OR 'periodontitis' OR 'periodontal' AND 'blood pressure' OR 'hypertension' OR 'arterial hypertension'" was conducted. The quality of the reported information was assessed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for systematic reviews.

Eight articles were considered for this systematic review. Five of the studies showed statistically significant reduction in systolic blood pressure (SBP) values.

Despite the limitations of the review, nonsurgical treatment of periodontal disease seems to reduce SBP values. Further research with larger and longer-term clinical trials are needed to demonstrate this potential positive effect.

Keywords
- periodontitis
- hypertension
- blood pressure
- periodontal disease
- periodontal therapy

Introduction

Arterial hypertension is one of the most important and better studied cardiovascular risk factor and is associated with an increased risk of cardiovascular morbidity and mortality.[1]

Arterial hypertension affects 30 to 45% of the adult population and is the leading cause of premature death in the world.[2] Its high prevalence is a global public health problem; it is estimated that by 2025 a third of the world's population could be hypertensive.[2]

In this scenario, the identification of hypertensive subjects and the control of their blood pressure (BP) measurements, to avoid cardiovascular events, is an unquestionable health goal.

The etiopathogenic mechanisms that trigger the onset of arterial hypertension are varied, multifactorial, and not fully known; they include hemodynamic mechanical changes and stiffness in the arterial wall, autonomic and neurohormonal dysregulations, endothelial dysfunction, oxidative stress, and local and systemic inflammation.[3]

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Periodontal diseases, gingivitis and periodontitis, are very prevalent multifactorial inflammatory pathologies caused by bacteria that affect periodontal tissues. The prevalence of periodontitis is estimated to be between 20 and 50% of the worldwide population.[4] Among its etiopathogenic mechanisms there is a chronic inflammation response catalyzed by different mediators.[5,6]

The etiopathogenic parallels and the high prevalence of both diseases in the same patients have raised the search for the relationship between both pathologies and the exclusion of confounding factors such as age, gender, smoking, educational level, socioeconomic status, obesity, and diabetes. In recent years, there have been numerous scientific evidences that support this relationship more solidly.[5,7-9] Its relationship has also been taken into account in different scientific societies and has been mentioned in dental and medical guides that address the management of high BP.[5,10]

Beyond the etiopathogenic and causal relationship, of great importance is the publication of some papers in which it is exposed that therapeutic approach of periodontal disease could have effects on the control of BP measurements.[10] Although the evidence is very limited, it is a very important concept since many of the hypertensive patients are not treated or do not reach recommended BP goals, or are poorly controlled despite various medical and pharmacological treatments. Arterial hypertension is a modifiable risk factor, and any progress or improvement in its control affects individual cardiovascular risk.

These findings highlight the relevant role that dentists and dental treatments can play in the management of arterial hypertension either in the field of primary prevention through the identification of untreated patients or as secondary prevention, implementing oral treatments for the management and control of high BP.

The aim of this review is to determine if there is a decrease in or better control of BP after performing nonsurgical periodontal treatment in patients with periodontitis.

Materials and Methods

Primary Outcome

The primary outcome of this systematic review is to determine changes in BP measurements following periodontal therapy.

Inclusion/Exclusion Criteria

The eligibility criteria were defined according to PECO strategy. This acronym represents the patient (P), exposition (E), comparison (C), and outcome (O) characteristics of the eligible question.

The inclusion criteria considered original intervention articles, published in peer-reviewed journals, including all kinds of longitudinal studies (randomized clinical trials, cohort studies and case-control studies) that included adult patients with periodontal pathology (P), which evaluated exposed (E) and nonexposed patients to periodontal therapy (C), and assessed the association between changes in BP and periodontal therapy (O). The search strategy was limited to articles published in English and studies conducted in humans. The exclusion criteria were case reports, reviews, descriptive studies, opinion articles, technical articles, and case series. Individuals under 16 years of age and pregnant women were also excluded.

Search Strategy and Study Selection

A comprehensive search of the PubMed, Scopus, and ISI Web of Science databases from its inception through November 2019 was conducted to identify studies that evaluated the relationship between arterial hypertension and periodontitis, and more specifically studies that evaluated the changes in BP after conducting nonsurgical periodontal treatment.

We queried MeSH terms and the article text for the following search terms: ('periodontal disease') OR ('periodontitis') OR ('periodontal') AND ('blood pressure') OR ('hypertension') OR ('arterial hypertension').

The articles resulting from this search were screened manually, first based on the title, then the abstract, and finally the complete manuscript, to determine their appropriateness for inclusion in the literature review. References cited in the included articles were also reviewed to identify additional published articles not identified by the database search.

Data Extraction

Selected publications were independently reviewed by two investigators (MZ and NL). The extracted data included information about the study design characteristics, group and patients' characteristics (periodontal status and BP assessment), the exact nonsurgical procedure, and the reported results. Disagreements between the authors were resolved through consensus. Quality assessment of all included articles was performed independently by a reviewer as part of the data extraction process.

The quality of the reported information included in each article was assessed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[11] for the improvement of the publication of systematic reviews (►**Supplementary Appendix A** [online only]).

Definitions of Periodontitis and Hypertension

Diagnosis of Arterial Hypertension

Hypertension was defined as systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥90 mm Hg or the use of antihypertensive medications.[2]

Diagnosis of Periodontitis

Following the guidelines of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions,[12-14] in the context of clinical care, a patient is a "periodontitis case" if:

- Interdental CAL (clinical attachment loss) is detectable at ≥2 nonadjacent teeth.
- Buccal or oral CAL ≥3 mm with pocketing ≥3 mm is detectable at ≥2 teeth but the observed CAL cannot be ascribed to nonperiodontitis-related causes.

Results

Studies Included

The study selection process for inclusion in the review is summarized in ►**Fig. 1** (diagram flow). The database search strategy identified 395 potentially eligible references. After screening titles and abstracts, 52 full-text articles were reviewed in their entirety. Forty-four articles were excluded because no periodontal intervention was performed or were focused only on the metabolic syndrome. Three additional articles were included after review of references. Eventually eight studies were included in the literature research (►**Table 1**).

