

## Periodontal Diseases and its Correlation with Stroke

### *Choroby przyzębia u osób z udarem*

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#### ABSTRACT

Systemic, peripheral infections may be a risk factor for common diseases of CNS with neurodegenerative, vascular and immunological background. Epidemiology of severe periodontitis in Polish population is still unknown. Therefore, to explore a link between periodontitis and general diseases, a study is performed with analysis of periodontal status among post-stroke patients and compare the results with the general healthy cohort. Periodontitis is an inflammatory condition of the periodontium, even though bacterial plaque is the primary initiator of the response, systemic factors such as stroke is a significant risk factor that can create further destruction to the gingiva and alveolar bone. The aim of this case-control study is to investigate the role of stroke in the development of periodontitis in patients. The test population comprises of 104 patients from the Department of Vascular Diseases of Nervous System in Poznan University of Medical Sciences (female = 61, male = 33, age range from 20–79 years [average of 45.97 years]) diagnosed with stroke and 94 relatively healthy patients from the Department of Oral Surgery and Periodontology in Poznan University of Medical Sciences (female = 45, male = 59, age range from 33–92 years [average of 67.38 years]). Patients' periodontal indices (Bleeding on Probing [BOP] and Approximal Plaque Index [API]) were measured and displayed in histogram and boxplots for visualization of data distribution. The data values were statistically analyzed with z-testing, and it is determined that there is a significant association between periodontal disease and stroke ( $p < 0.01$ ) in both BOP and API scores.

**Keywords:** peripheral infections, stroke, periodontitis.

#### STRESZCZENIE

Infekcje ogólnoustrojowe, obwodowe mogą stanowić czynnik ryzyka chorób OUN o podłożu neurodegeneracyjnym, naczyniowym i immunologicznym. Epidemiologia ciężkiego zapalenia przyzębia w polskiej populacji jest wciąż nieznana. Dlatego, aby zbadać związek między zapaleniem przyzębia a chorobami ogólnymi, przeprowadza się badanie z analizą stanu przyzębia wśród pacjentów po udarze i porównuje wyniki z ogólną zdrową kohortą. Zapalenie przyzębia jest stanem zapalnym przewlekłym i chociaż płytką bakteryjną jest głównym inicjatorem odpowiedzi immunologicznej, czynniki ogólnoustrojowe, takie jak udar, są istotnym czynnikiem ryzyka, który może powodować dalsze niszczenie dziąseł i kości wyrostka zębodołowego. Celem tego badania kliniczno-kontrolnego jest zbadanie roli udaru mózgu w rozwoju zapalenia przyzębia u pacjentów. Grupę badaną stanowiło 104 pacjentów z Kliniki Chorób Naczyń Układu Nerwowego Uniwersytetu Medycznego w Poznaniu (kobiety = 61, mężczyźni = 33, przedział wiekowy 20–79 lat [średnia 45,97 lat]) z rozpoznaniem udaru mózgu i 94 zdrowych pacjentów z Kliniki Chirurgii Stomatologicznej i Periodontologii UM w Poznaniu (kobiety = 45, mężczyźni = 59, przedział wiekowy 33–92 lata [średnia 67,38 lat]). Wskaźniki przyzębia pacjentów (Bleeding on Probing [BOP] i przybliżony wskaźnik płytki [API]) zostały zmierzone i wyświetlone na histogramie i wykresach pudełkowych w celu wizualizacji dystrybucji danych. Wartości danych poddano analizie statystycznej za pomocą testu z i ustalono, że istnieje istotny związek między chorobą przyzębia a udarem ( $p < 0,01$ ) zarówno w wynikach BOP, jak i API.

**Słowa kluczowe:** infekcje ogólnoustrojowe, udar mózgu, zapalenie przyzębia.

## Introduction

Periodontitis, inflammatory response of the periodontium, results in destruction to the tissue that supports the teeth within the maxilla and mandible. In severe cases of periodontitis, tooth loss may result in addition to soft-tissue inflammation and bone recession. Centers for Disease Control and Prevention of the United States estimates that 47.2% of adults 30 years or older have some forms of periodontal problem, and for senior population age above 65 years old, 70.1% have periodontal disease [1].

