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Original Research Article

Association between arterial hypertension and periodontitis in a Senegalese population: A bi-centric case-control study

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Abstract

Background: Some studies suggest a link between Periodontitis and hypertension that are chronic conditions of which underlying implications are not well understood. The aim of this was to investigate the association between Periodontitis and Arterial Hypertension in a Sub-Saharan population.

Materials and Methods: This was a bi-centric, analytical case-control study carried out on a sample of 224 patients (112 cases and 112 controls). Hypertensive Periodontitis patients formed the first group, while the second group consisted of non-hypertensive Periodontitis subjects. Periodontal parameters as probing depth, bleeding on probing, and clinical attachment level were assessed according to 2018's classification of periodontal diseases. Arterial Hypertension diagnosis corresponded to Systolic Blood Pressure ≥140 mm Hg/ Diastolic Blood Pressure ≥90 mm Hg. A stepwise degressive multivariate logistic regression model was used.

Results: Half of the hypertensive patients had Periodontitis 50% (n=56) versus 32.14% (n=36) in controls. The majority of hypertensive patients (67.85%) had Stage 3 Periodontitis, while only 13% had Stage 4 Periodontitis. Grade C and B Periodontitis were diagnosed in 12.5% and 87.5% of hypertensive patients respectively. A significant link was found between Arterial Hypertension and Periodontitis (OR: 1.56 [1.14 – 2.14]).

Conclusion: Association was found between Periodontitis and Arterial Hypertension. More research is needed in Africa, particularly in Senegal, with larger sample sizes to confirm this association and assess several covariates.

Keywords: Periodontitis, Arterial Hypertension, High blood pressure, Inflammation, Case-control study

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1. Introduction

Periodontitis is an infectious disease with inflammatory manifestations. Periodontal pockets, clinical attachment loss and radiographic alveolysis are the major clinical and paraclinical signs.[1,2] Periodontitis is a highly prevalent chronic inflammatory disease, making it a major public health problem. It has been associated with a range of systemic diseases including diabetes,[3,4] cardiovascular diseases CVDs.[5] Cardiovascular disease accounts for 32% of all deaths and 45% of chronic disease mortality.[6] Arterial Hypertension is defined as chronically elevated blood pressure with cardiovascular complications. Changes in collagen metabolism, increased systemic inflammation and oxidative stress are currently observed.[7] As a multifactorial disorder, essential or primary hypertension is characterized by an increase in systolic and diastolic blood pressure to 140 mmHg and 90 mmHg or higher.[8] The release of pro-inflammatory cytokines by immune cells is a similar mechanism to hypertensive and periodontal pathologies.[9] Endothelial dysfunction is often associated with reduced periodontal vascularization.[10] However, the mechanisms linking these two pathologies remain unknown.[11] Clinical and experimental studies have suggested some mechanisms related to: local and systemic inflammation, the microbial effect and, the host immune response.[12] Arterial Hypertension has an estimated prevalence of over 30%, but is declining in high-income countries.[13,14] In Africa, over 40% of the adult population is affected, with prevalence varying according country.[15] Arterial Hypertension affects one-third of Senegalese people (3 million individuals) with an estimated prevalence of 29% among 18-69 years old.[16] In

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this country, a single study carried out in 2011 by Leye and al. showed an association between these two conditions, but only incisors and molars were taken into account for the assessment of periodontal disease.[17] It seems important to investigate this association further, to enable the development of new preventive measures to tackle the burden of Arterial Hypertension in Senegal. To date, there is little published clinical data in our country on the relationship between Periodontitis and Arterial Hypertension. This study aimed to examine the link between Periodontitis and Arterial Hypertension in a sub-Saharan Senegalese population.

2. Materials and Methods

This bi-centric case-control study was conducted in the Cardiology and Odontology Departments in Dakar. This study lasted from February to August 2023 (7 months). Cases were patients with Arterial Hypertension; controls were free of Arterial Hypertension and were recruited from among patients' companions and staff working at the selected sites. STATA 17/IC software for Mac was used for sample size calculation. For a fixed power of 94% and a risk α of 5% based on study by Leye et al. in 2011,[17] a theoretical exposure to Periodontitis of 32.9% in controls was considered. A 2.6 risk level of hypertension Periodontitis patient was considered according to the literature. The sample included 112 patients with Arterial Hypertension and 112 as controls matched on age, diabetes, smoking status, dyslipidemia and body mass index.