Description of the Study Characteristics

The eight studies included in this review had variable design and quality, and no meta-analysis was performed because of the heterogeneity of the identified studies. The population of the studies varied from 40 to 125 patients depending on the article. Moreover, the types of studies were different: five randomized clinical trials,[15-19] one interventional prospective cohort study,[10] one clinical intervention trial,[20] and one pilot intervention study.[21] There were also different types of periodontal treatment compared. While some authors compared basic periodontal therapy (dental hygiene) and intensive periodontal treatment (scaling and root planning),[19] some others compared intensive periodontal treatment with or without administration of antibiotics, both local antimicrobials[15] and systemic.[16,20] There was another group of studies that had an intervention group where periodontal intensive treatment was performed and a control group that received no treatment until the end of the study.[17,18] Finally, there were two studies that only had one group of patients that received nonsurgical periodontal treatment, dental hygiene, or scaling and root planning according to need.[10,21]

Discussion

The relationship between periodontal disease and arterial hypertension seems quite evident and there is significant scientific evidence that points to this direction. However, the association between basic or intensive periodontal therapy and the improvement in BP levels is not entirely clear.

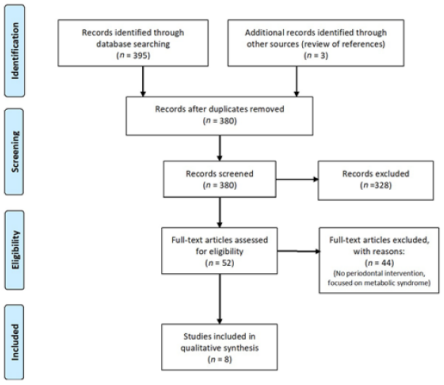

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram flow of the selection process.

First, the studies that address this issue have different and varied results. The consistency and magnitude of the association is not clear in all of them because different results and conclusions arise; from the significant decrease in BP measurements after an intensive periodontal treatment to the invariability in BP levels. Moreover, the groups are not homogenous, the measurements of BP are different among studies, and the follow-up is diverse.

Three of the included studies compared two groups of patients depending on whether periodontal treatment was performed with or without antibiotic therapy,[15-17] both systemic and locally delivered in periodontal pockets. The first one, by D'Aiuto et al,[15] is a randomized clinical trial in which 40 patients with periodontal chronic disease, defined as 50% of dentition with periodontal probing pocket depths ≥4 mm and with radiographic documentation of alveolar bone loss, were distributed in two groups. The first one received standard periodontal therapy (scaling and root planning session) and the second one received the same therapy to which small doses of local antibiotic therapy (minocycline microspheres) were added. The follow-up was performed 1, 2, and 6 months after the intervention. A decrease in SBP was detected at 2 months in the antibiotic therapy group with a mean difference of 7 ± 3 mm Hg (95% confidence interval [CI]: 1–12; $p = 0.0211$). Moreover, this decrease was more important in smokers. However, the reduction was not maintained at 6 months nor did occur in DBP.

Bizzarro et al[16] also performed a randomized controlled clinical trial comparing two groups of patients ($n = 110$). One group received basic periodontal therapy (scaling and root planning) and the second one received the same therapy with administration of systemic antibiotics (amoxicillin 375 mg and metronidazole 250 mg both thrice daily for 7 days). Periodontitis was defined as CAL of at least ≥3 mm in ≥2 nonadjacent teeth and patients were included if they had ≥30% alveolar bone loss at ≥2 teeth per quadrant and presence of ≥2 teeth per quadrant with periodontal pockets ≥5 mm with at least ≥3 mm of CAL and at least 50% of all sites in the mouth with bleeding on probing. The follow-up was performed 3, 6, and 12 months from baseline. A decrease in SBP was observed in both groups 12 months after treatment ($p < 0.05$) but with no statistically significant difference between them (reduction of 2.7 mm Hg in control group and 5.4 mm Hg in the antibiotic group). No changes in DBP were observed.

In 2017, Jockel-Schneider et al[20] performed a clinical intervention trial with 55 patients also comparing periodontal treatment (scaling and root planning) with or without administration of systemic antibiotic (amoxicillin 500 mg and metronidazole 400 mg thrice daily for 7 days). The periodontal parameters stated to be elected were: appearance of periodontal pockets ≥6 mm at a minimum of four teeth. Follow-up was performed at 12 months. No statistically significant changes in SBP or DBP were observed in any group of patients.

Table 1 Results of literature research

Author, y, country	Type of study	*n*	Periodontal intervention	Follow-up	Reduction in BP	Results
D'Aiuto, 2006, UK[15]	Randomized single-blind interventional trial	40	Group A: scaling and root planning; Group B: scaling and root planning + local antimicrobial	1, 2, and 6 mo	Reduction in SBP in Group B (7 ± 3 mm Hg) at 2 mo (p = 0.0211); not stable at 6 mo	Intensive periodontal treatment reduces systolic BP
Taylor et al, 2010, Australia[17]	Randomized controlled prospective trial	125	Group A: intervention group (periodontal treatment); Group B: no treatment until end of study (3 mo)	3 mo	No changes in BP	BP levels did not change significantly in any of participants during study
Vidal et al, 2013, Brazil[10]	Interventional prospective cohort study	26	Only one group, no control group; nonsurgical treatment (dental hygiene or scaling and root planning according to need)	3 and 6 mo	Reduction in SBP (12.5 mm Hg) and DBP (10.0 mm Hg) after 6 mo	Periodontal therapy significantly reduced levels of BP in refractory hypertensive patients
Hada et al, 2015, India[18]	Randomized trial	55	Control group: no periodontal treatment; Experimental group: scaling and root planning	1, 3, and 6 mo	Reduction in SBP (7.1 mm Hg) in treatment group in 6 mo with no change in lifestyle (p < 0.05)	Scaling and root planning is effective in reducing significantly systolic BP
Houcken et al, 2016, Holland[21]	Pilot intervention study	45	Only one group; nonsurgical periodontal treatment	3 and 6 mo	Decrease in SBP (2.9 mm Hg) after 6 mo (p = 0.04)	Peripheral systolic blood pressure significantly reduced after treatment
Bizzarro et al, 2017, Holland[16]	Randomized controlled clinical trial	110	Group A: basic periodontal therapy; Group B: basic periodontal therapy + antibiotics	3, 6, and 12 mo	Decrease in SBP of 2.7 mm Hg in Group A and 5.4 mm Hg in Group B at 12 mo (p < 0.05)	Systolic BP decreased in both groups with no statistically significant difference between them; no changes in DBP
Jockel-Schneider et al, 2018, Germany[20]	Clinical intervention trial	55	Group A: scaling and root planning + antibiotic; Group B: scaling and root planning	12 mo	No changes statistically significant from baseline to 12 mo	Peripheral blood systolic pressure was unchanged
Zhou et al, 2017, China[19]	Randomized clinical trial	107	Group A: dental hygiene; Group B: scaling and root planning	1, 3, and 6 mo	Reduction in SBP (12.57mmHg)and DBP (9.65 mm Hg) in Group B after 6 mo (p < 0.05)	Systolic BP and diastolic BP outcomes markedly reduced after treatment