Clinical examination of periodontal disease include detailed medical and dental history, panoramic radiograph, plaque indices, inflammation indices, and destruction of periodontal tissue indices. Inflammation can be measured by amount of bleeding and swelling while probing and destruction of periodontium is measured by probing pockets, clinical attachment loss, tooth mobilities, and etc. In this study, we followed the WHO guidelines clinically with WHO probe and light probing force of 20–25 grams. Bleeding on Probing (BOP) and Approximal Plaque Index (API) was measured as a quantitative representation of the inflammation in periodontium. Probing by dental probe is the most effective method for diagnosing periodontitis [2]. In healthy periodontium, the probing pocket depth should be less than three millimetres; depths above four millimetres suggest gingival recession or attachment losses due to bacterial destruction of periodontium, which are indications for immediate intervention before further destruction occurs.

Dental plaque is the initiator of periodontal diseases; in a patient with poor oral hygiene, the healthy oral microbiome balance is disturbed and shift to periodontogenic bacteria. These disease-causing bacteria produces pro-inflammatory mediators and enzymes that irritate the gingiva, causes swelling, bleeding, gingival recession, deep pocket formations, and destruction of periodontal ligaments and alveolar bone. There are several risk factors associated with periodontitis, such as stress, smoking, nutritional deficiencies, hormonal changes, immune deficiencies, medications, genetic disorders, and so on. In this article, periodontology and its correlation with the risk factor, stroke, is carefully examined.

Stroke occurs when the blood supply to the brain is interrupted, due to the presence of blood clots (ischemic stroke) or vessel rupture (hemorrhage stroke). As a result of the blockage, nutrients and oxygen cannot reach the brain tissues, causing

complications such as one-sided paralysis of face or limb. It is the number five leading cause of disability in the United States [3]. The exact relationship between stroke and periodontitis is not fully understood. The purpose of this study is to evaluate the association between periodontitis and stroke through statistical analysis of periodontal indices using z-test and box-plot.

## Material and Methods

Patients with stroke from the Department of Vascular Diseases of Nervous System and Department of Oral Surgery and Periodontology in Poznan University of Medical Science were recruited and examined to assess the possible correlation between periodontitis and stroke. The study comprises of two groups of patients: a control group of 100 randomly sampled patients without stroke who came to the periodontal department in 2018, six patients were excluded from the data as they were referred to the paediatric dentistry department (n = 2), orthodontic department (n = 1), or has incomplete data (n = 3). Of the patients who were not excluded (n = 94) in the control group, 61 are women and 33 are men, ages range from 20–79 years (average of 45.97,  $\sigma = 13.13$  years). The study group has 115 randomly sampled patients who are 72 hours post-stroke onset, and 11 patients are excluded from the study because of incomplete data or uncooperativeness (n = 8) and completely edentulous (n = 3). Of the 104 patients included in the study group, 59 are male and 45 are women, ages range from 33–92 years (average of 67.38 years,  $\sigma =$ ). The periodontal indices of both groups were precisely measured and recorded by trained staff from the periodontology clinic of Poznan University of Medical Sciences.

Approximal Plaque Index (API) according to Lange et. al. reflects a patient's oral hygiene status indirectly the state of inflammation [4]. In documentation, 1 is noted for each positive plaque finding, and the sum of total positive findings is used to calculate API using the formula: (sum of positive findings / sum of investigated approximal spaces) x 100%. API is a numerical grading method of patients' oral hygiene: API below 39 % means optimal oral hygiene and above 40% indicates insufficient oral hygiene. Bleeding on Probing (BOP), according to Ainamo and Bay, is a quantitative assessment of the amount of gingival inflammation and calculated as a percentage (%) of bleeding on probing sites divided by total number of sites in the mouth [5]. Ideal value of BOP is zero, but values less than or equal to 10% BOP value is accepted as normal.

