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Review Article

Prevalence and Incidence of Periodontal Diseases in Diabetes Mellitus Patients

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Abstract

Periodontal diseases, dental caries, malocclusion and oral cancer are among the most prevalent dental diseases affecting people worldwide as well as in Indian community. There is no national oral health data bank in India which reflects the prevalence of different oral diseases and risk factors responsible for them. No national oral health survey has been conducted in the country till date. Prevalence of disease is the key factor for effective and sound oral health care planning. Some cross-sectional surveys has been conducted in various regions of the country at local level but those observations cannot be generalized for the whole community because of the great diversity in composition of Indian populations e.g. literacy rate in Kerala is more than 90% and in Bihar it is about 40%. Males are more literate than females. 70% of the population in India continues to live in rural areas. Different cross sectional surveys or studies showing prevalence of periodontal diseases mainly in the last twenty years have been collected from different sources and compiled in this article to give a comprehensive outlook of the present status and scenario of periodontal diseases in different population of Indian community.

Keywords: *Diabetes Mellitus; Periodontal Diseases; Periodontitis; Incidence and Prevalence; Glycemic Control*

Introduction

Diabetes mellitus is a clinically and genetically heterogeneous group of disorders affecting the metabolism of carbohydrates, lipids and proteins, in which hyperglycemia are a main feature. These disorders are due to a deficiency in insulin secretion caused by pancreatic β-cell dysfunction and/or insulin resistance in liver and muscle. Diabetes mellitus affects about 21 million people in the United States, or more than 9% of the adult population, and has a dramatic impact on the health care system through high morbidity and mortality among affected individuals [1].

In Ontario, population-based data have revealed that the prevalence of diabetes mellitus increased by 69% over a recent 10-year period (from 5.2% in 1995 to 8.8% in 2005), which exceeded the global rate of increase of 39% that was predicted for the period 2000 to 2030. Furthermore, the rates of increase rose to a greater extent in the younger population. This increase was attributable to both a rise in incidence and a decline in mortality [2].

Similarly, in the First Nations community of Kahnawake, Quebec, the prevalence rates of type 2 diabetes mellitus increased over the period 1986 to 2003, from 6.0% to 8.4% among males and from 6.4% to 7.1% among females [3].

Type 1 diabetes mellitus results from cellular-mediated autoimmune destruction of pancreatic β-cells, which usually leads to total loss of insulin secretion; in contrast, type 2 diabetes mellitus is caused by resistance to insulin combined with a failure to produce enough additional insulin to compensate for the resistance [1].

Type 2 diabetes mellitus is commonly linked to obesity, which contributes to insulin resistance through elevation of circulating levels of free fatty acids derived from the adipocytes; these free fatty acids inhibit glucose uptake, glycogen synthesis and glycolysis. In many obese individuals, insulin resistance is compensated by increased insulin production. However, in one-third of obese individuals, β-cell mass is reduced by a marked increase in β-cell apoptosis, which results in inadequate production of insulin [1].

Few studies discusses the relationship between periodontitis and type 2 diabetes mellitus, focusing on the mechanisms through which periodontal infections contribute to the diabetes mellitus-related inflammatory state, the influence of periodontal infections on insulin resistance and the ways in which treatment of these infections can influence glycemic control [4].

Diabetes mellitus (DM) is a systemic disease with several major complications affecting both the quality and the length of life. Diabetes mellitus is certain to be one of the most challenging health problems in the 21st century. It is now one of the most common non-communicable diseases globally. Diabetes mellitus is the fourth leading cause of death in most developed countries, and there is substantial evidence that it is epidemic in many developing and newly industrialized nations [5].

India leads the world today with the largest number of diabetics in any given country. In the 1970s, the prevalence of diabetes mellitus among urban Indians was reported to be 2.1%, and this has now risen to 12.1%. According to the World Health Organization (WHO) projections, the present 30 million to 33 million diabetics in India will go up to 74 million by 2025. The WHO has issued a warning that India will be the "Diabetes mellitus Capital of The World".

The terms insulin dependent diabetes mellitus (IDDM) and non–insulin dependent diabetes mellitus (NIDDM) are obsolete. These previous designations reflected the observation that most individuals with type 1 DM (previously IDDM) have an absolute requirement for insulin treatment, whereas many individuals with type 2 DM (previously NIDDM) do not require insulin therapy to prevent ketoacidosis. However, because many individuals with type 2 DM eventually require insulin treatment for control of glycemia, the use of the latter term generated considerable confusion [6].

