Results

The results of the present study will be presented as follows:

A. <u>Histopathological evaluation:</u>

Samples from both groups were histopathologically examined to determine:

I. Inflammation and Fibrosis

II. Calcifications and Stone existence

III. Necrosis

IV. Angiopathy

B. <u>Statistical analysis:</u>

Included:

a) <u>Comparison between two groups</u>

As regards:

i. Demographic data

ii. Medical history and habits

iii. Laboratory investigation

b) <u>Correlation between stone areas and different variables in diabetic group.</u>

A. Histopathological evaluation:

Histopathological examination of the dental pulp of all teeth of the twenty (20) teeth of control group (group B) and the forty five (45) teeth of diabetic group (group A) was done to determine the presence or absence of each of the following:

I. Inflammation and Fibrosis
II. Calcifications and Stone existence
III. Necrosis
IV. Angiopathy

In the control group normal dental pulp was found in all teeth, which was characterized by the presence of a loose connective tissue, with few cells in the central part of the dental crown, and with higher density in the radicular dental pulp and at the apex. Collagen fibers and capillaries were numerous in fundamental substance, as shown in figure (2).

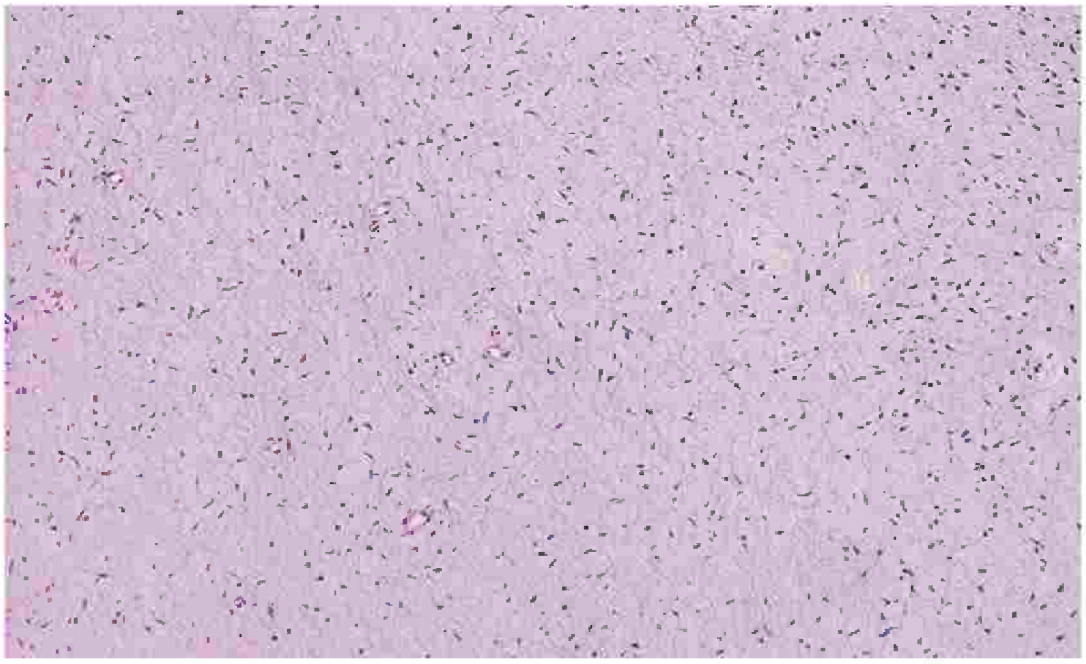


Figure (2): Photomicrograph of a case in control group showing normal pulp tissue (H&E × 200)

Histopathological examination of the dental pulp of diabetic group revealed the following:

I. Inflammation and Fibrosis:

None of diabetic specimens showed normal pulp. Inflammation was observed in 12 sections of 45 with a total percent (26.6%). Severe inflammation has the greatest percent in this group (20%). Fibrosis was seen in (15.5%). On the other hand, none of 20 control specimens revealed inflammation as shown in table (2) and figures (3, 4).

Table (2): Comparative percent of different degree of inflammation and fibrosis in histologic sections of control and diabetic groups

	None	Mild	Moderate	Severe	Fibrosis	Total no.	Total %
Control group	100%	0%	0%	0%	0%	20/20	100%
Diabetic group	0%	2.2%	4.4%	20%	15.5%	19/45	42.1%