Patients 18–70 years old attending the Cardiology services and clinically diagnosed with Arterial Hypertension, who gave inform consent to participate in the study were included. Patients must have no cardiac pathology in addition to Arterial Hypertension (ischemic heart disease, acute coronary syndrome, congestive heart failure, valvular heart disease, stroke, history of transient ischemic attack or atrial fibrillation) according to medical records. Periodontitis was the exposure factor and the 2018 periodontal disease classification was used to define cases of Periodontitis. Periodontitis was classified as stage 1 if interdental clinicial attachment loss (CAL) ranges from 1 to 2 mm and a maximum probing depth (PDmax) < 4mm. It was considered stage 2 when interdental CAL range from 3 to 4 mm and stage 3 or 4 if interdental CAL > 5 mm and PDmax ≥ 6 mm. Missing teeth for periodontal reasons, furcation involvement, and tooth mobility were assessed in order to establish stage 3 or 4. The grade is an indicator for Periodontitis progression (A, B or C) was assessed on the basis of indirect evidence of progression (bone loss/age ratio; phenotype) and grade-modifying factors (smoking, diabetes).[2] When less than 30% of the teeth were affected, Periodontitis was said to be localized, but when more than 30% of the teeth were affected, it was said to be generalized.

Comorbidities, history of Arterial Hypertension and patients meeting inclusion criteria were collected. The periodontal features collected include: plaque index, bleeding on probing index (BOP), maximum interdental clinical attachment loss (CAL max), maximum probing depth (PD max), clinically detectable furcation damage. Pocket depth was measured using a Williams periodontal probe, and dental formula and mobility were assessed using the Mühlemann index.[2] Interdental attachment loss represents the distance from the cementoenamel junction to the bottom of the periodontal pocket, measured at the proximal (mesial and distal) surfaces of the teeth. A clinical examination form had been pre-established, and patients were recruited during cardiology examination. The periodontal examination was performed by a single calibrated practitioner specializing in periodontology. He was calibrated for periodontal probing, tooth mobility testing, and BOP index recording until a Cohen's kappa > 0.61 was obtained, indicating at least substantial agreement.

After diagnosis of Arterial Hypertension, cardiologists referred patients to the principal investigator. We had informed consent from the patients. For each patient, a periodontal screening was carried out in the dental chair by the principal investigator. The principal investigator then took their blood pressure with an electronic sphygmomanometer (OMRON, M7 Intelli IT HEM-7361T-EBK, Shiokoji Horikawa, Shimogyō-ku, Kyoto 600-8530, Japan) on two occasions, at the beginning and end of the periodontal clinical observation in accordance with ESH and ESC recommendations.[18] The principal investigator had been trained by the nurses to take blood pressure on an electronic device (Cohen's kappa = 0.81, perfect agreement). In case of doubt, the principal investigator would call on the nurse. Clinical observation was carried out under the samIe conditions as for the cases.

Data were analyzed using STATA 17/IC/Mac software. Univariate analysis was essentially descriptive with proportions and means of studied variables. Upstream, certain variables were redefined or dichotomised. Each variable was also subjected to standard descriptive analysis with frequencies for qualitative variables and means and standard deviations for quantitative variables, all of which were normally distributed. Link between categorical variables was studied using chi-square or Fisher's exact test. For quantitative variables, Student's t-test or Wilcoxon's exact test was used. The relationship between hypertension and associated factors was analyzed using binary logistic regression. Associations between hypertension and other parameters were studied using the chi-square test or Fisher's exact test. Their strength was determined by odds ratios with their 95% confidence intervals. These were estimated using univariate logistic regression. In order to manage confounding factors multivariate analysis were used. With variables whose p value was less than 0.25 in univariate analysis, a model was developed. To objectify the "at risk" categories, the categories with the lowest proportion in the non hypertension group were used as references. The adjusted odds ratios, derived from the final model, were

presented with their 95% confidence intervals and the Wald test p-value. The Hosmer and Lemeshow test was used to verify the adequacy of the model to the data, and the variance inflation factor was used to verify the absence of collinearity between the predictors included in the final model. The model was built by calculating the relative OR fluctuation of the primary independent variable "Periodontitis" after checking each output variable. Interrelations with the variable "Periodontitis" were tested. If p = 5%, he results are considered marginally significant, and significant below 5%.