Diabetes mellitus is a heterogeneous group of disorders with different causes but all characterized by hyperglycemia. Type 1 diabetes mellitus is due to destruction of the insulin-producing cells. Type 2 diabetes mellitus is the result of insulin resistance coupled with relative beta-cell failure [7]. It is recently reported that type 2 diabetes mellitus comprises; 90% of all cases of diabetes mellitus in the population of several countries [8]. Diabetes mellitus is now one of the most common non-communicable diseases globally. It is the fourth or fifth leading cause of death in most high-income countries and there is substantial evidence that it is epidemic in many low- and middle-income countries. Diabetes mellitus is the most common chronic endocrine disorder, affecting an estimated 5% to 10% of the adult population in industrialized Western countries, Asia, Africa, Central America and South America, and it has a large impact on society [9].

The International Diabetes Mellitus Federation (IDF) has estimated the numbers of people with diabetes mellitus for 2011 of 366 million and forecasts for 2030 of 552 million [10]. Saudi Arabia has one of the highest percentages of Diabetes mellitus in the world. The overall prevalence of DM in adults in Saudi Arabia is 23.7% [11]. Five of the 10 countries where diabetes mellitus is most prevalent are located in the six-nation Gulf Cooperation Council, according to the International Diabetes Mellitus Federation (IDF) [10]. Kuwait is No. 3 while Qatar is sixth, Saudi Arabia seventh, Bahrain eighth and the United Arab Emirates No. 10. The rest of the top 10 are Pacific island nations with much smaller populations, apart from Lebanon which comes in fifth (Table 1). Diabetes mellitus is characterized by an increased susceptibility to infection, poor wound healing, and increased morbidity and mortality associated with disease progression.

2011			2030		
Country		Prevalence (%)	Country		Prevalence (%)
1	Kiribati	25.7	1	Kiribati	26.3
2	Marshall Islands	22.2	2	Marshall Islands	23.0
3	Kuwait	21.1	3	Kuwait	21.2
4	Nauru	20.7	4	Tuvalu	20.8
5	Lebanon	20.2	5	Nauru	20.7
6	Qatar	20.2	6	Saudi Arabia	20.6
7	Saudi Arabia	20.0	7	Lebanon	20.4
8	Bahrain	19.9	8	Qatar	20.4
9	Tuvalu	19.5	9	Bahrain	20.2
10	United Arab Emirates	19.2	10	United Arab Emirates	19.8

Table 1: *Top 10 countries for prevalence* (%) of diabetes mellitus (20-79 years), 2011 and 2030*

**Comparative Prevalence*

A Study Done in United States

Renal Data Systems (NIH), US Census Bureau has published studies. A question on pre-diabetes mellitus was included for the first time in the 2006 National Health Interview Survey given to a representative sample of households; approximately 24,300 adults of the ages 18 and older. Approximately 25.8 million Americans or 8.3% of the population, have diabetes mellitus: increased from 5.1% in 1997. Of these, 18.8 million people are diagnosed with diabetes mellitus and 7 million people are undiagnosed. Pre-diabetes mellitus is becoming more common in the United States: the U.S. Department of Health and Human Services estimates one in four U.S. adults aged 20 years or older, or 79 million people, had pre-diabetes mellitus in 2010. In addition, 1.9 million new cases of diabetes mellitus were diagnosed in people aged 20 years or older in 2010. Approximately 215,000, or 0.26% of all people under 20 years of age have diagnosed diabetes mellitus. About one in every 400 children and adolescents has diabetes mellitus [12,13].

Although type 2 diabetes mellitus can occur in youth, the national representative data necessary to monitor diabetes mellitus trends in youth by type is not available. Clinically-based reports and regional studies suggest that type 2 diabetes mellitus, although still rare, is being diagnosed more frequently in children and adolescents, particularly in American Indians, African Americans, and Hispanic/Latino Americans [14].