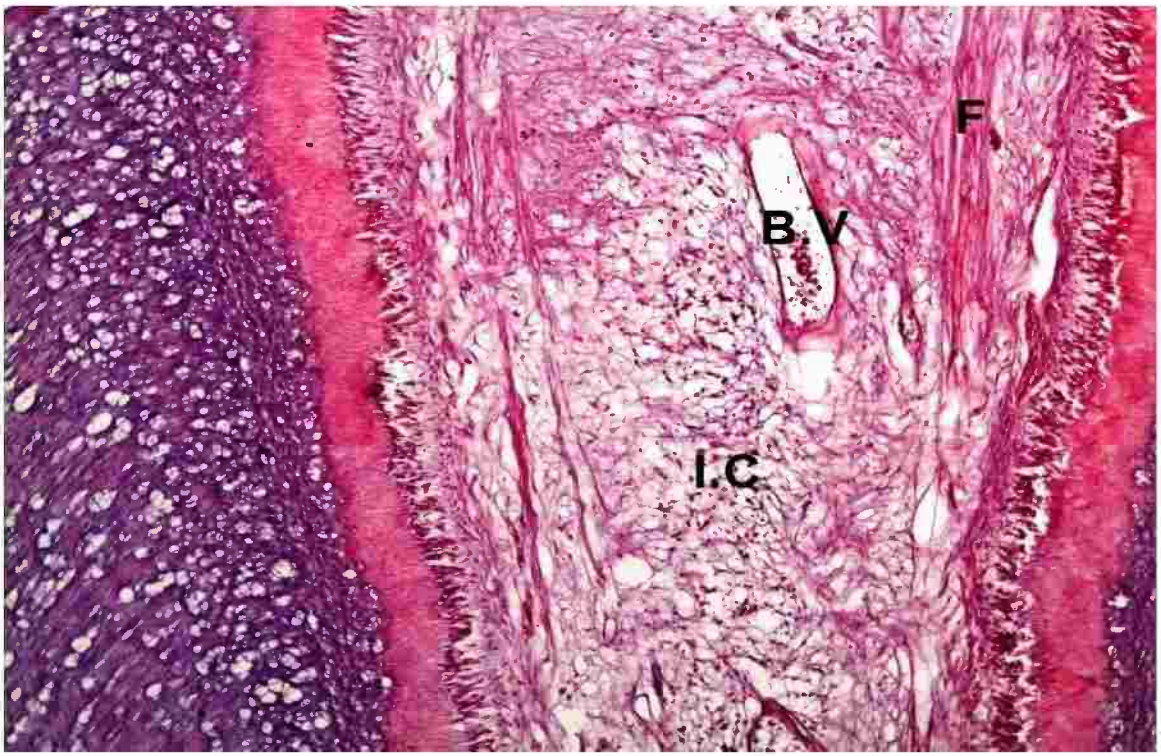


Figure (3): Photomicrograph of a case in diabetic group showing increased inflammatory cells infiltration (I.C), dilated blood vessel (B.V) and fibrosis (F) (H&E × 100)

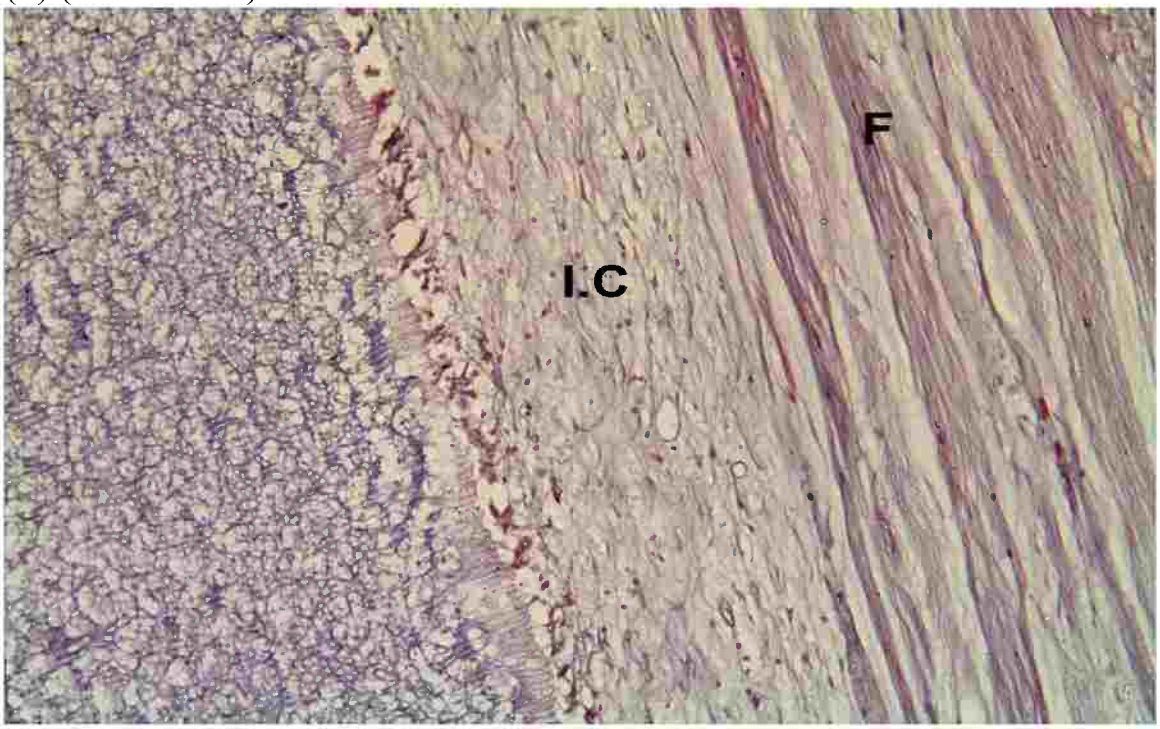


Figure (4): Photomicrograph of a case in diabetic group showing inflammatory cells infiltration (I.C) and fibrosis (F) (H&E × 200)

II. Calcifications and Stone existence:

Neither stones nor calcification were found in the control group. Calcification and stones were found in total (77.6%) of the diabetic group sections. Diffuse calcification was seen in (46.6%), pulp stones with variable sizes were seen in (26.6%) of group A, while total or complete calcification were only seen in (4.4%) of the same group table (3) and figures (5-9).

