The carotid artery calcification in type II diabetic patients on panoramic radiographs: An important marker for vascular risk

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The risk of stroke in diabetic patients is higher than other people. The most important cause of stroke is atherosclerotic plaque formation and detection of this defect is possible in panoramic radiography. This study was designed to evaluate the frequency of carotid artery calcifications (CACs) in type II diabetic patients and healthy individuals based on panoramic radiographs (PRs). We evaluated 458 PRs taken from 158 diabetic patients and 300 healthy subjects who served as the control group. Data were obtained using ‘chi-square’ test for comparing the CACs frequency between ‘type II diabetic patients’ and control group on PRs. Significance level was considered at P-value < 0.05. A significant difference was seen in the frequency of calcification between diabetic patients and healthy individuals (p<0.001). Also, compared to the bilateral involvement, the unilateral prevalence of calcification was significantly higher; no significant differences were found between diabetic patients with or without calcification in terms of sex, duration of diabetes, mean FBS (fasting blood sugar), high serum lipids, high blood pressure, history of infarcts and daily smoking. The CACs on PRs of diabetic patients are more prevalent than normal individuals. In comparison with other normal individuals, the chance of discovering any CACs is higher on PRs taken from diabetic patients.

Key words: Carotid artery calcification, diabetes type II, panoramic radiography.

INTRODUCTION

Diabetes mellitus is one of the most common diseases that is seen in two types:

Type I diabetes (insulin-dependent diabetes or IDDM) and type II diabetes (non-insulin dependent diabetes or NIDDM).

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Approximately, 85 to 90% of diabetics are type II diabetic patients. The disease is characterized with hyperglycemia and impaired metabolism of carbohydrates, lipids and proteins and associated with relative lack of insulin (Clausen et al., 2007). Epidemiological studies have indicated that almost 2 million people in Iran are affected by diabetes (Esteghamati et al., 2008). Due to their high serum glucose, lipid and blood pressure, diabetic patients are at a greater risk for a stroke (Friedlander et al., 2002). Studies have demonstrated that about 80% of strokes are induced by atherosclerotic plaques, mostly detected in
the main carotid artery bifurcates (Bifurcation), which has the highest tensile force (Kumagi et al., 2007; Almog et al., 2004). Friedlander (1981) described the application of PRs as a supplementary tool in detection of the patients at the risk of a stroke. In this type of radiography, the calcified carotid artery (CCA) is observed as a radiopaque nodular mass or vertical radiopaque lines, in the anterior posterior part of the mandibular angle in proximity to the greater horn of hyoid bone and the third and fourth cervical vertebrae (Friedlander and Lande, 1981). Various studies have been done to assess the capabilities of PRs in the diagnosis of CACs, all of which have proven to the effectiveness of this type of radiography in diagnosing the patients without symptoms but with high risk of stroke.

According to these studies, in comparison with the previous diagnostic methods, PRs is not only more commonly used, cheaper and easier but also is much less invasive (Chicano et al., 2006; Madden et al., 2007). The studies have shown that due to the high occurrence of dental infections in diabetic patients (Tan et al., 2006; Ardakani et al., 2007), the PRs taken to evaluate the oral status of these patients can also be used in detection of CACs presence and evaluation of the possible risk of stroke in them (Friedlander et al., 2002; Ardakani et al., 2007). Thus, this study aims to determine the CACs in type II diabetic patients and healthy individuals based on PRs. Some studies have revealed the detection of CACs on PRs in many populations (Hubar, 1999; Friedlander and Lande, 1981; Tamura et al., 2005; Friedlander, 2001) but, there is not enough study regarding this topic in Iranian population. The aim of the present study is to determine the presence of CACs detected on PRs in a group of diabetic and healthy population living in Qazvin (Iran). Further, the relationship between CACs and sex, duration of diabetes, mean FBS, high serum lipids, high blood pressure, history of infarcts and daily smoking was evaluated. According to our knowledge, this is the first study done in Qazvin investigating the risk factors related to CACs in the Iranian population.

MATERIALS AND METHODS

158 patients with diabetes mellitus of type II were picked out of the people who referred to Imam Ali clinic affiliated with Charity Diabetics Association. The criteria based on which the patients have been selected were as follows:

1) Carrying diabetes mellitus of type II.
2) Consuming the blood sugar controlling pills.
3) FBS ≥ 126 mg/dl in the last month.
4) Minimum age: 35 years.