Approximately 25.6 million, or 11.3% of all people aged 20 years and older have either diagnosed or undiagnosed diabetes mellitus, and 10.9 million, or 26.9% of all people 65 years or older have diabetes mellitus. Approximately 13 million, or 11.8% of all men aged 20 years or older have diabetes mellitus although nearly one third of them are unaware of their condition. Approximately 12.6 million, or 10.8% of all women aged 20 years or older have diabetes mellitus and again nearly one-third are unaware. The prevalence of diabetes mellitus is higher among non-Hispanic Black, Hispanic/Latino American, American Indian, and Asian/Pacific Islander women than among non- Hispanic white women [14].

Periodontal Disease as a Complication of Diabetes Mellitus

Diabetes mellitus is recognized as an important risk factor for more severe and progressive periodontitis, infection or lesions resulting in the destruction of tissues and supporting bone that form the attachment around the tooth. Periodontal disease has been reported as the sixth complication of diabetes mellitus, along with neuropathy, nephropathy, retinopathy, and micro- and macrovascular diseases [15].

A number of studies found a higher prevalence of periodontal disease among diabetic patients than among healthy controls. In a large cross-sectional study, Grossi and others showed that diabetic patients were twice as likely as non-diabetic subjects to have attachment loss (Figure 1). Firatli followed type 1 diabetic patients and healthy controls for 5 years. The people with diabetes mellitus had significantly more clinical attachment loss than controls. In another cross-sectional study, Bridges and others found that diabetes mellitus affected all periodontal parameters, including bleeding scores, probing depths, loss of attachment and missing teeth. In fact, one study has shown that diabetic patients are 5 times more likely to be partially edentulous than non-diabetic subjects [16].

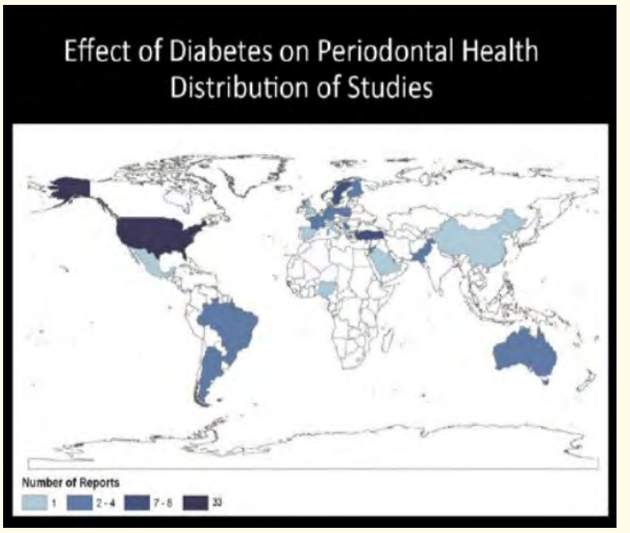

Figure 1: *Effect of diabetes mellitus on periodontal health distribution of studies.*

Both diabetes mellitus and periodontal disease are highly prevalent worldwide, and the prevalence is higher in the aged population. Epidemiological studies have shown a link between periodontal disease and diabetes mellitus for nearly a century (Figure 2). In 1936,

Sheppard first noted a higher incidence of periodontitis in diabetic patients. It is now widely accepted that periodontal disease is one of the diabetic complications [17]. In addition, many epidemiological studies have shown a bidirectional relationship between periodontal disease and diabetes mellitus.