Table (3): Comparative percent of diffuse, complete calcification and stone existence in histologic sections of control and diabetic groups

	Diffuse clacification	Complete calcification	Stone existence	Total no.	Total %
Control group	0%	0%	0%	0/20	0%
Diabetic group	46.6%	4.4%	26.6%	35/45	77.6%

Figure (5): Photomicrograph of dental pulp of a case in diabetic group showing large detached pulpal stone with smaller two stones (arrows) (H&E × 40)

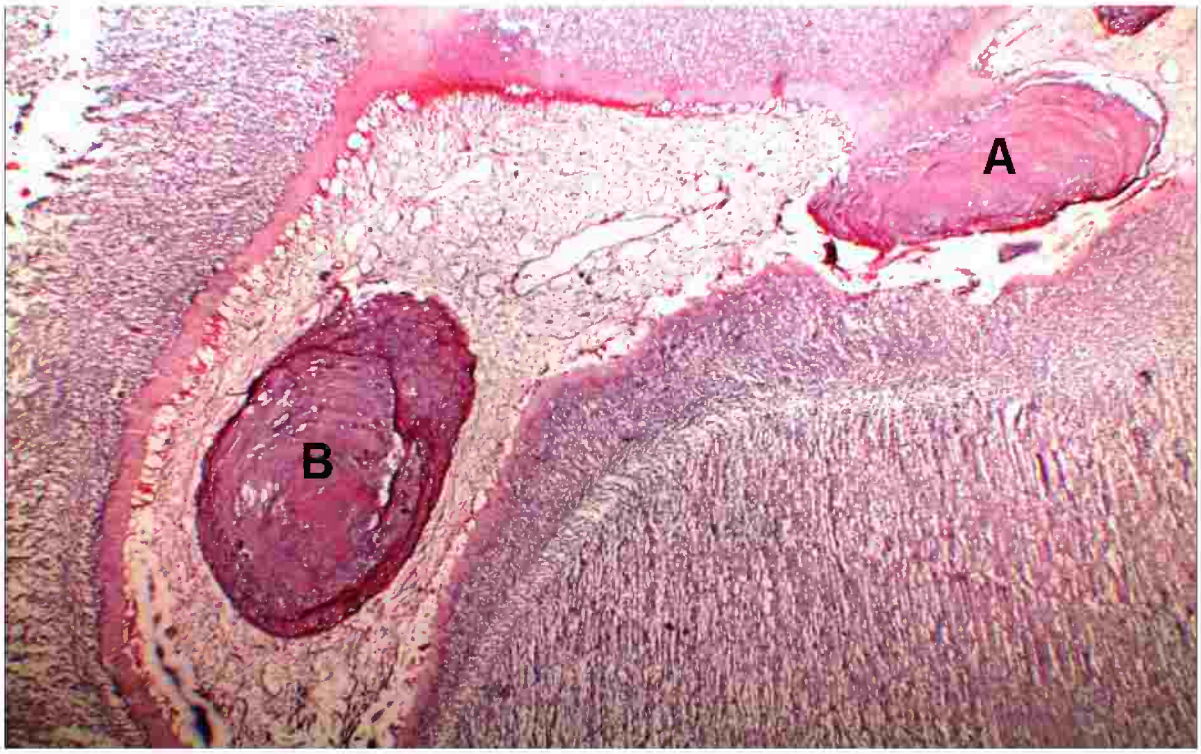


Figure (6): Photomicrograph of dental pulp of case in diabetic group showing; A: attached stone, B: detached stone (H&E × 40)

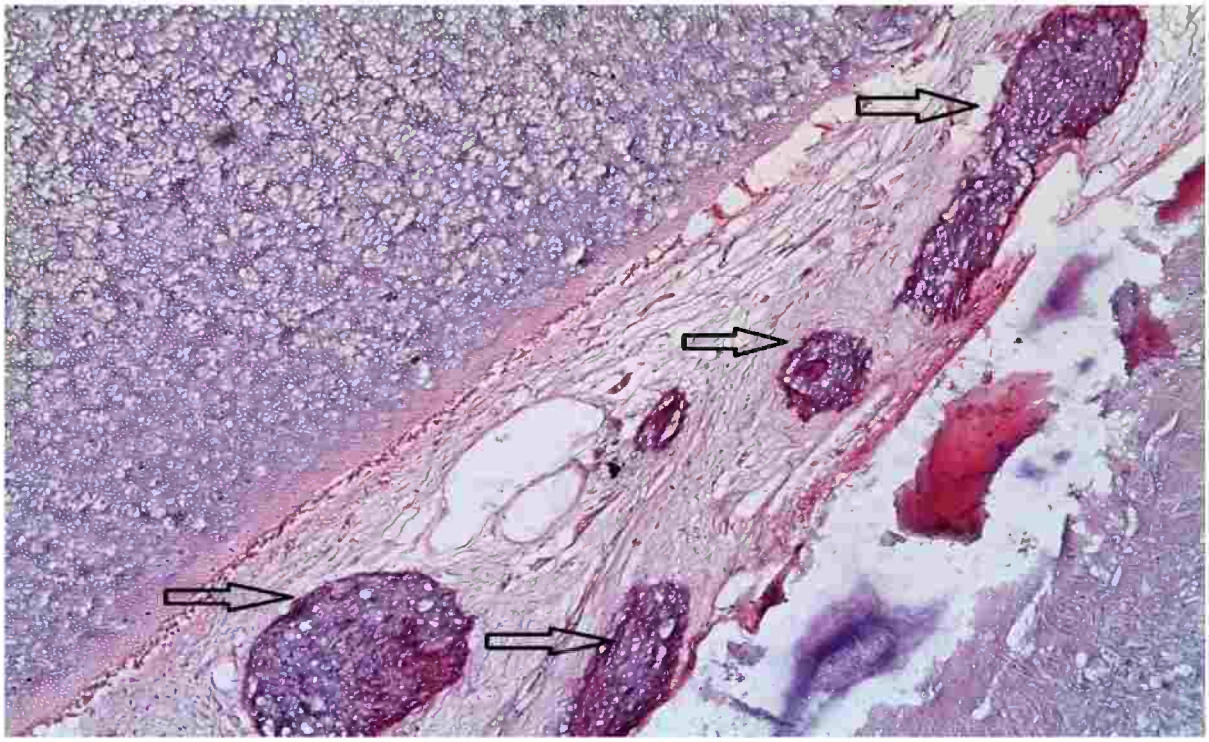


Figure (7): Photomicrograph of dental pulp in diabetic group showing small multiple detached stones (arrows) (H&E × 100)