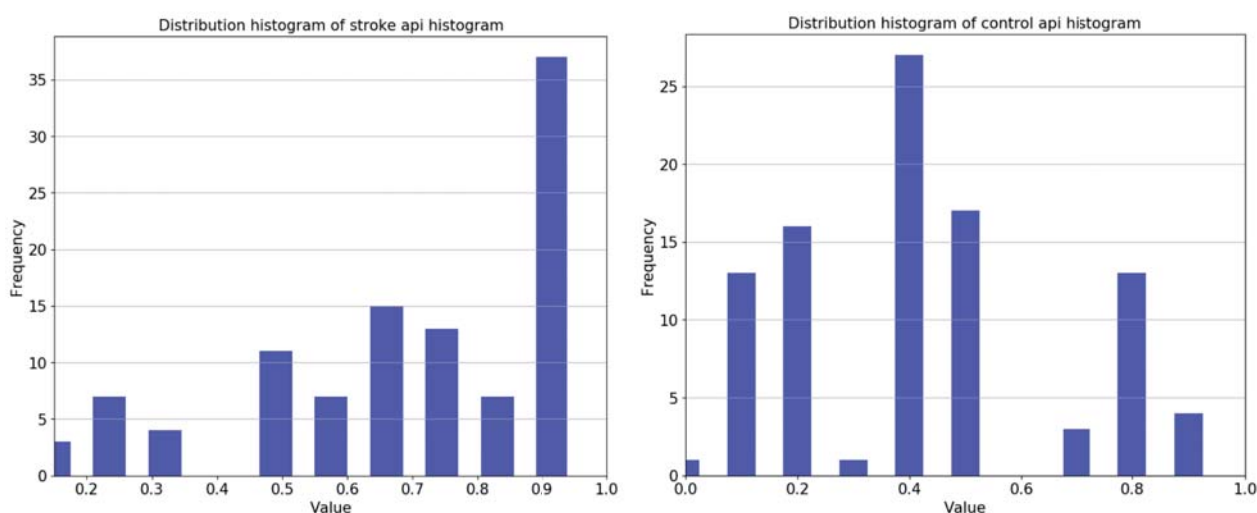
The tested subjects (study group- with stroke and control group- without stroke) are questioned for medical history then thoroughly examined with API and BOP indices. The observations are then recorded to the patient charts. After data collection of API and BOP indices, we plotted the data into histogram and box-plot to visualize data distribution. Furthermore, the data was analyzed statistically to determine if there is a correlation between periodontal disease and stroke by z-test.

## Results

Histogram analysis expresses frequency distribution of data value. It is a useful visualization of numerical data; suitable for periodontal disease measurements. In the API histogram, the stroke group expressed the highest frequency in value of 0.9. Ho-