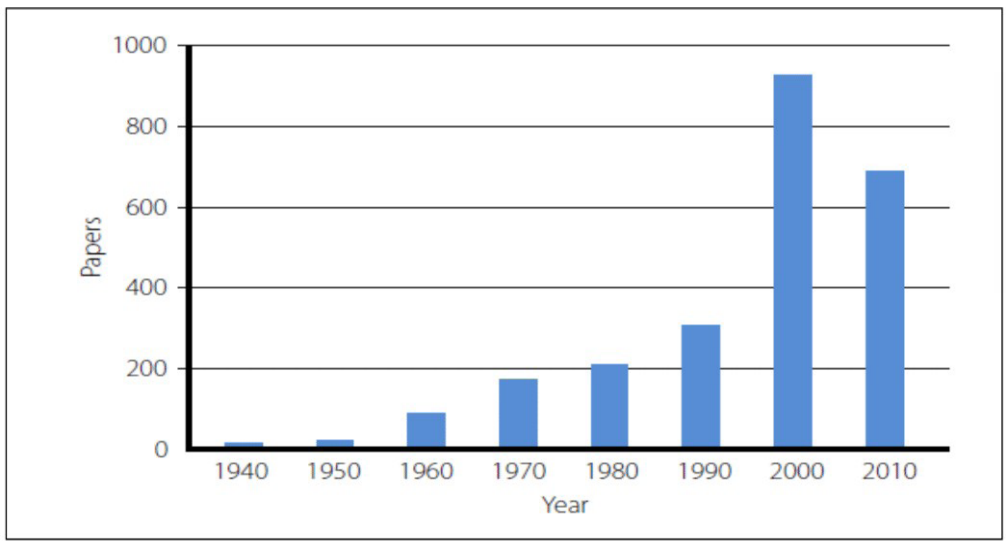

Figure 2: *The number of papers about periodontal disease and diabetes mellitus in PubMed.*

It is accepted that periodontal disease is more prevalent and more severe in persons with type 1 and type 2 diabetes mellitus than in non-diabetic persons. A German population-based longitudinal study showed that uncontrolled (glycated hemoglobin ≥ 7.0%) type 1 or type 2 diabetes mellitus is associated with the progression of periodontal disease [17]. A systematic review reported that type 2 diabetes mellitus patients with poorer periodontal health have a greater risk of developing poorer glycemic control [18].

Randomized prospective studies were carried out mainly during the past two decades. Meta-analysis showed that the treatment of periodontal disease can reduce the glycated hemoglobin level on average by 0.40% in type 2 diabetes mellitus patients. However, the number of patients was small, and the treatment of periodontal disease varied among the studies used in this meta-analysis. Recent the Diabetes mellitus and Periodontal Therapy Trial (DPTT), a large-scale multicenter randomized clinical trial, showed that non-surgical periodontal therapy did not improve glycemic control in type 2 diabetes mellitus patients despite the improvement of the periodontal measurements [19].

Does Periodontal Disease Affect Diabetic Complications?

A prospective study of 628 Pima Indians with type 2 diabetes mellitus, the median follow up of which was 11 years, showed a significant increase of the adjusted relative risk for cardio-renal mortality in those with severe periodontitis (odds ratio 3.2) compared with those with no or only mild to moderate periodontitis. In 2012, the American Heart Association reviewed the relationship between periodontal disease and atherosclerotic vascular disease in their scientific statement [20].

They reported that epidemiological and experimental studies showed an association between periodontal disease and atherosclerotic vascular disease. However, they also reported the lack of evidence that treatment of periodontal disease would prevent atherosclerotic

vascular disease or modify its outcome. Vascular abnormalities, both macrovascular and microvascular, are characteristic diabetic complications. The relationship between microvascular /macrovascular diabetic complications and periodontal disease might have some similarities with that between cardiovascular disease and periodontal disease. So far, there have been only a small number of studies about the relationship between diabetic macrovascular/ microvascular complications and periodontal disease. Further large-scale clinical studies and pathological animal studies are required [20].

As aforementioned, periodontal disease is accepted as one of the diabetic complications by its high prevalence and severity in diabetes mellitus patients. Additionally, there is a bidirectional relationship between periodontal disease and diabetes mellitus. A recent consensus report of the Joint European Federation of Periodontology and the American Academy of Periodontology (EEP/AA) workshop on periodontitis and systemic disease also discussed a strong relationship between periodontal disease and diabetes mellitus. However, large-scale randomized prospective trials and pathological studies including animal studies are required for further investigation [21].

There is substantial evidence from cross-sectional and prospective studies that people with types 1 and 2 diabetes mellitus have more than double the risk of developing periodontitis; reviewed by Taylor and Borgnakke [21]. Diabetes mellitus can also result in more severe periodontal destruction than in matched non-diabetes mellitus groups. The increased risk for periodontitis is dependent on glycaemic control and not the duration of diabetes mellitus.