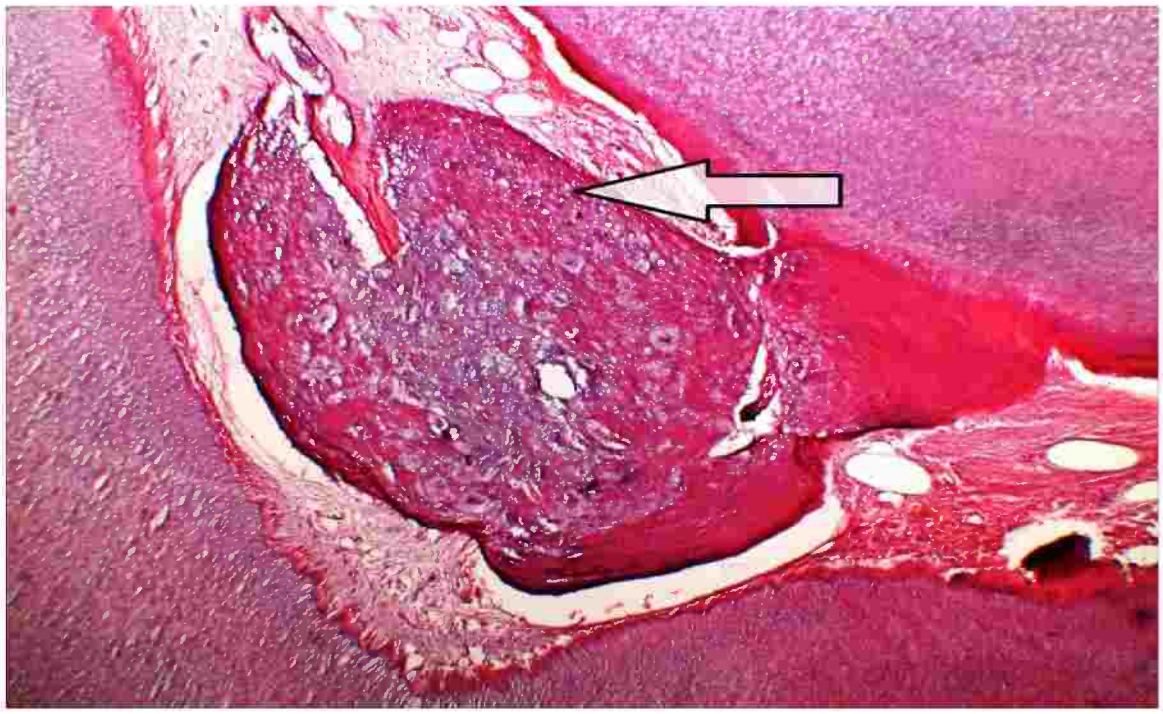


Figure (8): Photomicrograph of pulpal tissue of specimen in diabetic group showing large attached stone (arrow) (H&E × 40)

