Original Article

A Hospital-Based Case–Control Study to Explore the Association of Bruxism and Cardiovascular Diseases in Himachal Pradesh, India

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Abstract

Aims and Objectives: The cardiovascular diseases (CVDs) all over the world results in huge disease burden that has catastrophic social and economic effects. The main objectives of this study are to explore possible association of bruxism with CVD and to document other factors associated with (CVDs) and bruxism. **Subjects and Methods:** It is an observational study done in two hospitals of district Kangra, Himachal Pradesh. A case–control study design was used to study the association of bruxism and CVDs. Cases were patients having history of CVDs and controls were without CVDs. Self-reporting questionnaire and tooth wear index were used as research instruments. **Results:** A total of 80 subjects with CVD (62 years, standard deviation [SD] - 11.8, 53% men) were compared with 80 controls (58.9 years, SD - 11.15, 55% men). Bruxism was found to be more prevalent in patients with CVD (71.3% vs. 57.3%, $P = 0.00043$). On multivariate logistic regression analysis, bruxism was independently associated with CVD (adjusted odds ratio (OR) 2.61, 95% confidence interval [CI] 1.2–5.8, $P = 0.016$ and an unadjusted OR 3.16,95% CI, 1.66–6.21, $P = 0.000529$), explaining that the odds of having CVD is 3.16 times higher in patients with bruxism than participants without bruxism. **Conclusions:** More research (cohort studies) needs to be conducted to find the emerging risk factors for CVDs. Through the help of dentists, doctors, and community health workers, the general population shall be made aware of bruxism, CVDs, and their possible association.

Keywords: Bruxism, cardiovascular diseases, prevalence of bruxism in cardiovascular disease patients

Introduction

Bruxism is characterized by the grinding of the teeth and clenching of the jaw. In 2018 Lobbezzo *et al*. included "Bracing" and "Thrusting" to the definition of bruxism and also showed that bruxism is a centrally controlled phenomenon.[1] Sleep bruxism (SB) is a mastication muscle activity during sleep that is rhythmic (phasic) or nonrhythmic (tonic) and is not a movement disorder or sleep disorder in usually healthy individuals. Awake bruxism is a masticatory muscle activity at his/her wakefulness that is characterized by repetitive or sustained tooth contact.[2]

International Classification of Sleep Disorders (ICSD) classifies SB that includes the presence of frequent tooth-grinding sounds during sleep, abnormal tooth wear, transient morning jaw muscle pain or fatigue, temporal headache, and/or jaw locking upon awakening.[2,3]

A systematic review by Manfredini *et al*. describes the epidemiology of bruxism that reported to have a prevalence of 12.8%+/–3.1%.[4] Tooth wear index (TWI) and patient's self-reported bruxism episodes are the commonly used methods for assessment of bruxism clinically.[5] Self-reporting can include questionnaires. Definitive diagnosis

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of SB can only be achieved using electrophysiological tools. Laboratory-based (Polysomnography [PSG]) detects SB which records the muscle activity of masticatory muscles.

The exact etiology of SB is ambiguous and can be multifactorial in nature. Malocclusion and occlusal interferences like crowded teeth or high edge fillings can be the cause.[6,7] Present literature suggests that SB is regulated centrally and not peripherally.[1] Central factors can be grouped into pathophysiological and psychosocial factors. The link between SB and psychosocial factors such as chronic stress was supported by the studies reporting elevated levels of urinary catecholamine in patients with SB.[8] Also, SB activity had been related to higher levels of perceived psychological stress and salivary cortisol.[9] A study found that people with higher (body mass index [BMI]) have higher chances of SB. Smoking, caffeine, alcohol, the use of certain medications, and breathing problems can be considered as risk factors for SB.[10] At present, there is no effective treatment that cures SB but palliative treatment can give relief to the patients and avoid further damage.

The World Health Organization has described cardiovascular diseases (CVD) as diseases of blood vessels with multifactorial etiology.[11] Around 17.9 million people died from CVDs in 2016, a big chunk of 31% of all global deaths. In 2016, the estimated prevalence of CVDs in India was 54.5 million. These diseases result in increased social and economic burden.[12,13]

Subjects and Methods

The study was initiated after receiving approval from the ethical committee of the institute. All the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional) and with the Helsinki Declaration of 1975, as revised in 2000.