Abbreviations: BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure.

There is another group of studies from the included ones that compare the BP levels between groups of patients with no periodontal treatment (or only a dental hygiene) and periodontal treatment (scaling and root planning).[18-20] The first one by Taylor et al[17] is a randomized controlled prospective trial with 125 patients comparing no periodontal treatment with scaling and root planning. Periodontitis parameters for the inclusion were six or more sites with ≥5 mm periodontal probing depth and ≥2 mm attachment loss at teeth other than third molars. The duration of the study was 3 months and no changes in BP were observed. The second study by Hada et al[18] was also a randomized clinical trial with 55 patients. The control group did not receive periodontal therapy and the experimental group had two sessions of scaling and root planning. Periodontal parameters for the inclusion were: patients with at least 14 teeth (excluding third molars) and advanced chronic gingivitis and mild-to-moderate chronic periodontitis (at least four teeth with CAL ≤4 mm at a minimum of one site). Follow-up was performed 1, 3, and 6 months after the intervention. At 6 months, a statistically significant reduction of 7.1 mm Hg in SBP in the intervention group was observed (p < 0.05). The third study by Zhou et al[19] is a randomized clinical trial with 107 patients that compared BP levels in two groups of patients: the first one received a dental hygiene and the second one received periodontal treatment (scaling and root planning). Patients

with moderate to severe periodontitis were included considered as the presence of at least two sites between adjacent teeth with ≥4 mm attachment level and at least two such sites with ≥5 mm pockets. Follow-up was performed 1, 3, and 6 months after the intervention. At 6 months, BP levels were markedly reduced in the treatment group. They observed an absolute difference of 12.57 mm Hg in SBP and 9.65 mm Hg in DBP (95% CI: 10.45–14.69 and 7.06–12.24; $p < 0.05$).

Finally, there are two studies of the included ones that only have one group, the treatment group with no control group.[10,21] The first one, by Vidal et al,[10] is an interventional prospective cohort study of 26 patients that had periodontal treatment, a dental hygiene or scaling and root planning according to its need. The periodontal parameters in this study were the diagnosis of generalized advanced chronic periodontitis. Follow-up was done 3 and 6 months after the intervention. After 6 months, a significant reduction in SBP and DBP was observed, 12.5 mm Hg and 10.0 mm Hg, respectively. The last study included in the review was done by Houcken et al,[21] a pilot intervention study of 45 patients with only one treatment group (scaling and root planning was performed). The follow-up was done 6 months after the intervention, where a significant reduction in SBP was observed (from 119.8 ± 14.6 mm Hg to 116.9 ± 15.1 mm Hg; $p = 0.04$).

With all the studies reviewed we can conclude that periodontal treatment could have positive effects on BP measurements, specifically in SBP. Five of the studies showed statistically significant reduction in SBP values.[15,17-19,21] However, while in some articles[19] questions about changes in lifestyle or habits were asked in the follow-up visits, in other ones,[16] confounders such as smoking habits, diet, or physical activity were not taken into account; or even smoking patients were not included in the research.[18] Moreover, the periodontal parameters of inclusion and exclusion criteria were different in the studies, either because of the different definitions of periodontal diseases considered, or because in some studies the most severe forms of periodontitis were not included.[18] Furthermore, different evaluation methods of hypertension were applied. From our point of view all these different criteria may have affected the results due to a potential bias. The lack of publications and clinical studies that address this association, their heterogeneity, the role of inflammation in this process as bias, the variability that can occur in BP measurements, and the different guidelines in the treatment of periodontal disease must be taken into account when analyzing these two diseases.

Our study has several limitations, which are also inherent to many systematic reviews. The retrospective nature of our review, incorporating data from published studies and not on individual patients, limits the availability of information on some issues, such as different clinical end points, comorbidities, or concomitant therapies. No meta-analysis was performed, which was probably because of the heterogeneity of the identified studies.

Finally, the results observed forces us to reflect and ask ourselves new questions and challenges, as whether periodontal disease is a marker or mediator or some patients may have a genetic or metabolic susceptibility[22] that might also play a part, as well as whether it affects only the SBP by some unknown mechanism or the periodontal treatment really has an initial effect on the BP but not maintained over time.

Conclusions

Hypertension is an important modifiable cardiovascular risk factor and therefore all measures aimed at identifying and controlling its development and progression are a global public health priority.

Although there are few publications that address this topic, nonsurgical treatment of periodontal disease could have a positive effect on the reduction of SBP values. To our knowledge this is the first systematic review that points in this direction.

Further research with larger and longer-term clinical trials are needed to demonstrate this association. Periodontitis could influence the prevalence of hypertension and periodontal interventions could play an important role in the prevention of cardiovascular diseases.

Authors' Contributions

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in all the parts of the realization of the manuscript.

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None.

Conflict of Interest

None declared.

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9.2. Annex 2: Carta acceptació segon article

DMP-02711-2022-03

DENTAL AND MEDICAL PROBLEMS

Decision: **accept without changes**

June 27, 2022
DMP-02711-2022-03
Prevalence of high blood pressure in periodontal patients: a pilot study

Dear Neus Lanau Solé,

I am pleased to inform you that your manuscript, entitled: Prevalence of high blood pressure in periodontal patients: a pilot study, has been finally accepted for publication in our journal.