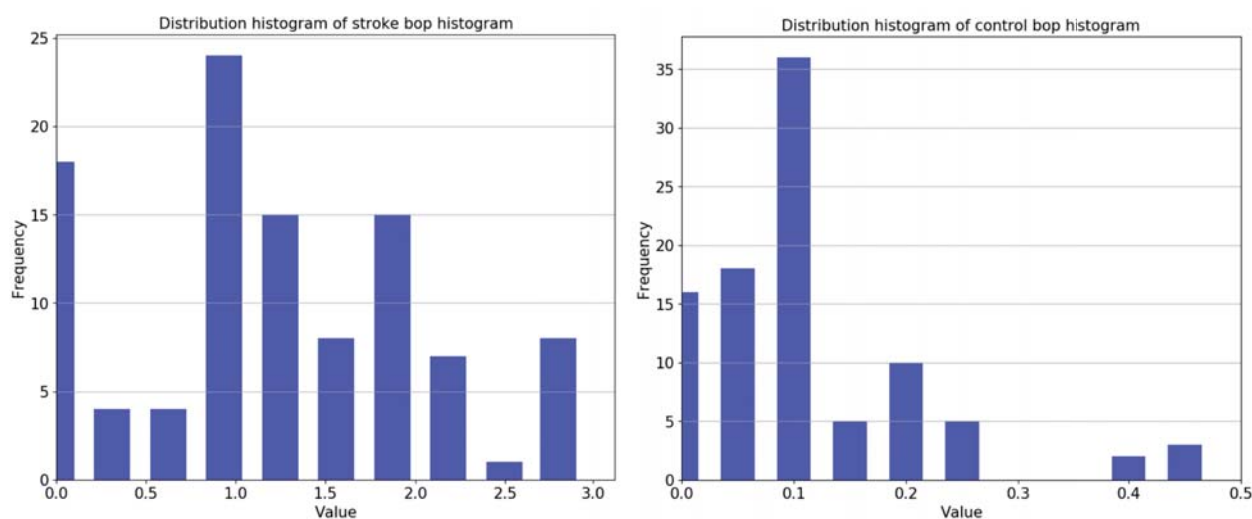
wever, in the control group, the highest frequency is in value of 0.4. In the BOP histogram, the stroke study group presented high frequency from value of 1.0 to value of 2.0. On the other hand, the control group expressed high frequency below and at value of 1.0. From examining the charts, the mean of dental health score of healthy subjects significantly differ from those with stroke. The box-plot of the study group's BOP exhibited a wider range of variability than the control's. In the asymmetrical pattern of the study group's API, box-plot showed the interquartile range concentrated between 0.6–1.0. Conversely, the box-plot of the control group's API indicated a more symmetrical figure.

Because of the fairly symmetrical datasets and relatively large sample sizes, the z test was used to analyze the data. The data of population was



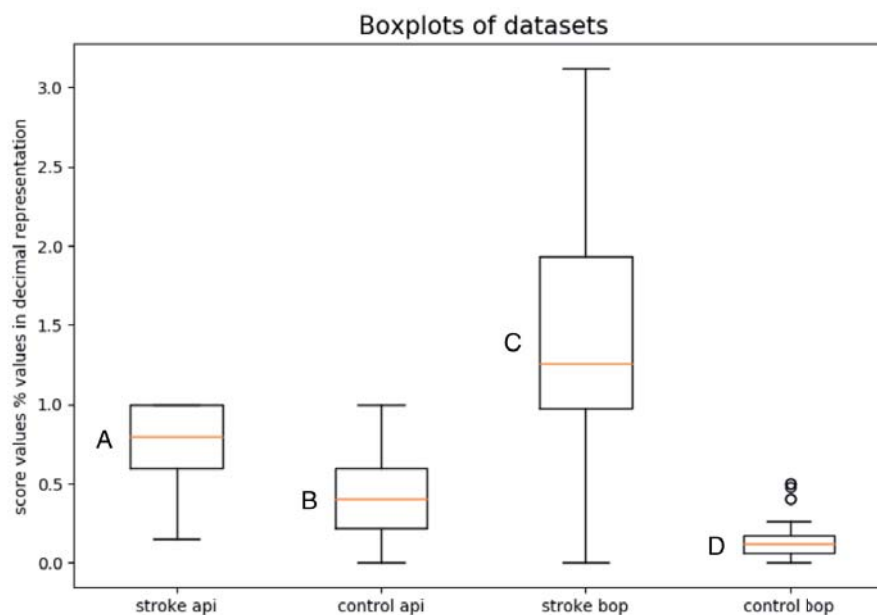
**Figure 1.** Histogram of API value and the sampling distribution. Stroke study group (left) and control group (right)

*Rycina 1. Histogram wartości API i rozkład próbkowania. Grupa badana z udarem (po lewej) i grupa kontrolna (po prawej)*



**Figure 2.** Histogram of BOP value and the sampling distribution. Stroke study group (left) and control group (right)

*Rycina 2. Histogram wartości BOP i rozkład próbkowania. Grupa badana z udarem (po lewej) i grupa kontrolna (po prawej)*