After explaining the goals of the study for each patient, the consent form and information form consisting of the patient medical history questionnaire were completed. PRs were obtained from 158 diabetic patients at the Oral and Maxillofacial Radiology of Qazvin Dental Faculty. All the radiographs were obtained by panoramic machine (proline model 2002cc, Helsinki, Finland) and also, the radiation factors had been specifically established based on patient’s body. The extra-oral Agfa films (Belgium) and amplification plates were used. The exposed films were processed based on the manufacturer’s instructions guide in the automatic processor (USA, Velopex). Then, all radiographs were interpreted by two oral radiologists. All radiographs were viewed on a standard view box in a room with subdued ambient light. The radiopaque nodular mass adjacent to cervical vertebrae inside or below the c3-c4 intervertebral disc level, or the retromandibular area, generally at angle of 45° from the angle of mandible independent of hyoid bone was considered as a CAC (Figures 1, 2 and 3) (Friedlander, 1995). If there were any differences in the diagnosis, the observers viewed the radiographs together for one final verdict. Also, the PRs of 300 patients who had referred to the oral and maxillofacial radiology ward of the dental faculty for common dental treatment with negative systemic disease history were used as the control group, and the following observation of CAC on their radiographs; they were referred to an endocrinologist for blood glucose testing.

The statistical analyses were performed by using of SPSS statistical package (Version 16.0; SPSS, Inc., Chicago, IL, USA). Data were obtained using ‘chi-square test’ for comparing the CACs frequency between type II diabetic patients and control groups on PRs. The results were considered to have a significant difference if the significance level was less than 0.05.

RESULTS

In this study, a total of 458 panoramic stereotypes belonging to 290 women (63.3%) and 168 men (36.7%) in the age range of 35 to 72 years were studied. Of these cases, 158 radiographs were belonged to the diabetic patients with an average age of 52.4 years (104 women with the average age of 48.9 years and 54 men with an average age of 55.9 years). Due to the lack of the appearance of the spine in the radiographic stereotypes, 42 radiographs including 18 radiographs related to diabetic patients (6 women and 12 men) and 24 radiographs belonging to healthy subjects (8 women and 16 men) were excluded. In a total of 416 appropriate radiographs, CACs were detected in 49 stereotypes (11.7%) that belonged to 46 diabetic patients (32.8%) and 3 healthy individuals (1.08%); in this regard, there was a significant difference between the two groups.
Figure 1. The panoramic radiographs of a 58 year old diabetic patient showing radiopaque mass on the left side of the retromandibular (white arrow).

Figure 2. Carotid artery calcifications visible on the left side below C3 (white arrows) as shown on a panoramic radiography in a 46 year old diabetic patient.

(P<0.001). Among the 140 radiographs of diabetic patients, CAC were seen in 46 cases including 31 women and 15 men. There has been no significant difference between men and women (P = 0.783). The average age of women and men with calcification stood at 47.6 and 60.4, respectively. In the 46 diabetic patients diagnosed with calcification, 38 cases (82.6%) were unilateral and 8 (17.4%) were bilateral. This difference was statistically significant (P<0.001). In the 38 cases of visible unilateral calcification, 21 cases (55.2%) were on the right side and 17 cases (44.7%) were on the left side. This difference was not statistically significant (P = 0.036) (Table 1). In this study, no significant differences were observed between diabetic patients with or without calcification regarding the duration of diabetes, mean FBS, high blood lipid rate, high blood pressure, history of infarcts and daily smoking (Table 2).

In the 276 appropriate radiographs related to the control group, including 176 women with the age of 51.3 years and 98 men with age of 48.2 years averagely, CAC was unilaterally detected in only 3 cases (two females and one male).

DISCUSSION
CACs appear as a calcified radiopaque masses on the
Table 1. Location of carotid artery calcification in terms of sex.

<table>
<thead>
<tr>
<th>Calcification site/sex</th>
<th>Right</th>
<th>Left</th>
<th>Bilateral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>13</td>
<td>10</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Women</td>
<td>8</td>
<td>7</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>17</td>
<td>8</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 2. Other studied parameters in diabetic patients with or without calcification.

<table>
<thead>
<tr>
<th>Group/parameter</th>
<th>Diabetics with calcification (N = 46)</th>
<th>Diabetics without calcification (N = 94)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age</td>
<td>51.7</td>
<td>49.5</td>
<td>-</td>
</tr>
<tr>
<td>Duration of diabetes</td>
<td>5.57 ± 4.3</td>
<td>9.4 ± 4.6</td>
<td>0.42</td>
</tr>
<tr>
<td>Mean FBS</td>
<td>155 ± 43.9</td>
<td>147.2 ± 46.9</td>
<td>0.32</td>
</tr>
<tr>
<td>High blood lipid</td>
<td>17</td>
<td>42</td>
<td>0.49</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>15</td>
<td>19</td>
<td>0.16</td>
</tr>
<tr>
<td>History of Infarct</td>
<td>2</td>
<td>2</td>
<td>0.84</td>
</tr>
<tr>
<td>Smoking</td>
<td>8</td>
<td>13</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Figure 3. Portion of radiographs in the same patient that is seen in Figure 2.