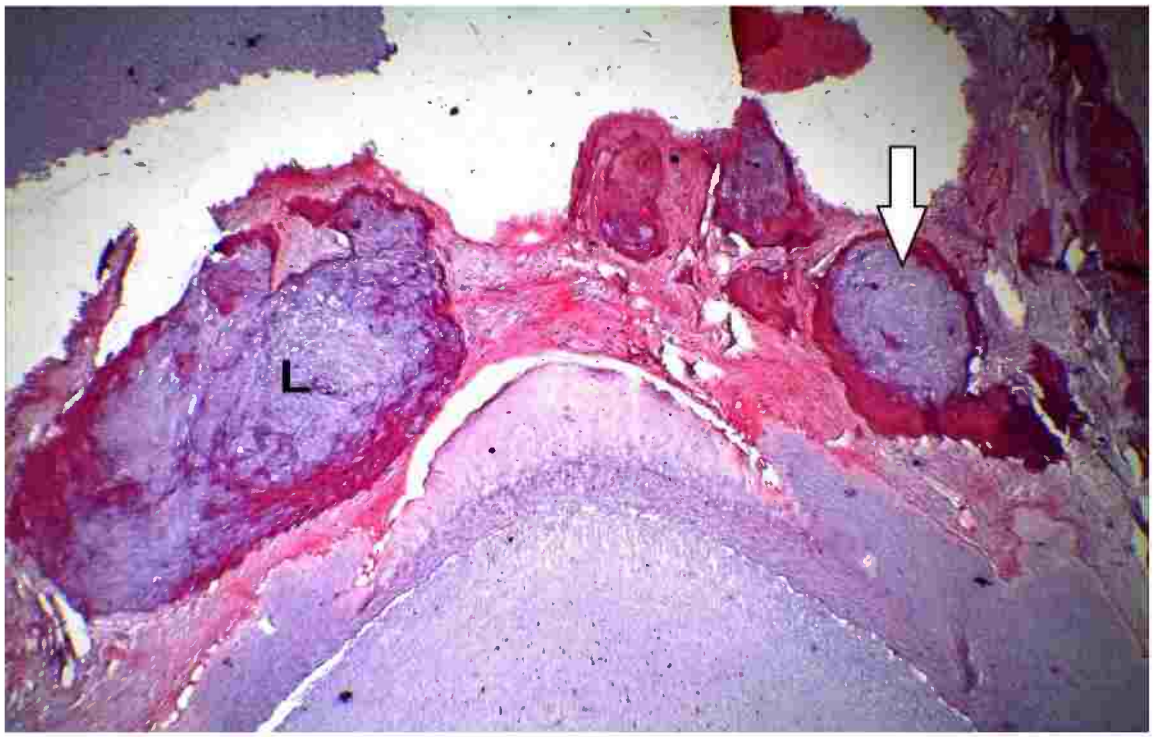


Figure (9): Photomicrograph of pulpal tissue of specimen in diabetic group showing large stone (L) and smaller stone (arrow) located at canals orifices (H&E × 40)

III. Necrosis:

Partial necrosis was seen in (26.66%) of the diabetic group while none of control group showed any necrosis as shown in table (3) and figures (10-11).

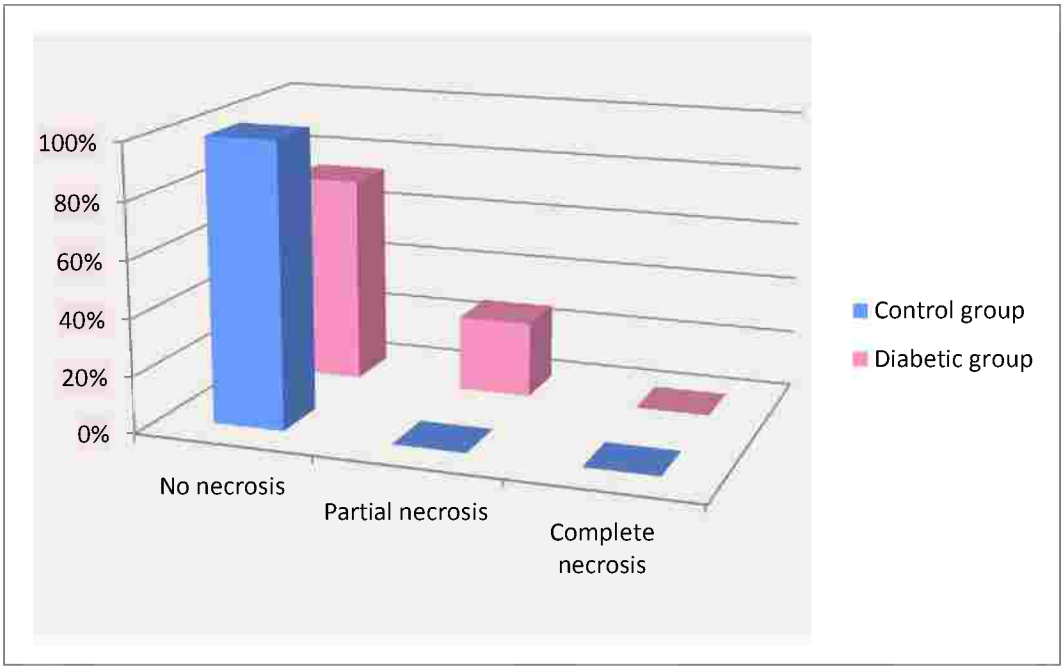
Table (4): Comparative percent of necrosis in histologic sections of control and diabetic groups

	No necrosis	Partial necrosis	Complete necrosis	Total no.	Total %
Control group	100%	0%	0%	20/20	100%
Diabetic group	73.33%*	26.66%	0%**	45/45	100%

* Sections show degree of inflammation, characteristic vaculation and calcification but with no necrosis.

**Complete necrosis was not found in the sections of this study but it could happen.

The following diagram shows the difference in percent of necrosis found in histological sections between the two groups.



Graph (1): Showing a comparison between diabetic and control group in percent of necrosis found in histological sections