Thank you for submitting your work to us.

Yours sincerely,
prof. dr hab. Mieszko Więckiewicz
Editor-in-Chief
Dental and Medical Problems

Editorial System

9.3. Annex 3: Tercer article original

Original Article

Impact of Nonsurgical Periodontal Treatment on Blood Pressure: A Prospective Cohort Study

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Eur J Dent

Abstract

Objectives Arterial hypertension and periodontitis are two of the most common diseases worldwide and recent evidence supports a causal relationship between them. Despite all antihypertensive strategies, an important number of patients are undiagnosed and a large number of the diagnosed fail to achieve optimal blood pressure (BP) measurements. Some studies point out that periodontal treatment could have positive effects on BP levels. The aim of this study is to determine if nonsurgical periodontal treatment can help BP level control in prehypertensive patients with periodontitis.

Materials and Methods Thirty-five patients were included in the study and received nonsurgical periodontal treatment according to necessity. Clinical data, periodontal data, and BP measurements were taken at baseline, periodontal re-evaluation visit (4–6 weeks after treatment), and 6-month follow-up.

Results Periodontal treatment caused a statistically significant reduction ($p < 0.05$) of systolic blood pressure (SBP) and diastolic blood pressure (DBP) at re-evaluation visit of 4.7 ($p = 0.016$) and 3.4 mm Hg ($p = 0.015$), respectively. The effect was maintained at 6-month follow-up visit with a reduction in SBP and DBP of 5.2 ($p = 0.007$) and 3.7 ($p = 0.003$) mm Hg, respectively.

Conclusion Despite the limitations of this study, it suggests that nonsurgical periodontal treatment can be effective in lowering BP levels in patients with prehypertension and periodontitis. Moreover, it highlights the importance of dentists in prevention, detection, and control of this important cardiovascular risk factor.

Keywords
- periodontitis
- hypertension
- prehypertension
- blood pressure

Introduction

Arterial hypertension is one of the most prevalent cardiovascular risk factors.[1] It is estimated to affect 1.4 billion people (>30% of world population) and cause around 10 million deaths per year worldwide, representing the first cause of premature death.[2] In this context, early detection of hypertensive patients and their medical control is essential in order to prevent cardiovascular events.

In addition, and despite all the antihypertensive strategies, it is estimated that 15 to 50% of people are undiagnosed[3] and around 70% of the diagnosed patients fail to achieve optimal blood pressure (BP) measurements.[4]

The concept of prehypertension or high normal pressure encompasses patients who have systolic blood pressure (SBP) values between 130 and 139 mm Hg and/or diastolic blood pressure (DBP) values between 80 and 89 mm Hg.[2] This

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condition is associated with three more times probabilities of developing hypertension.[1] Moreover, it has been linked with worse cardiovascular risk profile, higher prevalence of metabolic disorders, and cardiovascular mortality.[5–7]

Periodontal diseases, gingivitis and periodontitis, are one of the most prevalent chronic multifactorial inflammatory diseases worldwide.[8] It is estimated that 20 to 50% of the population is affected.[1,8] Periodontal diseases are caused by bacteria and not only affect support tissues around teeth but can also cause endothelial dysfunction, metabolic dysregulation, and systemic inflammation.[9] Likewise observational and experimental evidence suggests the importance of systemic inflammation in the development and progression of hypertension.[3]

Recent evidence supports a causal relationship between hypertension and periodontitis.[9,10] Regarding this relationship, it is important to take into account, for example, the genetic predisposition of both diseases[11,12] and the effect that local inflammation of periodontal tissues has into systemic inflammation and vascular endothelium.[11,13,14] Patients with moderate or severe periodontitis tend to present higher BP measurements and have 30 to 70% more probability to develop hypertension[10,13,15]. In some recent medical guides,[16] periodontitis is now being considered as a cardiovascular risk factor. Moreover, some studies conclude that periodontal treatment helps reducing BP measurements.[16–23]

Therefore, with this interventional prospective cohort study, we aimed to investigate if nonsurgical periodontal treatment could have a positive effect in BP levels, in patients with periodontitis and prehypertension.

Materials and Methods

The participants in our study were consecutive patients from general dental practice in Barcelona, Spain, enrolled between January 2021 and March 2022. This study was approved by the Ethics Committee of Hospital Universitario Dexeus Grupo Quironsalud with code 2018/ODI-2018-01. Written consent to participate in the study was given by all patients.

Adult patients aged 18 or older, diagnosed with prehypertension, were enrolled into the study if they also presented with moderate-to-severe periodontitis. Moreover, patients must have 10 or more teeth and full capacity to understand, authorize, and sign informed consent. Exclusion criteria included acute and major chronic inflammatory/immune disorders, chronic diseases, and malignancies (within the last 5 years) as assessed by the examining clinician. Patients who had received treatment with medications known to affect periodontal status and patients using systemic or local immunosuppression within the previous 6 months were excluded, as were patients with any cause of secondary hypertension; meaning patients with hypertension caused by medications, alcohol, or drug consumption or hypertension caused by other systemic, metabolic, or immune diseases such as hyperthyroidism. Moreover, patients with necrotizing periodontitis, patients who had periodontal treatment in the previous 6 months and breastfeeding, and pregnant women were also excluded.

Definition of Periodontitis

Regarding the Classification of Periodontal and Peri-implant Diseases and Conditions[24] established in 2017 in the American Academy of Periodontology and the European Federation of Periodontology World Workshop, a patient is considered a "periodontitis case" in the context of clinical care if:

- Interdental CAL (clinical attachment loss) is detectable at two or more adjacent teeth.
- Presence of buccal or oral CAL more than or equal to 3mm with pocketing more than or equal to 3mm detectable at 2 or more adjacent teeth (CAL only caused by periodontitis causes).