Setting of the study

This Hospital based study was conducted in two government hospitals of district Kangra, namely Dr. Rajendra Prasad Government Medical College, Tanda and Civil Hospital Nagrota Bagwan, Himachal Pradesh where cases and controls were selected based on inclusion and exclusion criteria.

Sampling design and sample size

Case–control study design was employed for this study. Through literature research, the prevalence of bruxism was obtained and formula was employed to calculate the sample size of 196 which included 98 cases and 98 controls in the study group. 1:1 ratio for cases and controls was taken. It was also checked through Epi info software (Version 7.2.4.0). The sample size was restricted to 160 due to rising COVID-19 infections. Eighty cases and 80 controls were enrolled for this study after assessing for inclusion and exclusion criteria.

Formula for case control studies[14]

Sample size = $r + 1\ (p^*)\ (1-p^*)\ (Z\beta + Z\alpha_{/2})^2$

$r\ (p_1 - p_2)^2$

r = Ratio of control to cases; p* = Average proportion exposed = proportion of exposed cases + proportion of control exposed/2; Zβ = Standard normal variate for power = for 80% power it is 0.84 and for 90% value is 1.28; $Z\alpha_{/2}$ = Level of Significance, p_1 = proportion of cases, p_2 = proportion of controls according to previous studies.

Case group

All patients referred to the Cardiology Unit with previously diagnosed case for CVD such as myocardial infarction, angina pectoris stroke, heart failure, hypertensive heart disease, abnormal heart rhythms, congenital heart disease, valvular heart disease, carditis, rheumatic heart disease, cardiomyopathy, aortic aneurysms, peripheral artery disease, thromboembolic disease, and venous thrombosis were considered.

Control group

Controls were taken from the Medicine Out Patient Department (OPD), patients of the same hospital without positive anamnesis for CVD and who had come for other ailments. Controls were matched for age.

Inclusion criteria for cases/controls: (1) Patients aged between 35 and 70 referred to the Cardiology OPD for cases and Medicine OPD for controls; (2) Patients who will give signed informed consent.

Exclusion criteria for cases/controls: (1) Pregnancy; (2) Orthodontic therapy during the study; (3) Other systemic pathologies except for CVD; (4) Other sleep disorders except for bruxism; (5) Severe psychiatric disorders; (6) Conditions requiring antibiotic prophylaxis or any other therapies; (7) Severe physical handicaps; (8) Diagnosed carcinoma; (9) Radiotherapy within 12 months; (10) Immunosuppressive therapy within 6 months; (11) Patients who will not give informed consent.

Research instrument

After explaining the details of the study through participant information sheet in local language, a signed informed consent was taken, then following forms and questionnaires were used in the study: (1) The basic information and health status form. Variables such as gender, hypertension, tobacco consumption, smoking status, etc., were documented for each patient separately; [Appendix 1] (2) Self-reporting questionnaire was given to the participant to know the awareness of the participant on bruxism episodes; (3) All the patients included in the study received a complete dental check-up and they were clinically examined for bruxism by means of the "TWI." TWI given by Smith and Knight given in Table 1[15] is a generic index to measure the tooth wear and it ranges from 0 to 4 depending on the extension and depth of lost substance on different tooth surfaces. A mean TWI value higher than 2 for the 50% of the teeth defined the diagnosis of bruxism for a single patient.

Data analysis

Following data was collected from all the participants after informed consent. Data for each participant was collected from April 2020 to June 2020. Results were separately analyzed for

self-reported bruxism and bruxism combined for TWI as modes of assessment as many people do not report bruxism due to lack of awareness. Data was collected in hard copy and entered in Microsoft Excel in order to perform data analysis. Pearson's Chi-squared-test was performed to compare the proportion of bruxism between the CVD patients (cases) and non-CVD patients (controls). Logistic regression was performed to find out the association between CVDs and bruxism as well as other factors such as gender, age, alcohol consumption, hypertension, etc. The level of statistical significance was set at 0.05 for all analysis. Data analysis was done using R commander for logistic regression and (odds ratio [OR]), which is a package in R software (Version 4.0.0).