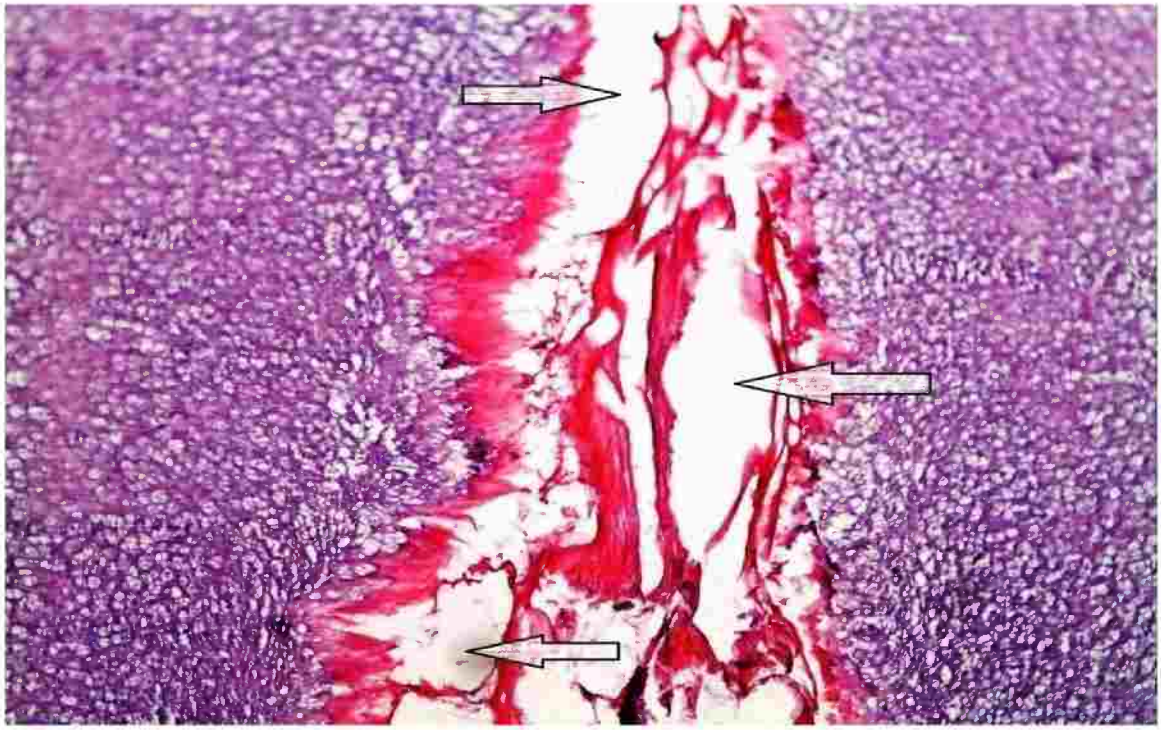


Figure (10): Photomicrograph of pulpal tissue of specimen in diabetic group showing partial necrosis (arrows) (H&E × 100)

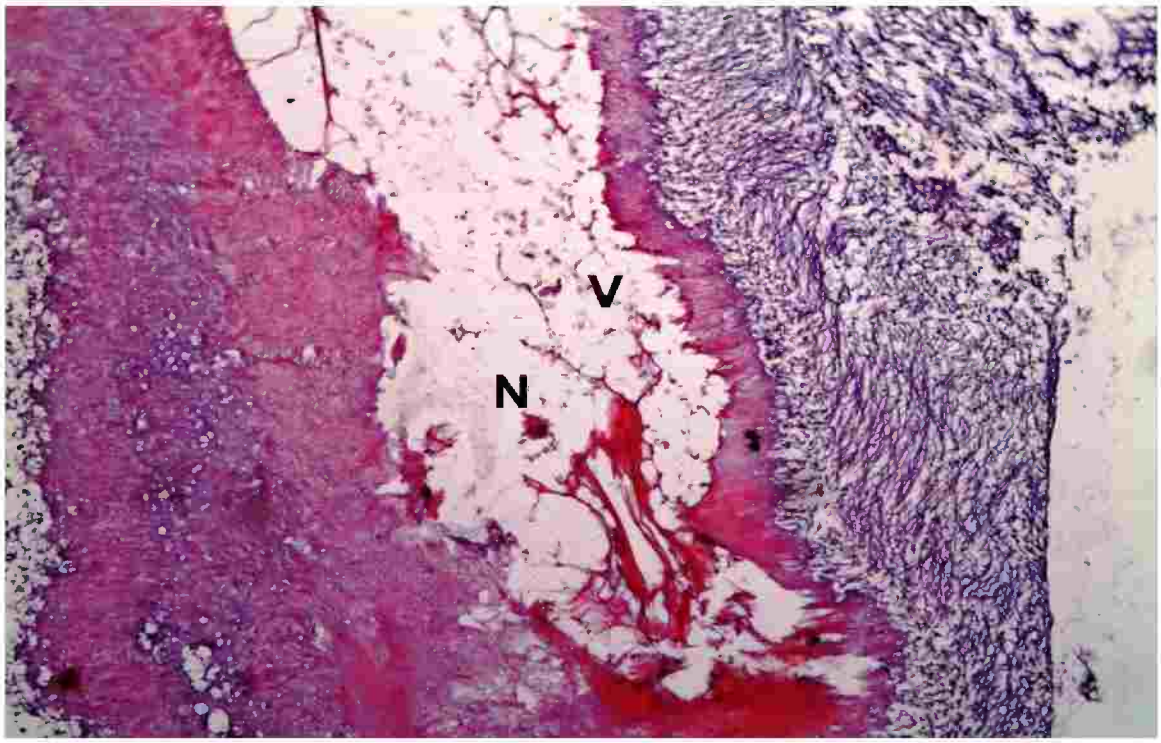


Figure (11): Photomicrograph of dental pulp of specimen in group A (diabetic group) showing partial necrosis (N) and vaculation (V) (H&E × 100)

IV. Angiopathy:

Angiopathy was found in 30/45 specimen (66.6%) in diabetic group including dilated blood vessels, thickened blood vessel wall, blood vessel calcification, ruptured blood vessel or hemorrhage. Blood vessel calcification was seen only in diabetic group with (22.2%) of total specimens as shown in figures (12-14).