Impact of Periodontitis on Glycaemic Control

A bi-directional relationship between periodontitis and type 2 diabetes mellitus has been suggested with the presence of chronic periodontitis thought to have a reciprocating negative effect on diabetes mellitus control. Early evidence came from studies in a distinct population group of Pima Indians who have a very high prevalence of type 2 diabetes mellitus. These studies indicated that severe periodontal inflammation was predictive of a greater deterioration in glycaemic control over time compared with a non-periodontitis group, and was a strong predictor of mortality from the common diabetes mellitus-associated complications of ischaemic heart disease and diabetic nephropathy [22].

These results could not be directly extrapolated to other population groups due to genetic homogeneity within the Pima Indian group who may be particularly susceptible to hyper-inflammation and derangement in glycaemic control Epidemiological surveys within more diverse population groups have therefore been conducted. A US-based cross-sectional study examined the electronic medical records and dental insurance data of more than 5,000 dually insured people with diabetes mellitus and insurance claims for periodontal care were taken as a proxy measure for periodontitis. Mean glycated haemoglobin (HbA1c) was 7.66 % and was 0.08 % higher in the 38.00 % of patients who had received periodontal care, but insufficient information about the periodontal status of participants were available within this study to draw firm conclusions from the results [23].

Many cross-sectional studies have undertaken comprehensive periodontal examination in diabetes mellitus patients although the logistical difficulties of doing so have led to relatively small sample sizes within many studies. A survey of 35 people with type 2 diabetes mellitus (17 with periodontitis matched with 18 without periodontitis) and a larger survey of 181 type 2 diabetes mellitus adults both reported correlations between periodontal status and HbA1c. The severity of periodontitis was an independent predictor of both elevated HbA1c and hsCRP in a group of 140 type 2 diabetes mellitus participants [24].

A large-scale, prospective study has been conducted in Japan that addresses some of the limitations of the smaller studies and had two strands; study 1 examined the risk of developing periodontal pockets in 5,856 participants over five years with baseline HbA1c levels ≥ 6.5%, while study 2 examined 6,125 participants with HbA1c < 6.5% at baseline and determined their relative risk for elevated HbA1c over five years with baseline periodontal status. Relative risk of developing a periodontal pocket was 1.17 times greater in those with HbA1c of ≥ 6.5% at baseline, confirming the accepted evidence of an increased risk of periodontitis with poor glycaemic control. The risk

of having elevated HbA1c (≥ 6.5%) over the five years was increased 2 - 3 fold, depending on the severity of the periodontal lesion at baseline. Periodontitis was also associated with increased risk for diabetes mellitus incidence in a seven-year prospective study of 5,848 non-diabetic individuals but significance was lost when adjusting for confounding factors. HbA1c levels correlated with the surface area of the inflamed periodontal lesions and therefore the extent of periodontal inflammation in one study conducted within a type 2 diabetes mellitus group [25].

Some studies have examined the relationship between periodontal condition and plasma glucose levels; non-diabetics with periodontitis are reported to have higher resting plasma glucose and HbA1c levels than matched controls. Analysis of data from 12,254 participants in the Third National Health and Nutrition Examination Survey (NHANES III), showed that participants with the most severe periodontal destruction had an increased odds ratio for both impaired fasting glucose (≥ 100 but < 126 mg/dl) and diabetes mellitus (≥ 126 mg/dl) after adjustment for potential confounders [26]. Animal studies (while limited in their ability to provide direct evidence applicable to humans) have confirmed the destabilisation of glycaemic control by periodontal inflammation.

Periodontitis is readily initiated in Wistar rats by the tying of ligatures around teeth for a period of weeks. These periodontitis rats had increased blood glucose compared with non- periodontitis rats. The precise mechanism underlying the effect on glycaemic control by periodontal inflammation has been investigated using this same animal model (n = 48) with half the animals having a ligature applied and the other half remaining as controls. Plasma concentration of TNF-α was higher in periodontitis rats compared with controls. The periodontitis rats group showed decreased insulin sensitivity and insulin signal transduction in adipose and skeletal muscle tissues compared with the control group, which may have been mediated by the increased plasma TNF-α [27].

Various studies have been done to determine the prevalence and severity of periodontitis in diabetics. Type1 as well as type 2 diabetes mellitus have been shown to be the major risk factor for the development of periodontal disease in certain population. Emrich (1991) and Taylor (1996) on Pima Indians reported a 2.6, 3 and 4 times amount of periodontal destruction in diabetics when compared with non-diabetics respectively. Further the duration of diabetes mellitus also affects periodontitis which was evaluated by the Juan Cerda G (1994) and Khader Y S (2008) who reported an increase in periodontal tissue destruction when the duration of the diagnosis of type 2 diabetes mellitus was more than five years [28].