Results

The population was normally distributed for cases and controls. The mean age of CVD patients was 62 years with a mean standard deviation (SD) of 11.8 and the mean age of non-CVD patients was 58.9 years with a mean SD of 11.15. Statistics for other variables are given in Table 2 below.

It was seen in Table 2 that more CVD patients have TWI score 4, more CVD patients have poor health status and obesity.

Table 3 shows that more participants with normal BMI have bruxism, bruxists had poor oral health, more stage 2 hypertension and bruxists have more prevelance of smoking and tobacco chewing.

Pearson's Chi-square test was performed in R to see the association of bruxism (self-reported combined with TWI score) and CVDs. The results are shown in Table 4 given below.

Table 4 shows results for combined form of assessment of bruxism and here, the $P = 0.00043$ which is <0.05, therefore, we can conclude that there is an association between bruxism and CVD [Table 4]. Shows the results for self-reported bruxism with a $P = 0.0064$ again proving that bruxism has an association with CVD.

Graph 1 reports that 52.5% of the test group (42 out of 80 cardiopathic patients) were diagnosed with bruxism that was self-reported. On the contrary, only the 31.25% of the control group (25 out of 80 noncardiopathic patients) presented self-reporting bruxism. It also shows that when TWI was also combined to the results, 71.25% of CVD patients had positive history for bruxism, and 43.75% had bruxism in non-CVD patients.

Multivariate Logistic Regression to see the association of CVD with bruxism and various variables:

Table 1: Smith and knight tooth wear index[15]

Score	Surface	Criterion
0	BLOI	No loss of enamel surface characteristics
	C	No change of color
1	BLOI	Loss of enamel surface characteristics
	C	Minimal loss of contour
2	BLO	Enamel loss just exposing dentine <1/3 of the surface
	I	Enamel loss just exposing dentine
	C	Defect less than 1 mm deep
3	BLO	Enamel loss just exposing dentine >1/3 of the surface
	I	Enamel loss and substantial dentine loss
	C	Defect less than 1-2 mm deep
4	BLO	Complete enamel loss, or pulp exposure or 2° dentine exposure
	I	Pulp exposure or 2° dentine exposure
	C	Defect more than 2 mm deep, or pulp exposure

B: Buccal, L: Lingual, O: Occlusal, I: Incisal, C: Cervical

Table 2: Statistics of other variables showing association with cardiovascular diseases and non-cardiovascular diseases patients

	CVD patients, *n* (%)	Non-CVD patients, *n* (%)	*P*
Total number (*n*=160)	80 (50)	80 (50)	
Gender			
Males	42 (53)	44 (55)	0.7512
Females	38 (47)	36 (45)	
Age (years), mean (SD)	62 (11.8)	58.9 (11.15)	
TWI score			
Score 0	2 (2.5)	5 (6.2)	0.00000194
Score 1	5 (6.2)	8 (10)	
Score 2	8 (10)	22 (27.5)	
Score 3	30 (37.5)	33 (41.25)	
Score 4	35 (43.75)	12 (15)	
Poor oral health	52 (65)	22 (28)	0.00000247
BMI status			
Normal	46 (57.5)	56 (70)	0.0710
Obese	14 (18)	5 (6.2)	
Overweight	20 (25)	19 (23.7)	
Smoking status			
Smokers	50 (62.5)	51 (63.75)	0.8698
Nonsmokers	30 (37.5)	29 (36.25)	
BP status			
Normal	12 (15)	46 (57.5)	0.000000134
Stage 1 hypertension	33 (41.25)	21 (26.25)	
Stage 2 hypertension	35 (43.75)	13 (16.25)	
Alcohol intake			
Alcoholic	4 (5)	10 (12.5)	0.104
Nonalcoholic	76 (95)	70 (87.5)	
Tobacco chewing			
Yes	27 (33.75)	23 (28.75)	0.495
No	53 (66.25)	57 (71.25)	
Occupation			
Office	14 (17.5)	12 (15)	0.6682
Nonoffice	66 (82.5)	68 (85)	

TWI: Tooth wear index, BMI: Body mass index, BP: Blood pressure, CVD: Cardiovascular diseases, SD: Standard deviation

After reordering the variables correctly and performing generalized linear regression model, it was found that variables that were significant were bruxism, obesity, poor oral health, BP [Table 5]. In Table 6, an unadjusted OR of 3.16 for bruxism status that also combines TWI score was obtained and an OR of 2.43 for self-reported bruxism concluding that the odds of having CVD is 3.16 and 2.43 times higher, respectively, for a patient with bruxism than someone without bruxism.