Moreover, each periodontitis case can be classified regarding stage (severity of periodontitis, from I to IV) and grade (expected progression, biological characteristics and risk factors). The stage takes into account the severity (CAL, radiographic bone loss and tooth loss), complexity (probing pocket depth [PPD] and type of bone loss horizontal or vertical), and extent and distribution. Regarding grade, a moderate progression is always assumed and evidence must be found to change grade into slow or rapid rate of progression.[24]

Definition of Hypertension and Prehypertension

According to the 2018 European Society of Cardiology (ESC) guidelines,[2] optimal BP values are defined as SBP less than 120 mm Hg and DBP less than 80 mm Hg. Hypertension is defined as SBP more than or equal to 140 mm Hg and/or DBP more than or equal to 90 mm Hg diagnosed in a medical office. High-normal BP (formerly prehypertension) is defined as SBP 130 to 139 mm Hg and/or DBP more than or equal to 85 to 89 mmHg.[2] These patients were the target of our study.

Sample Size

A calculated minimum of 37 patients were necessary to recognize a statistically significant difference of 5 mm Hg in BP between visits, accepting an alpha risk of 0.05 and a beta risk of 0.2 in a two-sided test. The standard deviation was assumed to be 10 and a drop-out rate of 15% was anticipated. A final sample size of 35 patients was enrolled.

Study Dynamics and Patient Information

This study consists of three visits: baseline, periodontal re-evaluation (4-6 weeks after the treatment), and follow-up at 6 months. During all the study, STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology)[25] was followed.

The data collected were the following:

a) *Sociodemographic data*: age, sex, ethnicity, height, weight, and body mass index (BMI).
b) Periodontal data:
Dental habits questionnaire: frequency and type of brushing, type of interdental hygiene (interproximal brushes, dental floss, or none) and frequency, presence of bleeding while brushing, and regularity of dental appointments (Supplementary ►**Table 1**, available in the online version).

Table 1 Baseline characteristics of the participants in the study

	Total participants ($n=35$)	Male ($n=18$) 51.4%	Female ($n=17$) 48.6%
Age, mean (years)	45.42 (28–65)	45.42 (30–65)	45.42 (28–58)
Smoking, *n* (%) Current Never Past	 17 (48.6%) 7 (20%) 11 (31.4%)	 10 2 6	 7 5 5
BMI, *n* (%) · Underweight · Healthy weight · Overweight · Obesity	 1 (2.9%) 18 (51.4%) 11 (31.4%) 5 (14.3%)	 0 11 5 2	 1 7 6 3
DM2, *n* (%)	1 (2.9%)	1	0
Average SBP (mm Hg)	129.6 ± 7.6	131.6 ± 5.6	127.4 ± 8.8
Average DBP (mm Hg)	87.0 ± 5.0	86.2 ± 5.5	87.9 ± 4.4
Heart rate (bpm)	70.5 ± 11.46	70.5 ± 11.7	70.5 ± 11.46
Mean PPD (mm)	4.14 ± 0.49	4.15 ± 0.52	4.13 ± 0.47
Mean CAL (mm)	4.51 ± 0.71	4.64 ± 0.86	4.37 ± 0.49

Abbreviations; BMI, body mass index; bpm, beats per minute; CAL, clinical attachment loss; DBP, diastolic blood pressure; PPD, probing pocket depth; SBP, systolic blood pressure.

- Electronic periodontogram recording PPD, CAL, and bleeding on probing (BOP). Third molars if present were excluded of the data analysis.

c) Clinical data:

- Cardiovascular risk factors: diabetes mellitus, dyslipidemia, systemic diseases, and family background.
- Toxic habits: smoking (number of cigarettes per day), alcohol consumption (number of drinks per day/week).
- Healthy habits: healthy diet, consumption of carbonated, and sugared drinks, physical activity (Supplementary ►**Table 2**, available in the online version).

In all visits, patients were asked if there had been any change of habits whether it was an improvement in dental hygiene or any lifestyle change such as smoking reduction, increase in physical activity, diet changes, or weight changes.

Blood Pressure Measurements

Blood pressure measurements (SBP, DBP, and heart rate) were obtained by a trained operator, with a validated electronic upper-arm cuff (Boso Medicus Family 4 Bosch + Sohn GMBH U.CO. KG, Jungingen, Germany) according to the ESC guidelines.[2] Patients were asked not to talk during the measurements and not to exercise, smoke, or consume caffeine the previous 30 minutes to the appointment. When the patients arrived, measurements were taken after 5 minutes of rest and in both arms. If there were important differences between them, the arm with higher values was used. Measurements were taken three times at 2-minute intervals; the first one was discarded and the mean of the other two was used. The patients were with back support,

Table 2 Effects on blood pressure and periodontal changes (*p*-value calculated between baseline and periodontal re-evaluation and between baseline and 6-month follow-up)

Parameters	Baseline	Periodontal re-evaluation 4–6 weeks		6-month follow-up	
SBP (mm Hg)	129.6 ± 7.6	124.9 ± 10.2	($p=0.016$)[a]	124.4 ± 9.8	($p=0.007$)[a]
DBP (mm Hg)	87.0 ± 5.0	83.6 ± 7.5	($p=0.015$)[a]	83.3 ± 6.1	($p=0.003$)[a]
PPD (mm)	4.14 ± 0.49	3.44 ± 0.52	($p<0.001$)[a]	3.41 ± 0.55	($p<0.001$)[a]
CAL (mm)	4.51 ± 0.71	3.78 ± 0.78	($p<0.001$)[a]	3.76 ± 0.81	($p<0.001$)[a]
BOP (%)	96.2	43.4	($p<0.001$)[a]	44.6	($p<0.001$)[a]

Abbreviations: BOP, bleeding on probing; CAL, clinical attachment loss; DBP, diastolic blood pressure; PPD, probing pocket depth; SBP, systolic blood pressure.
[a]Statistically significant.

feet flat on the floor, with the arm bare resting and with mid-arm at heart level. To perform the study and in order to include the patients, BP measurements were taken in the first two visits to the clinic. The baseline BP measurements presented are the average of the first- and the second-visit measurements.