Periodontal disease is the most prevalent oral complication in IDDM and NIDDM patients and has been labeled the "sixth complication of diabetes mellitus [15]". Numerous studies have shown both increased prevalence and severity of periodontal disease in patients with IDDM. Diabetic children and adults with less than optimal metabolic control show a tendency towards higher gingivitis scores. Early case reports suggested that diabetic adolescents and teenagers may suffer from periodontitis [29]. In a more recent study, the prevalence of periodontal disease was 9.8% in 263 patients with IDDM, compared with 1.7% in people without diabetes mellitus. Most of the periodontal disease was found in those age 11 - 18 years. However, earlier rapid periodontal destruction was not found in adolescent patients with IDDM in Finland. This difference may be related to different levels of metabolic control in participants of the two studies. For example, case reports suggest a strong relationship between rapid periodontal breakdown and elevated blood glucose levels [29].

Patients with IDDM of > 10 years duration had greater loss of periodontal attachment compared with those of < 10 years duration. This was found to be particularly true for patient's age 35 years. More recently, it was reported that IDDM patient's age 40 - 50 years with long IDDM duration had significantly more sites with advanced periodontal destruction and alveolar bone loss than people without diabetes mellitus. It has also been demonstrated and confirmed that in IDDM patients with retinal changes the loss of periodontal attachment is significantly larger than in IDDM patients without retinal changes [30].

Several studies have clearly demonstrated that IDDM patients with poor long-term control of diabetes mellitus have increased extent and severity of periodontal disease, whereas those who maintain good metabolic control have minimal periodontal problems. Patients

with IDDM of long duration who have retinopathy tend to exhibit more loss of periodontal attachment as they reach age 40 - 50 years. Good oral home care and frequent professional check-ups and care are important for these patients. Few studies have dealt with NIDDM subjects. In a study of Pima Indians, 40% of whom have NIDDM, diabetic patients age < 40 years had increased attachment loss, and alveolar bone loss was associated with increased glucose intolerance.

Periodontal tissue loss increased with age and was higher in people with diabetes mellitus compared with people without diabetes mellitus in all age groups. In this population, the age- and sex-adjusted incidence of periodontal disease in subjects with NIDDM was 75 cases per 1,000 person-years, which was substantially higher than the rate of 29 cases per 1,000 person-years in subjects without diabetes mellitus [31].

Early studies of the pathogenesis of periodontal disease in diabetic patients centered on the general feature of "basement membrane thickening" and possible changes in the vasculature. More recent studies have focused on the role of the periodontal infection, the microflora of dental plaque, collagen metabolism, leukocyte function, and other aspects of the host response. All of these factors may individually or synergistally contribute to periodontal disease.

The reason for the greater occurrence of periodontal destruction in diabetics is not clear. However, studies of the periodontal flora find similar microorganisms in diabetic and nondiabetic people, suggesting that alteration in host responses to periodontal pathogens account for these differences in periodontal destruction. For example, increased susceptibility to infection by periodontal bacteria associated with altered phagocyte functions and reduced healing capacity associated with altered collagen metabolism may explain, in part, the increased levels of periodontal disease in diabetic patients. The response to treatment suggests that the periodontal lesions are eminently treatable and that eradication of the infection and the inflammatory foci may reduce insulin requirements. The knowledge among people with diabetes mellitus of oral co-morbidity is generally poor and suggests the need for appropriate health education and health promotion to improve the oral health of diabetic patients [32].

Conclusion

Periodontal diseases are one of the more prevalent oral diseases affecting more than 50% of Indian community. Untreated chronic periodontitis is responsible for tooth loss in majority of the cases. Constant presence of chronic inflammation and inflammatory mediators has also been proved to be a significant risk factor of several systemic diseases e.g. preterm low birth weight babies, coronary artery diseases, diabetes mellitus etc. Foreseeing the bad effects of periodontal diseases on oral as well as general health, the prevention of these diseases should include in national health programme and national oral health survey should be conducted to get meaningful data for different oral diseases and plan around preventive/curative measures.

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