Odds of having CVD = 0.081 + 2.607Bruxism Status + 5.22 Blood pressure (stage 1) + 7.85 Blood pressure (stage 2) + 3.4 Poor oral health (yes) + 4.5 BMI (Obese).

Table 3: Descriptive statistics for other variables showing positive or no association with bruxism

Numerical summary	Bruxist, *n* (%)	Nonbruxist, *n* (%)	*P*
Total number (*n*=160)	92 (57.5)	68 (42.5)	
Gender			
Males (*n*=86)	50 (54.3)	36 (52.9)	0.860
Females (*n*=74)	43 (46.7)	31 (45.5)	
BMI status			
Normal	60 (65.2)	39 (57.3)	0.5690
Overweight	21 (22.8)	08 (11.7)	
Obese	11 (11.9)	21 (30.8)	
BP			
Normal	25 (27.1)	32 (47.0)	0.0672
Stage 1 hypertension	32 (34.7)	22 (32.3)	
Stage 2 hypertension	35 (38.0)	14 (20.5)	
Poor oral health	50 (54.3)	23 (33.8)	0.0130
Occupation			
Nonoffice	82 (89.1)	52 (76.4)	0.0098
Office	10 (10.8)	16 (23.5)	
Smoking status			
Smokers	38 (41.3)	20 (29.4)	0.0925
Nonsmokers	54 (58.6)	48 (70.5)	
Tobacco			
Tobacco chewing	28 (30.4)	20 (29.4)	0.6663
Not chewing tobacco	64 (69.5)	48 (70.5)	

BMI: Body mass index, BP: Blood pressure

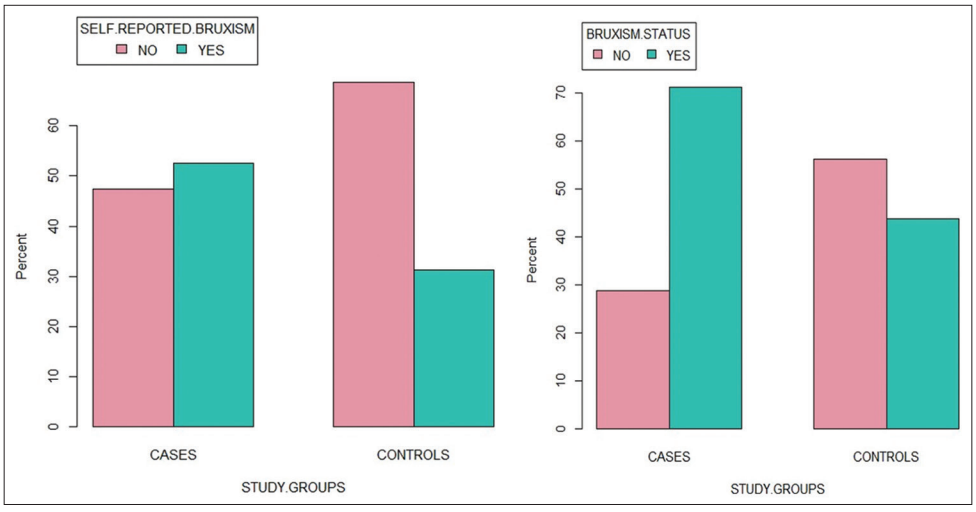
Findings

CVD was found to be more prevalent in patients with poor oral health, higher TWI, and high blood pressure. Bruxism was more profound in patients with poor oral health, higher BP, and occupation (office going). Bruxism was found to be more prevalent in patients with CVD (71.3% vs. 57.3%, $P = 0.00043$). On multivariate logistic regression analysis, bruxism was found to be independently associated with CVD (adjusted OR 2.61, 95% confidence interval [CI] 1.2–5.8, P 0.016 and unadjusted OR 3.16,95% CI, 1.66–6.21, $P = 0.000529$). This explains that the odds of having CVD is 3.16 times higher in patients with bruxism than participants without bruxism. Age, gender, occupation, educational status, and smoking status did not show any association with the disease. Similarly, being overweight was also not associated with CVD.