Periodontal Examination and Treatment

Periodontal treatment consisted of nonsurgical periodontal treatment (scaling and root planning), divided in two half-mouth sessions separated 7 to 10 days between them. Patients were locally anesthetized with articaine 4% epinephrine 1:100.000 (Septodont, Mataró, Barcelona, Spain) or mepivacaine 3% (Septodont) if necessary. Treatment was performed first with H3 ultrasound tip (Acteon Satelec, Acteon Médico-Dental Ibérica, Sentmenat, Barcelona, Spain) and then with Gracey curettes (Bontempi—American Eagle, Missoula, Montana, USA). Irrigation with oxygen peroxide was performed at the end of each session. Patients were given postoperative and dental hygiene instructions and were asked to rinse with chlorhexidine 0.12% + CPC 0.05% (Dentaid, Cerdanyola del Vallès, Barcelona, Spain) two times a day during 2 weeks following the treatment. Data was recorded by hand, checked for errors, and then converted to an electronic data sheet.

Data Analysis

Variable Description

SBP and DBP levels were described as quantitative variables expressed in mm Hg. PPD and CAL were assessed at six points sites around each tooth, and were described as quantitative variables expressed in mm. For analysis purposes, the mean of all sites was calculated for each patient in each visit. BOP was described as a categorical variable (presence or absence of bleeding) and assessed for each tooth. For analysis purposes, the percentage of BOP was calculated for each patient in each visit. BMI was calculated as a quantitative variable but was classified in four groups: underweight (p <18.5), healthy weight (18.5–24.9), overweight (25–29.9), and obesity (>30).

Statistical Analysis

Statistical analysis was performed with python scipy.stats. Shapiro–Wilk test was used to assess if variables were normally distributed. Paired samples Student's t-test was used to compare BP levels and PPD and CAL values before and after nonsurgical periodontal treatment. Normally distributed variables were reported as mean ± SD. Wilcoxon signed-rank test was used to compare BOP percentages before and after nonsurgical periodontal treatment. Relationship between the decrease of BP levels and the amount of periodontal improvement was assessed with Pearson or Spearman Correlation as needed. p-Value less than 0.05 was considered statistically significant.

Results

After a screening of 56 patients, 38 meet the inclusion criteria for adults with prehypertension and periodontal disease. Three patients did not reach the 6-month time point and were lost to follow-up. Finally, 35 patients (17 females and 18 males) finished the 6-month follow-up and were included in the study (►**Fig. 1**). Baseline characteristics of the patients included are shown in ►**Table 1**.

Effects of Periodontal Treatment on Blood Pressure

There were statistically significant differences ($p < 0.05$) of BP values before and after nonsurgical periodontal treatment (►**Fig. 2**).

Periodontal treatment caused a significant reduction at the re-evaluation visit of SBP (►**Fig. 3A**) and DBP (►**Fig. 3B**) by 4.7 and 3.4 mm Hg, respectively. The effect was maintained over time and is reflected in the 6-month follow-up visit with a reduction in the SBP (►**Fig. 3C**) and DBP (►**Fig. 3D**) by 5.2 and 3.7 mm Hg, respectively.

Effects of Periodontal Treatment on Periodontal Health

The dental treatment produced a substantial improvement in periodontal parameters of all participants when compared to baseline. The analyzed variables, PPD, CAL, and BOP, had statistically significant reduction during follow-up (►**Table 2**).

There is a reduction in the mean values of PPD, CAL, and BOP percentages as well as the mean values of SBP and DBP between baseline and re-evaluation visit (Supplementary ►**Fig. 1**, available in the online version) and between baseline and 6-month follow-up visit (►**Fig. 4**). However, there was no direct relationship between the amount of periodontal improvement and the amount BP levels improvement. No relevant changes in clinical data (toxic and healthy habits) were observed between visits. An important number of patients (82.8%) had an improvement of dental hygiene habits at 6 months follow-up (Supplementary ►**Table 1**, available in the online version). Age, sex, smoking habit, alcohol consumption, type of diet, physical activity, and changes in dental hygiene habits had no statistically significant impact in the improvement of BP levels.

Discussion

Recent studies suggest a causal link between periodontitis and high BP[9,10,13,16,26] confirming that patients with severe periodontitis tend to have higher BP levels than patients with healthy periodontal tissues. Moreover, evidence suggests that periodontal treatment can improve BP levels.[18–23,27]

This study found a statistically significant reduction in SBP and DBP both in the periodontal re-evaluation visit (4–6 weeks after the treatment) that was maintained at 6-month follow-up visit. Despite the heterogeneity in groups, follow-up protocols and types of study our findings are in line with recent studies regarding the effect of nonsurgical periodontal treatment in BP levels. BP reductions described in literature are highly variable from no decrease at all,[28] not statistically significant,[29] or reductions in 11.1 mm Hg.[9]

In 2006 D'Aiuto et al[18] found reduction in SBP after periodontal treatment combined with antimicrobials of 7 ± 3 mm Hg at 2 months but this reduction was not stable at 6-month follow-up. Vidal et al in 2013[19] described a reduction both in SBP and DBP of 12.5 and 10.0 mm Hg,

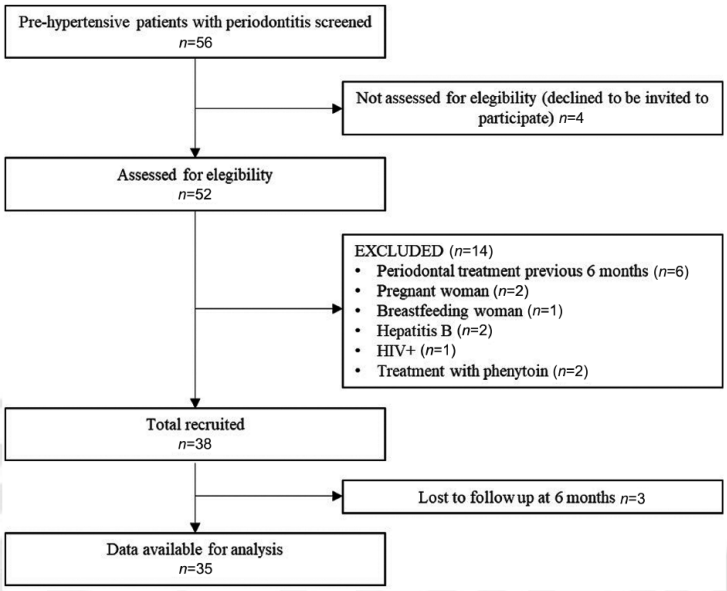

Fig. 1 Flow diagram of patient inclusion and exclusion.