3. Results

The sample size included 224 subjects (112 cases vs 112 controls). The average age was 56.36 ± 13.01 for hypertensive patients and 45.87 ± 15.63 for controls. Hypertensive patients were more numerous in the 46-64 age group (66.26%), whereas the most representative age group for controls was 25-45 (71.26%) **(Table 1).**

Table 1: Comparative characteristics of cases and controls.

Variables	Modalities	Numbers (%)		Mean (SD) P-value		P-value
		Cases =112	Control =112	Cases	Control	
Age (years)				56.36(13.01)	45.87(15.63)	<0.001
	24-45 years	25(28.74)	62(71.26)			<0.001
	46-65 years	55(66.27)	28(33.73)			
	+65 years	32(59.26)	22(40.74)			
Sex	Female	76(53.52)	66(46.48)			0.21
	Male	36(43.90)	46(56.10)			
Occupation	Non-employee	63(54.78)	52(45.22)			0.18
	Employee	49(44.95)	60(55.05)			
BMI	Underweight	0	2(100)			0.53
	Normal	46(47.42)	51(52.58)			
	Obese	11(50)	11(50)			
	Overweight	55(53.40)	48(46.6)			
BP Systolic				163.09(13.41)	110.47(9.07)	<0.001
BP Diastolic				96.3(8.27)	75.96(6.71)	<0.001
brushing	1 time/day	69 (61.60)	48 (42.85)			0.005
	more than once/day	43 (38.40)	64 (57.15)			
Alcohol	Yes	0	0			1
	No	112(100)	112(100)			
Tobacco	Yes	0	3(2.68)			1
	No	112(100)	109(97.32)			
Dyslipidemia	Yes	9(8.03)	0			1
	No	103(91.97)	112(100)			
Diabetes	Yes	14(82.35)	3(17.65)			0.006
	No	98(47.34)	109(52.66)			

Table 2: Periodontal characteristics in cases and controls

Variables	Modalities	Numbers (%)		Mean (SD)		P-value
		Cases	Control	Cases	Control	
PI %				71.98 (10.44)	71.20 (14.21)	0.06
BoP %				48.13(13.42)	40.84(14.78)	<0.001
Interdental CAL (mm)				3.14(3.28)	1.57(2.34)	< 0.001
PD (mm)				3.14(3.28)	1.57(2.34)	< 0.001
Teeth missing due to periodontal causes (tooth)				4.58(3.58)	3.89(3.53)	0.3
Tooth mobility (tooth)				5.99 (3.46)	2.45 (2.86)	0.03
Radiographic alveolysis		51(45.54)	36(32.14)			<0.001
Percentage of bone loss (%)				26.74(27.92)	12.54(19.26)	<0.001
Ratio of bone loss to age of bone loss (%)				42.43(44.09)	20.55(31.48)	<0.001
Periodontitis	(+)	50(58.70)	32.14(43.94)			0.03
	(-)	50(41.30)	67.86(56.06)			

Periodontitis (stage and grade)	ST2/GB	3 (2.68)	16 (14.29)			0.004
	ST3/GB	34 (30.36)	19 (16.96)			
	ST3/GC	4 (3.57)	0 (0.00)			
	ST4/GB	12 (10.71)	0 (0.00)			
	ST4/GC	3 (2.68)	1(0.89)			

CAL=Clinical Attachment Loss, Bop=Bleeding on probing, PI=Plaque Index

Table 3: Multivariate analysis with binary logistic regression: hypertension and associated factors