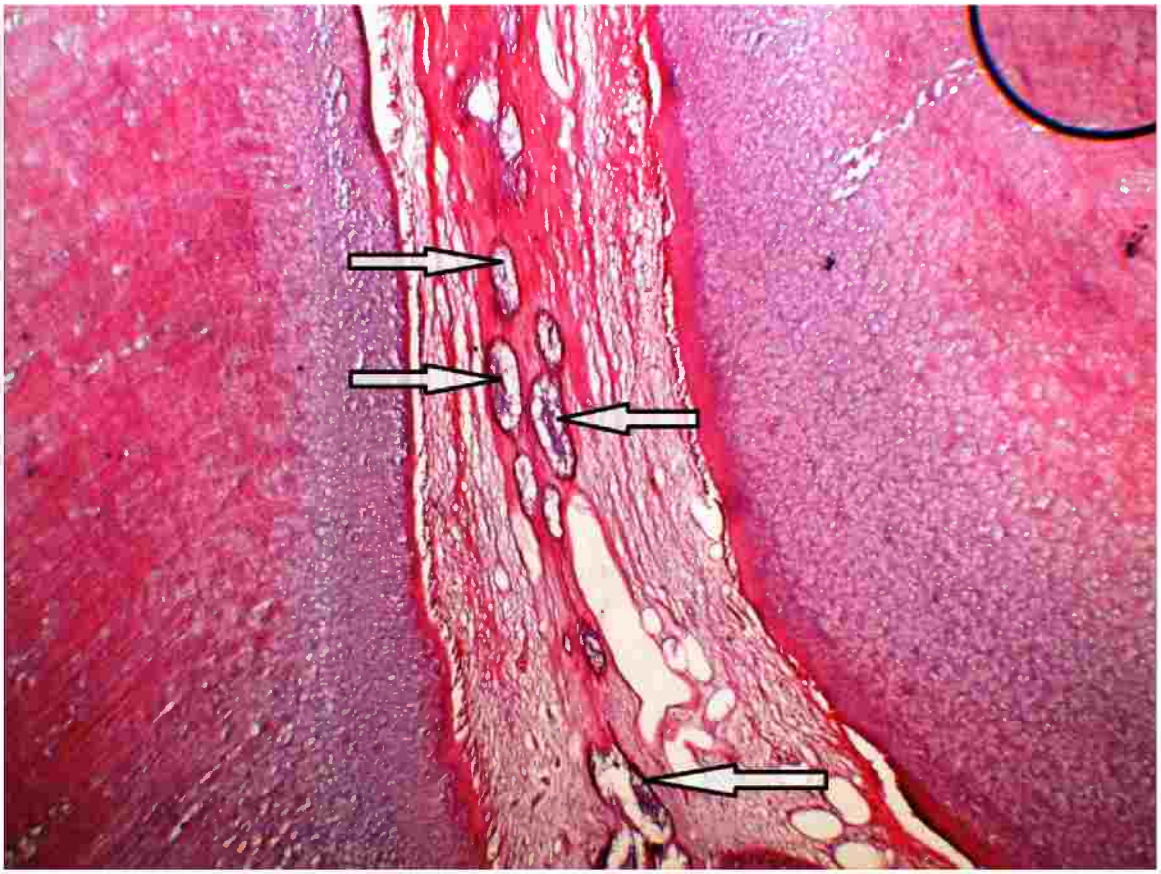


Figure (12): Photomicrograph of pulpal tissue in diabetic group showing calcification in blood vessels (arrows) (H&E × 40)

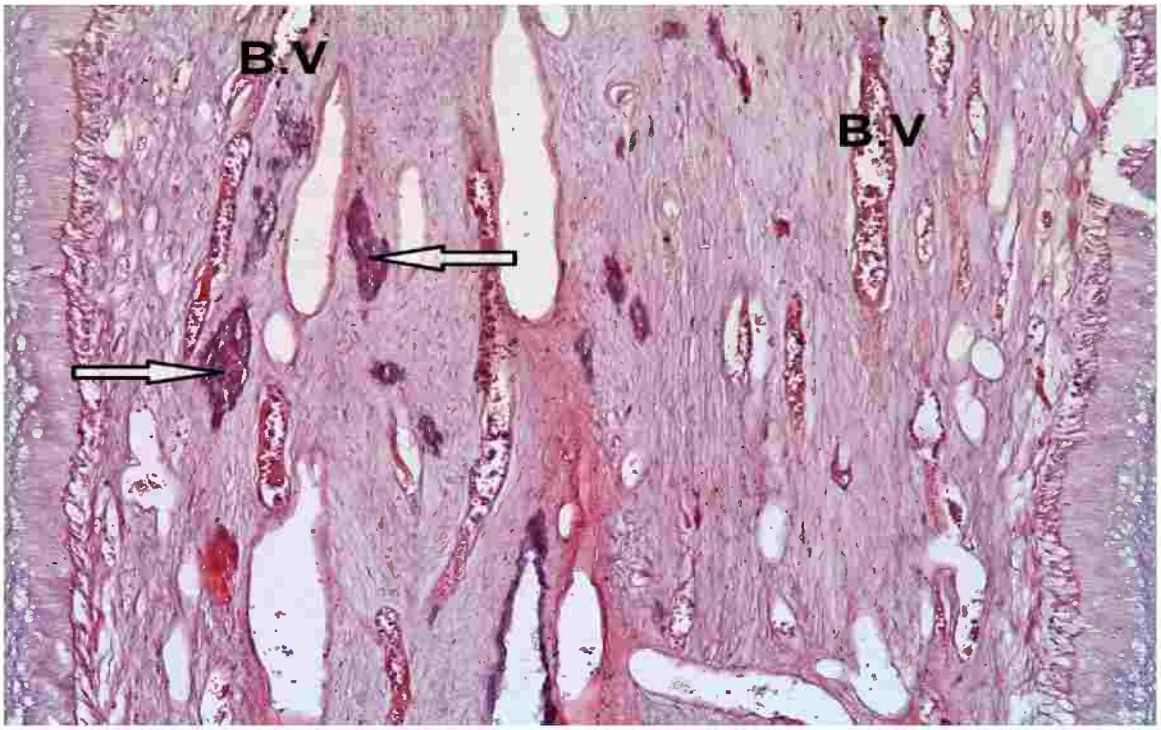


Figure (13): Photomicrograph of dental pulp of case in diabetic group showing blood vessels dilatation (B.V) and focal areas of calcification (arrows) (H&E × 100)