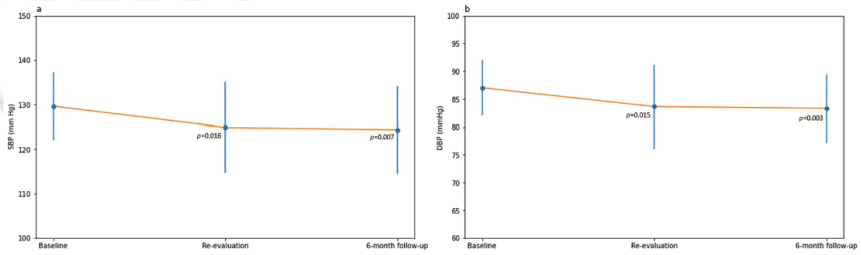

Fig. 2 Systolic blood pressure (SBP) and diastolic blood pressure (DBP) during 6-month follow-up period. Parts A and B represent mean SBP and mean DBP, respectively. Vertical bars represent standard deviation (SD). *p*-Values were calculated with paired samples Student's t-test between baseline and re-evaluation visit and between baseline and 6-month follow-up visit.

respectively, 6 months after nonsurgical periodontal treatment. In 2015, Hada et al[20] found a reduction in SBP of 7.1 mm Hg at 6 months. In 2016, Houcken et al[21] described a decrease in SBP of 2.9 mm Hg at 6 months. Similar results were found by Bizzarro et al[22] in 2017, which described a reduction of 2.7 mm Hg at 12 months in patients that received nonsurgical periodontal treatment which increased to 5.4 mm Hg reduction when treatment combined with antibiotics.

In 2017, Zhou et al[23] described a reduction in SBP and DBP of 12.57 and 9.65 mm Hg, respectively, at 6 months following scaling and root planning periodontal treatment. Similar results were published by Czesnikiewicz-Guzik et al[9] in 2019, which found a reduction in SBP of 11.1 mm Hg and DBP of 8.3 mm Hg 2 months after periodontal treatment. In this last case, BP measurements were taken with a 24-hour ambulatory blood pressure monitoring (ABPM). While this measurement method is more reliable in diagnosing high BP, some evidence suggests[11] that studies using ABPM show the greatest reduction both in SBP and DBP. Our findings are also consistent with recent large cross-sectional survey of 11,753 participants which showed that periodontal health is

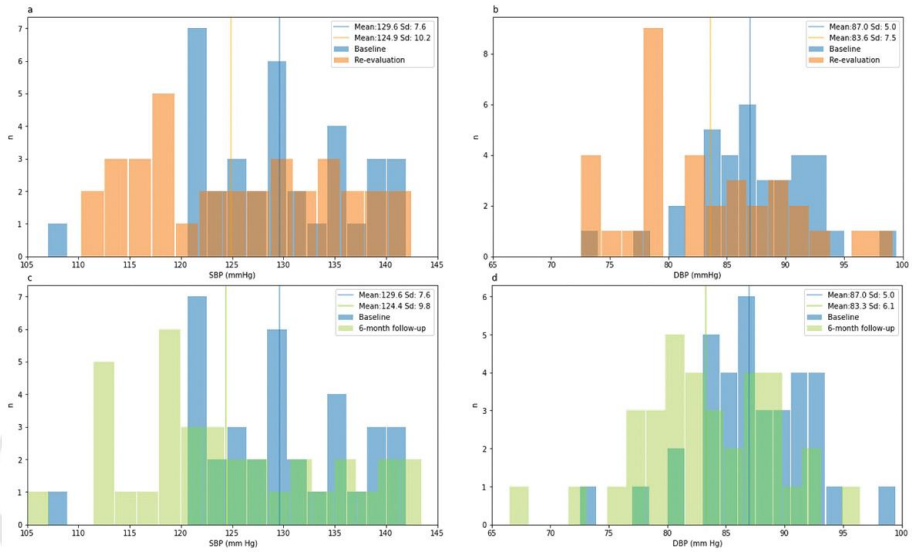

Fig. 3 Histogram of blood pressure (BP) distribution. Parts A and B represent changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP) distribution, respectively, between baseline and periodontal re-evaluation visit. Parts C and D represent changes in SBP and DBP distribution, respectively, between baseline and 6-month follow-up visit. Vertical lines represent BP mean values of each visit.

associated with better SBP profile by about 3 mm Hg and with lower odds of antihypertensive treatment failure.[30]

The prevalence of high normal BP is estimated to be 30 to 50% of overall population[5–7,31] and is associated with three times more likelihood of developing hypertension in the future.[1] Therefore, any strategy focused on diagnosing and lowering BP levels on these patients is an important preventive public health goal. The study published by Kawabata et al[27] suggests that the presence of periodontitis can be a risk factor for developing hypertension in patients with prehypertension.

The exact mechanisms that link high BP and periodontitis remain unclear. Different factors are described in the literature. The most important pathomechanism seems to be systemic inflammation that may be exacerbated by local gingival inflammation, and secondary damage to the vascular endothelium.[11] Moreover, the bacteremia and oral pathogens dysbiosis that occur in periodontal diseases has an important role. Oral bacteria can influence nitric oxide production and this may produce metabolic abnormalities that contribute to BP levels rising.[11] Furthermore, recent evidence demonstrates common genetic predisposition factors for both diseases,[11] which can explain the frequent coexistence of them.

This study has not found a proportional relationship between the rate of improvement of periodontal values (PPD, CAL, BOP) and the rate of BP level improvement (SBP and DBP). This may be explained by the fact that performing nonsurgical periodontal treatment in patients with periodontitis decreases by itself gingival and systemic inflammation.

This simple periodontal treatment that patients need is already a benefit for the individual cardiovascular risk profile of patients. An improvement in only 5 mm Hg in SBP can reduce stroke mortality by 14% and cardiovascular disease mortality by 9%.[26]

Our clinical study has its limitations. The low number of patients included needs to be confirmed in a large cohort of prehypertensive patients. Moreover, there may be an overestimation of BP levels due to white coat hypertension. Twenty-four hours ABPM monitoring would be a very useful tool to confirm diagnostics. Also, a longer follow-up of 12 months would be needed to allow for therapeutic recommendations and conclusions. Finally, it should be considered that the decrease in BP may be due to the result of general healthy instructions and oral hygiene improvement apart from periodontal treatment.