PRs, in the soft tissue of the neck, at 1.5 to 2.5 cm from inferior - posterior mandibular angle. Its characteristic location and appearance assists in its differentiation from other anatomical radio-opacities (hyoid bone, epiglottis, ...) and pathological radiopacities (Sialolith, phlebolith and ...) present in the area (Ardakani et al., 2007). Today, consistent with the wide usage of the panoramic images in dental treatments and the discernibility of CAC’s on these radiographs (due to their close location to cervical vertebrae); there is the possibility of random early detection of CAC with the panoramic radiography. Thus, the role of dentists in the early diagnosis of the disease and referral of asymptomatic patients to the relevant physician becomes more prominent (Almog et al., 2002). In this study, CACs were seen in 32.8% of diabetic patients. Ardakani et al. (2007) indicated that the prevalence of CACs in type II diabetic patients was 43%, whereas in the study by Friedlander et al. (1981, 1994, 1998, 1999), the presence of CACs in asymptomatic individuals was assessed between 2 to 4.2% (Friedlander and Lande, 1981; Friedlander and Baker, 1994; Friedlander and August, 1998; Friedlander and Friedlander, 1999). In this study, the frequency of CACs on PRs were a significant difference between diabetic patients and healthy individuals (P<0.001). The reason can be considered as the presence of other risk factors associated with CACs, including high serum lipid and high blood pressure in diabetic patients than the normal individuals, since these factors have been known as the factors related to progression of atherosclerosis (Ardakani et al., 2007). The average age of diabetic patients who had CACs were 51.7 years. These results match those of studies performed by Friedlander and Baker (1994), Ardakani et al. (2007) and Yoon et al. (2008). It was found in these studies that the presences of CACs are higher in people over 50 years. In the present study in diabetic subjects, the CACs were observed more in women (67%). However, no significant difference existed between men and women (P = 0.783). This may be due to more women being
present in this study. These results are similar to the obtained results in studies of Ohba et al. (2003), Tamura et al. (2005), Carter et al. (1998) and Hubar et al. (1999). Based on the results of this study, CACs seen in PRs of diabetic patients were more unilateral (82.6%) and were often seen on the right side (55.2%). This can be related to the location of bifurcation of left side carotid artery is slightly lower than the right side, which reduces its probable observation on PRs (Christou et al., 2010). It was also indicated in studies of Carter et al. (1998), Sochaya et al. (2006), Ohba et al. (2003) and Friedlander et al. (2002) that the calcification of the carotid artery on the right side is higher (Chicano et al., 2006; Carter et al., 1998; Suchaya and Supanee, 2006; Friedlander and Altman, 2001). However, these results stood at odds with those of Tamura et al. (2005). In this study, it was found that CACs is seen more on the right side. In this study, a statistically significant difference was seen between the presence of unilateral and bilateral calcification (P<0.001), while this difference was not significant in presence of calcification on the right and left sides (P = 0.036). To determine the relationship between diabetes and CACs, risk factors such as level of FBS, duration of diabetes, blood lipids, blood pressure, history of MI and smoking were studied in the present study. In this study, no statistically significant difference between FBS in diabetic patients with and without CACs were found (P = 0.325). The results are similar to results obtained in studies of Ardakani et al. (2007). Also, the duration of diabetes in diabetic patient with and without CACs were not statistically significant (P = 0.422).

Associated with high blood lipid, the significant difference between diabetic patients with and without CACs were not found (P = 0.492). This result is contrary to the study result of Ardakani et al. (2007). The reason of this difference can be considered as that in the study of Ardakani et al. (2007); the comparison has been made between all people with and without calcification, while in the present study the comparison has been rendered only between the diabetic patients with and without calcification. Regarding other risk factors associated with diabetes such as hypertension, myocardial infarction and smoking history, no statistically significant difference is seen between diabetic patients with and without calcification (respectively P = 0.162, 0.841 and = 0.58). These results show that the presence of CACs in diabetic patients do not relate to other risk factors associated with calcification including cardiovascular problems, high blood pressure and smoking. These results are consistent with the study results of Ardakani et al. (2007).

CONCLUSION

The frequency of CACs on PRs of diabetic patients is higher than normal individuals. Therefore, the dentists must be informed of the possible observation of this calcification on PRs, and in the case of observing the linear and nodular opacities in the space between the third and fourth cervical vertebrae, especially in high risk patients; they should refer to cardiovascular specialists for precise medical examinations.

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REFERENCES


Friedlander AH, Friedlander IK (1999). The prevalence of carotid