Discussion

This observational study tried to find the association of bruxism and CVDs. Atilgan *et al.* (2011) reported an association between bruxism and intima-media thickness of the bilateral carotid arteries. The thickness of intima media is increased due to atherosclerosis and hence poses a risk for heart failure. It was found to be proportional to bruxism status.[16] The current study agreed with the results of Atilgan, reporting a greater prevalence of bruxism among patients with a positive history for CVD. CVD may be a contributing cause of bruxism or vice versa. It could also be possible that the association may be due to a third variable, "stress," which can be a contributing cause of both bruxism and CVDs. However, longitudinal studies will be needed to establish whether bruxism is an independent risk factor for CVDs or vice versa.

Nashed and co-workers (2012) studied the association between SB and high blood pressure although the sample size was small. They found that there was a significant rise in blood pressure during rhythmic masticatory muscle activity movements in



Graph 1: Self-reported bruxism and bruxism (combining TWI) versus cases and controls to show the association

Table 4: Pearson's Chi square test for showing association of cardiovascular diseases with self-reported bruxism and bruxism (combining tooth wear index)

Exposure	Disease status		*P*	χ^2
	With CVD (*n*=80), *n* (%)	Without CVD (*n*=80), *n* (%)		
Having bruxism	57 (71.25)	45 (57.25)	0.00043 df=1 $\chi^2_{(1)}$=12.37	12.37
Not having bruxism	23 (29.75)	35 (43.75)		
Having self-reported bruxism	42 (52.5)	25 (31.2)	0.0064 df=1 $\chi^2_{(1)}$=7.42	7.42
Not having self-reported bruxism	38 (47.5)	55 (68.8)		

CVD: Cardiovascular disease

Table 5: For logistic regression for unadjusted odds ratio to see the association of cardiovascular disease with bruxism and other factors

Independent variables	Unadjusted OR	*P*	95% CI
Bruxism status (1=yes, 0=no)	3.16	0.000529	1.66-6.21
Bruxism status (self-reported) (1=yes, 0=no)	2.43	0.0069	1.28-4.68
Gender (1=male, 0=female)	00.90	0.751	0.55-1.98
BP (1=stage 1, 0=normal)	6.023	0.000023	2.66-14.38
BP (1=stage 2, 0=normal)	10.32	0.00000036	4.33-26.26
Poor oral health (1=yes, 0=no)	5.07	0.0000024	2.38-9.41
BMI (1=overweight, 0=normal)	1.3	0.46	0.51-3.40
BMI (1=obese, 0=normal)	4.37	0.0142	1.40-19.53

Dependent variable=CVD. BMI: Body mass index, CVD: Cardiovascular disease, OR: Odds ratio, CI: Confidence interval, BP: Blood pressure

Table 6: For logistic regression (adjusted odds ratio) for showing association of cardiovascular disease with bruxism combined with other factors

Independent variables	Adjusted OR	*P*	95% CI
Bruxism status (1=yes, 0=no)	2.607	0.016	1.20-5.80
Gender (1=male, 0=female)	0.790	0.5564	0.35-1.72
BP (1=stage 1, 0=normal)	5.22	0.00053	2.10-13.80
BP (1=stage 2, 0=normal)	7.85	0.000054	2.97-22.26
Poor oral health (1=yes, 0=no)	3.41	0.00171	1.59-7.45
BMI (1=overweight, 0=normal)	1.47	0.38989	0.61-3.60
BMI (1=obese, 0=normal)	4.52	0.02485	1.30-19.23

Odds of having CVD=0.081+2.607 Bruxism status+5.22 BP (stage 1) +7.85 BP (stage 2)+3.4 poor oral health (yes) +4.5 BMI (obese). BMI: Body mass index, OR: Odds ratio, CI: Confidence interval, BP: Blood pressure, CVD: Cardiovascular disease

bruxism patients at night. Bruxism resulted in increased systolic and diastolic blood pressures.[17] A similar study was conducted by Martinowicsz *et al*. to assess the severity of SB in patients with hypertension. They found that the Bruxism Episode Index (BEI) was higher in the study group (hypertensives) than the control group (without hypertension). This can be due to the increased sympathetic activity in hypertension and SB. Thus, the hypertension present in CVD patients may be due to bruxism activity or vice-versa.[2] These findings were confirmed in this present study that presented that maximum number of patients having bruxism were having stage 2 hypertension. Hypertension (both systolic and diastolic) was found more prominent in patients having bruxism. This shows that bruxism, CVDs, and hypertension all are co-related.