Variables	Modalities	Numbers	% HTA reached	OR [IC 95%]	P-value
Dental mobility	< 2 ≥ 2	117 107	45.30 55.14	10.77[3.42 – 33.93]	< 0.001
Age	24-45 years 46-65 years + 65 years	87 83 54	25.58 66.27 59.26	1 3.44 [1.2 – 9.87] 2.13 [1.24 – 7.25]	0.021
Periodontitis	Yes No	92 132	58.70 43.94	1.56 [1.14 – 2.14] 1	0.005
Brushing	Yes No	216 8	48.61 87.5	0.16 [0.01 – 1.55] 1	0.11
Ratio of bone loss to age (%)		224	42.43 ± 44.09	1.03 [1.01 - 1.05]	0.002
Diabetes	Yes No	17 207	82.35 47.33	2.91 [0.56 – 15.21] 1	0.20
Lysis type		224	26.74 ± 27.92	0.21 [0.05 - 0.90]	0.036
PI		224	71.98 ± 10.44	0.92 [0.89 – 0.96]	< 0.001
Occupation	Employee Non-employee	109 115	44.95 54.78	0.51 [0.25 – 1.04]	0.066

Age was significantly correlated with hypertension. Indeed, the majority of patients with Periodontitis and Arterial Hypertension (66.27%) were aged between 46 and 64 years (OR= 4.87; 95% CI [2.54-9.33], p<0.0001) and 65 years and over (OR= 3.60; 95% CI [1.76-7.36], p<0.0001), with a peak between 45 and 65 years **(Table 3).**

Approximately 58% of hypertensive patients had grade 2 Arterial Hypertension (grade 2= Systolic Blood Pressure [160 – 179 mm Hg] and/or Diastolic Blood Pressure [100-109 mm Hg]) and 8.93% had grade 3 Arterial Hypertension (SBPressure >180 mmHg and/or DBPressure >110 mm Hg).

Concerning periodontal-related parameters, the average plaque index (PI) was virtually identical in both groups (71.98% ± 10.44 for cases and 71.20% ± 14.21 for controls). However, the score of bleeding on probing (BoP) was greater in hypertensive patients (48.13% ± 13.42) than in the controls (40.84% ± 14.78) with a statistically significant difference between the two groups (p<0.001). In addition, the average of periodontal pockets depth (PD) was greater in cases (3.14±3.28) than in controls (1.57±2.34) with also a statistically significant difference (p<0,001). Interdental CAL max was greater in the cases (3.14mm ±3.28) than in the controls (1.57 ±2.34 with p<0.001) (**Table 2)**. Tooth loss due to periodontal disease was higher (4,58 ±3,58 and 3,89 ±3.53) in cases than in controls. Half of hypertensive patients had Periodontitis 50% (n=56) versus 32.14% (n=36) in controls with a statistically significant difference between the two groups (p=0.03). Around 13% of hypertensive patients had stage 4 periodontitis, and 67% had stage 3 periodontitis. Grade C and B Periodontitis were found in 12.5% and 87.5% of hypertensive patients respectively. Clinical attachment Loss (CAL), probing depth (PD), bleeding on probing (OR= 1.03; 95% CI [0.95-0.99], p < 0.0001), mean percentage of alveolysis and ratio bone loss/age were associated with Arterial Hypertension.

According to logistic regression adjusted for the other variables in the model, Periodontitis is a risk factor for Arterial Hypertension (p = 0.005) **(Table 3).** Indeed, taking into account the other variables, having Periodontitis gives a 1.56 times chance of having HBP than not having it. Periodontitis was statistically associated with hypertension (OR: 1.56 [1.14 – 2.14], p=0.005).

4. Discussion

A statistically significant association was founded between Periodontitis and Arterial Hypertension in this study. Leye and al. in 2011 had found similar results.[17] Data from the 2015-2016 National Health and Nutrition Examination Survey (NHANES), show the prevalence of Arterial Hypertension falling from 7.5% between the ages of 18 and 39 to 1.5% between the ages of 20 and 30.[19]

Mean plaque index PI scores were essentially identical in both groups. Bivariate analysis showed no association between mean plaque index scores and hypertension in Periodontitis patients. In contrast, Chiu et al. found lower plaque index scores in hypertensive patients compared to normotensive patients with respectively PI=59.45% ± 21.46