**Figure 3.** Box-plot analysis of Approximal Periodontal Index (API) and Bleeding on Probing (BOP) periodontal indices. A) Study group (stroke patients) API. B) Control group (healthy patients) API. C) Study group (stroke patients) BOP. D) Control group (healthy patients) BOP. Circles indicate outliers

*Rycina 3.* Analiza wykresu pudełkowego przybliżonego wskaźnika przyzębia (API) i wskaźników przyzębia (Bleeding on Probing). A) Grupa badana (pacjenci po udarze) API. B) Grupa kontrolna (pacjenci zdrowi) API. C) Grupa badana (pacjenci po udarze) BOP. D) Grupa kontrolna (pacjenci zdrowi) BOP. Kółka oznaczają wartości odstające

analyzed with z-test and with 99% confidence, it is concluded that there is an association between stroke and periodontitis.

## Discussion

Despite the outcome demonstrating strong association between stroke and periodontitis, there is a large discrepancy between control group and study group's gender and age. In the control group, the women to men ratio is 1.85 to 1, while in the study group, the women to men ratio is 1.31 to 1. According to study by Woelber et. al., women generally have better oral hygiene conditions than men, and a significant difference of OHSE (oral hygiene-related self-efficacy) between male and female [6]. Therefore, the effects of gender and oral hygiene of test populations has to be considered for a more accurate study result. Furthermore, the age range of the control group (20–79 years [average of 45.97 years]) is significantly younger than the study group (33–92 years [average of 67.38 years]). Study by Guzik et. al. displayed that young to middle aged patients, stroke is more common in men than women. However, higher life-time risk of stroke happens in women, instead of men, because of worse functional outcomes [7]. To improve accura-

cy of the study result, we should consider limiting the confounding factors of gender and age, so that both groups have similar sample conditions.

The most important characteristic to distinguish gingivitis and periodontitis is the loss of hard tissue in the periodontium for the latter disease. The periodontal indices, API and BOP, are not specific standards of diagnosing periodontitis; they usually play a role in predicting gingivitis status. Clinical Attachment Loss (CAL) measurements, probing depth, plaque index and furcation involvement are better indices for periodontitis status as they grade the amount of bone loss and clinical attachment loss, and can be considered for future studies' parameters in proper periodontal examination [8] [9].

And we may recollect the API and BOP score if unsure of the units (are they both in %) Due to the study group's post-stroke status, it is difficult in some cases to do an intensive intra-oral examination. This hypothesis testing may have left out some confounding factor considerations and doesn't necessarily suggest a causation or correlation between dental health and stroke. This study revealed the mean values of stroke subjects should differ significantly from that of control subjects'

dental health values. For instance, stroke patients have higher plaque values due to causation factors not controlled in this study such as post-stroke subjects have decreased dexterity due to loss of motor functions, and as a consequence, poor oral hygiene and higher API values is found.

Although the periopathogenesis on cerebrovascular diseases is not fully understood, periodontitis and stroke share many similar characteristics, such as having analogous risk factors (old age, smoking, hypertension, and cardiovascular diseases) [10, 11]. To explore the relationship between stroke and periodontitis, inflammatory processes are an important aspect to consider for deciphering this complex topic. Both diseases, stroke and periodontitis, are linked to elevated inflammatory mediators which may spread to the whole body through the circulation [12]. Paraskevas et. al.'s study on patients suffering from inflammatory disorders, demonstrated that treatment methods resulting in lowered CRP levels contributed to better treatment outcomes in both periodontal disease patients and systemic inflammation disorder patients. Correspondingly, our study concludes high correlation between periodontitis and stroke. Further studies should be conducted, after eliminating the confounding variables, to determine if there is a causal relationship between periodontitis and stroke. If there is a causal relationship, future multidisciplinary studies should analyze treatment methods and prevention techniques in reducing the inflammatory grade of periodontitis, for the purpose of managing stroke or other cerebrovascular diseases, or vice versa.

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### Conflict of interest statement

The authors declare no conflict of interest.

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