The patients who had bruxism also showed more prevalence of smoking and tobacco chewing. This is in congruence with several studies that gave the same results.[10] Smoking and tobacco may be a cause of bruxism itself. Stress may lead to adopting harmful habits and thus leading to bruxism.

Another study that agrees with the results of the present study was done by Marthol *et al.* which stated that autonomic cardiovascular control is impaired in hypertension that leads to a reduction in the parasympathetic and an increase in the sympathetic tone. To assess sympathetic cardiac activity in bruxism patients, they monitored cardiac autonomic modulation using spectral analysis of heart rate variability and compared results to those of age-matched healthy participants. In bruxism patients, sympathetic cardiac activity was found to be higher than in volunteers.[18]

There is a study by Marconcini *et al*. which tried to find if stress acts as an underlying causative agent for bruxism. This study was similar to the current study as they compared the prevalence of bruxism among patients having cardiac disease and patients without cardiac disease and concluded that cardiopathic patients suffered more from bruxism as compared to noncardiopathic patients.[5]

Another finding was that patients having positive history for bruxism had poor oral health. Few studies are reported to prove this association, but Nakayama *et al*.(2018), Hanamura (1987), and Camara Souza *et al*.(2019) studies showed correlation between bruxism with poor oral health and poor oral health-related quality of life.[19-21]

A study found that people with higher BMI have increased amount of circulating catecholamines, hypertension and increased sympathetic overactivity, thus having a predilection for SB.[22] However, this study was contradicted by the present study results where the BMI of bruxism patients was found to be less as compared to participants without bruxism.

Limitations

This study has some limitations. This study is based on

self-reporting of bruxism by the patients which can be faulty and under-reported usually due to sheer neglect, stigma, lack of knowledge, and awareness about bruxism. In this study, PSG was not used for the assessment of bruxism which is a gold standard for the diagnosis of SB. Comorbidities, old age, or living alone may also be a reason for poor self-reporting of bruxism. It is an observational study conducted in hospital settings with a small sample size so it may not be possible to generalize the results to whole population. This observational study merely documented the association, but the fact that, whether bruxism leads to CVDs could not be established. The small sample size may affect the power of study.

Conclusions

This study showed that the prevalence of bruxism is significantly greater in CVD patients as compared to non-cardiopathic patients. Association was more profound in relation to TWI as compared to self-reporting of bruxism, which is done by a limited number of participants. This is due to the fact that patients have negligible information on bruxism and its signs and symptoms. People consider it as a social stigma, and dental health means only being free of toothache and dental caries. Population needs to be informed about bruxism.

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Conflicts of interest

There are no conflicts of interest.

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APPENDEX 1

Parameters for taking BP, BMI, and oral health

For analyzing the results for blood pressure and BMI, latest AHA (American Heart Association) guidelines for blood pressure were followed:

1. Normal: Less than 120/80 mmHg
2. Elevated: Systolic between 120-129 and diastolic less than 80
3. Stage 1: Systolic between 130-139 or diastolic between 80-89
4. Stage 2: Systolic at least 140 or diastolic at least 90 mmHg
5. Hypertensive crisis: Systolic over 180 and/or diastolic over 120.

Underweight	Below 18.5
Normal	18.5-24.9
Overweight	25.0-29.9
Obesity	30.0 and above

BMI: Body mass index

BMI categories to find the association

Poor oral health was assessed using DMFT criteria, that is how many teeth were decayed, how many missing due to caries, and how many filled/restored due to caries. All these numbers were added and a score was given. If 50% or more teeth were decayed, missing, or filled, that participant was considered to have poor oral health.