(Arterial Hypertension group) and PI=77.45% ± 15.07 (non hypertensive) with p<0.001.[20] Leye et al. in Senegal had found an association between plaque index and Arterial Hypertension (OR= 4.1; 95% CI [3.04-7.38], p <0.001).[17] However, the different plaque control assessment methods used in these studies could explain the differences between the results. Bleeding on probing (BoP) is regularly assessed during the periodontal examination. It is considered a valuable clinical parameter of periodontal inflammation. In our study, assessment of BoP reported higher mean scores in hypertensive patients compared with controls. Multivariate analysis showed an association between BoP assessed and Arterial Hypertension. The study carried out by Pietropaolia et al. in 2018 on a sample of 5396 hypertensive patients divided into two groups ("stable Periodontitis", in the presence of clinical signs but with BoP <10% and "active Periodontitis" in the concomitant presence of signs of Periodontitis and BoP >10%) showed that participants with active Periodontitis had a PAS 2.8 to 3.7 mm Hg higher than those with stable periodontitis, independently of age (p < 0.001). Multivariate analysis showed a significant link between elevated blood pressure and periodontal status (OR=1.61; 95% CI [1.38-1.88], p <0.001).[21] However, Yildirim et al. had found no association between bleeding on probing and Arterial Hypertension after logistic regression (OR = 1.93; 95% CI: [0.94-3.97], p = 0.073).[22]

Concerning the diagnosis of periodontitis, several studies have shown an association between Periodontitis and Arterial Hypertension.[23,24] A meta-analysis had revealed that moderate and severe Periodontitis were associated with Arterial Hypertension (OR= 1.22; 95% CI [1.10-1.35] and OR=1.49; 95% CI: [1.09 to 2.05].[25] The results of our study showed a significant link between Periodontitis and Arterial Hypertension (OR=1.56; 95% CI: 1.14–2.1).

Chiu et al. reported in their case-control study on a sample of 204 patients (104 hypertensives and 100 controls) a prevalence of severe Periodontitis of 57% in patients with essential Arterial Hypertension and 30.4% in controls.[20] A study by Darnaud et al. had not found significant association between oral parameters and risk of hypertension in subjects aged 65 and over. However, in patients under 65, these oral variables and the risk of Arterial Hypertension were associated.[25] In a longitudinal study in a cohort of 540 patients, Aremu et al. reported that severe Periodontitis significantly increased the risk of pre-hypertension and Arterial Hypertension by 47% (95% CI: [1.01 - 2.17]) after adjusting for confounding factors like age, sex, smoking, family history of Arterial Hypertension, diabetes, waist circumference, alcohol consumption and physical activity.[26] Similarly with the results of Yildirim; Chiu and Darnaud, we also found an association between Interdental Clinical Attachment Loss (CAL), PD and HBP (CAL: OR=1.20; 95% CI: [1.09-1.32], p=0.0001; PD: OR=1.78; 95% CI: [1.01-1.05], p<0.0001]). However, our study showed no association between Arterial Hypertension and the number of teeth missing for periodontal reasons (OR= 0.96; 95% CI: [0.89-1.03], p=03) and tooth mobility (OR=1.48, 95% CI: [0.87-2.51], p=0.14). Grade B stage 3 Periodontitis was a significant risk factor for Arterial Hypertension (OR = 2.13; 95% CI: [1.128-4.03]). In addition to the inclusion criteria excluding some patients with Arterial Hypertension, the lack of funding meant that blood tests could not be prescribed for all patients. Thus, for diabetes, the question was asked directly to the patients. Glycated hemoglobin would have enabled us to assess glycemic control for periodontal diagnosis. In the absence of a lipid profile, the presence of dyslipidemia was taken into account if it had been self-reported by the patient or if the patient was under treatment. This was limitation in this study to ascertain diagnoses.

Also, in this work, we did not investigate the effects of periodontal treatment on lowering blood pressure figures, as studies showing that periodontal treatment can lower blood pressure are still limited because, interventional studies in this area are few and far between. Surma et al. showed that the combined effect estimates of eight trials on the reduction of Systolic Arterial Pressure and Diastolic Blood Pressure after periodontal treatment were respectively 4.31 mmHg with 95% CI [0.48-9.10] and 3.16 mmHg with 95% CI [0.19-6.51.[24]

5. Conclusion

This study showed a significant link between Periodontitis and Arterial Hypertension in a Senegalese population. Within its limitations, prospective longitudinal and interventional studies are recommended to clarify the pathophysiological mechanisms linking these two diseases. It would be advisable to integrate periodontal management of hypertensive patients into prevention, treatment and follow-up.

6. Source of Funding

None.

7. Conflicts of interest

There are no conflicts of interest.

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