Findings of this study suggest the importance and impact of periodontal treatment in BP levels in patients with prehypertension, and the importance of early detection of this subgroup of patients, who are usually underdiagnosed because they do not meet the strict criteria for hypertension.

Likewise, and just as important as the clinical findings, our study emphasizes the figure of the dentist in the context of public health. The role of professionals in dental clinics is fundamental in the primary and secondary prevention of

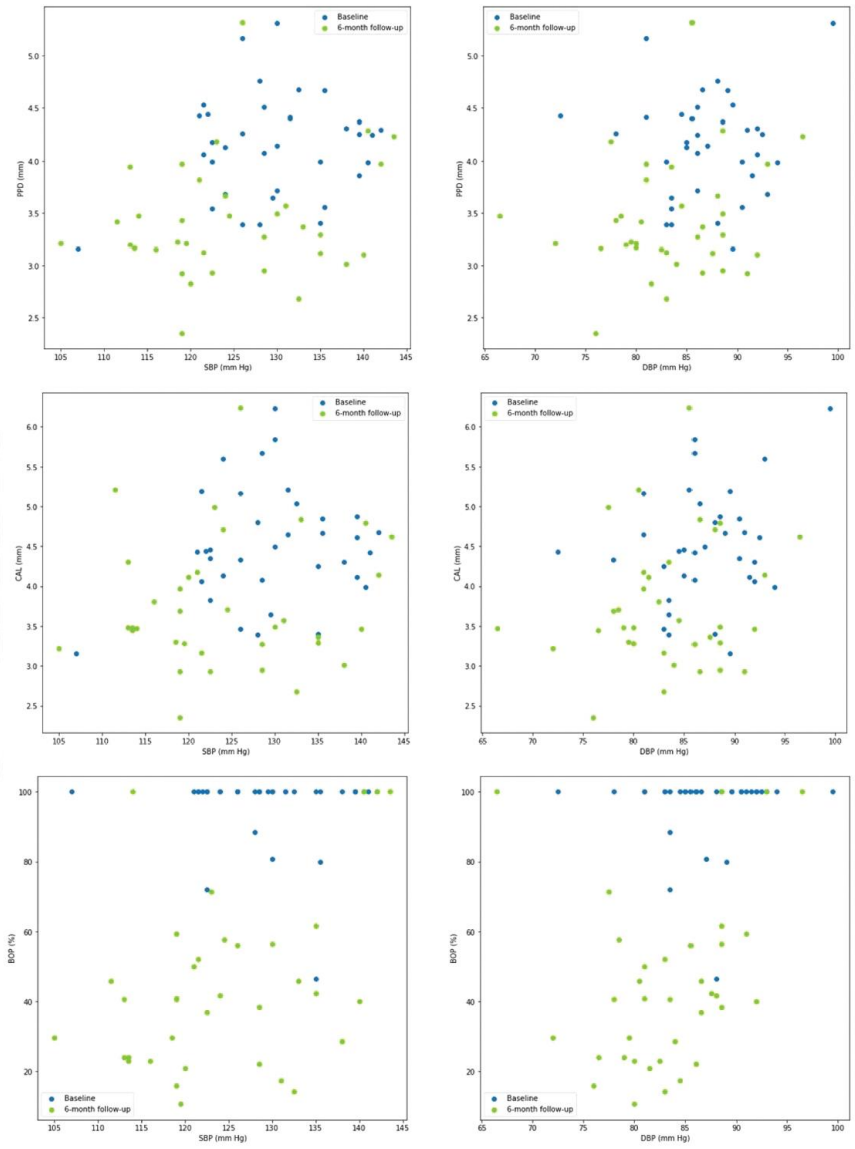

Fig. 4 Relationship between periodontal parameters (probing pocket depth, PPD [mm], clinical attachment loss, CAL [mm], bleeding on probing, BOP [%]) and systolic blood pressure (SBP) and diastolic blood pressure (DBP; mm Hg) measurements (left and right column, respectively). Baseline values are presented in blue and 6-month follow-up values are presented in green.

arterial hypertension. The implementation of BP screening programs in patients with periodontitis and practical circuits where to refer affected patients is essential. Finally, the clinical practice of the dentist can be fundamental in the nonpharmacological control of this cardiovascular risk factor.

Conclusion

This study shows that nonsurgical periodontal treatment can be effective in lowering BP levels in patients with prehypertension and periodontitis, without any antihypertensive medication. It also highlights the importance of dentists in prevention, detection, and control of high BP and cardiovascular risk

Ethical Approval Statement

Ethics Committee of Hospital Universitario Dexeus – Grupo Quironsalud with code 2018/ODI-2018-01.

Funding

None.

Conflict of Interest

None declared.

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9.4. Annex 4: Carta comitè ètica Hospital Universitari Quirón-Dexeus

quirónsalud
La salud persona a persona

APROBACIÓN DEL COMITÉ ÉTICO DE LA INVESTIGACIÓN

Dr. José Luis Simón Riazuelo, Presidente del Comité Ético de la Investigación del Grupo Hospitalario Quirón en Barcelona,

CERTIFICA

Que este Comité ha evaluado la propuesta correspondiente al estudio con Código de protocolo: **2018/ODI-2018-01**, titulado: "**Hipertensión arterial y enfermedad periodontal.**"

Se cumplen los requisitos necesarios de idoneidad del protocolo en relación con los objetivos del estudio y están justificados los riesgos y molestias previsibles para el sujeto.

La capacidad del investigador y los medios disponibles son apropiados para llevar a cabo el estudio.

Son adecuados los procedimientos previstos para obtener el Consentimiento Informado.

El alcance de las compensaciones económicas previstas no interfiere con el respeto a los postulados éticos.

Y que este Comité acepta que dicho estudio sea realizado por **Neus Landau como Investigadora Principal del servicio de Cirugía Oral y Maxilo-Facial en Maxilonet-Hospital Universitari Dexeus-Grupo Quirónsalud.**

En Barcelona, a 19 de julio de 2018.

Fdo.: Dr. José Luis Simón Riazuelo