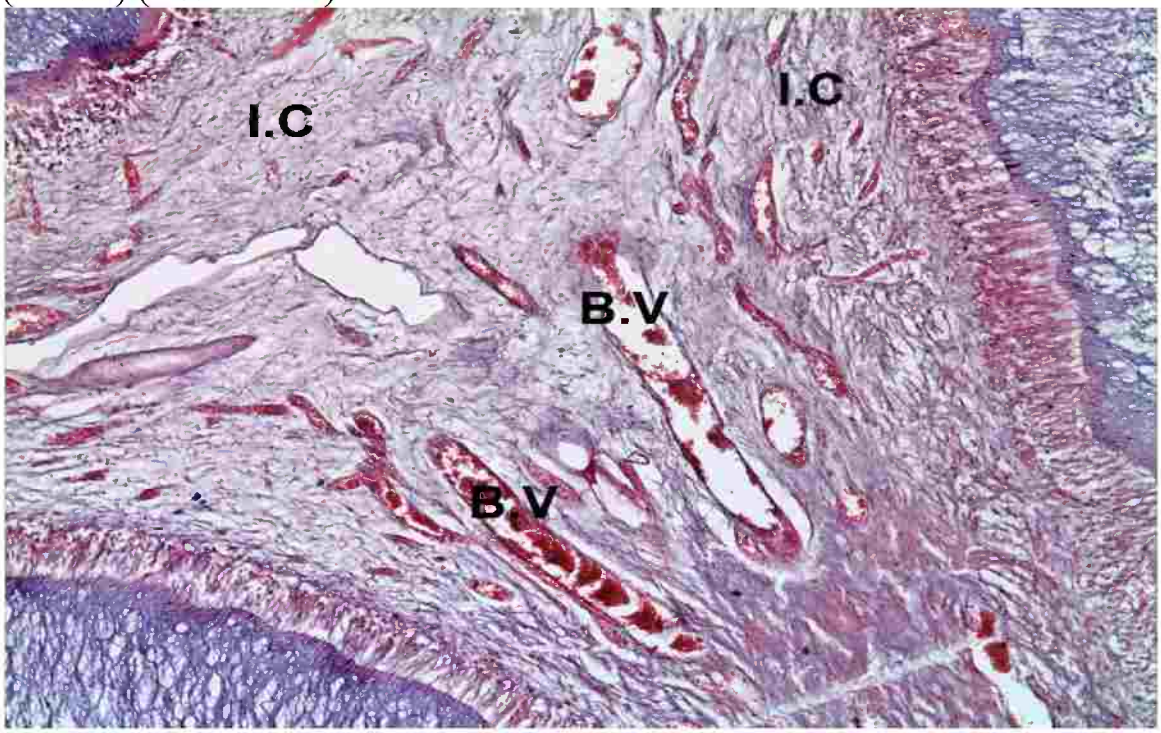


Figure (14): Photomicrograph of dental pulp of case in diabetic group showing blood vessels dilatation (B.V) and inflammatory cells infiltration (I.C) of pulpal tissue (H&E × 100)

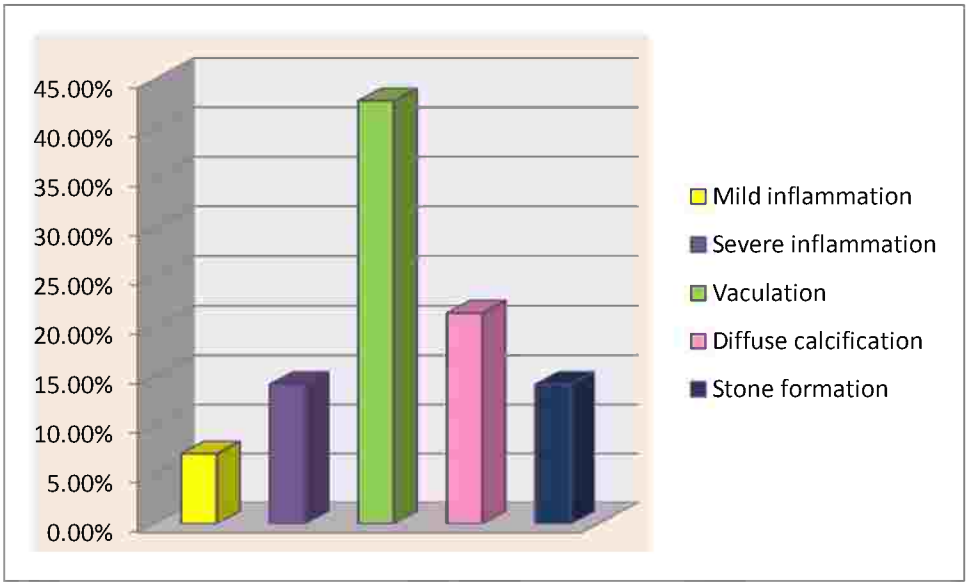
Relation between Hypertension and histoathological findings:

Fourteen patients of diabetic group had hypertension (31.1%). The histopathological findings observed are shown in the following table:

Table (5): Histopathological findings in diabetic patients having hypertension

histopathological findings	No\14	percent
Mild inflammation	1	7.14%
Severe inflammation	2	14.2%
Vaculation	6	42.8%
Diffuse calcification	3	21.4%
Stone formation	2	14.2%

Characteristic vaculation has the greatest percent (42.8%) in hypertensive specimens as shown in graph (2).



Graph (2): Showing a comparison between histopathological findings in hypertensive cases in diabetic group

Characteristic vaculation is a special finding seen in hypertensive specimens as shown in figures (15, 16).

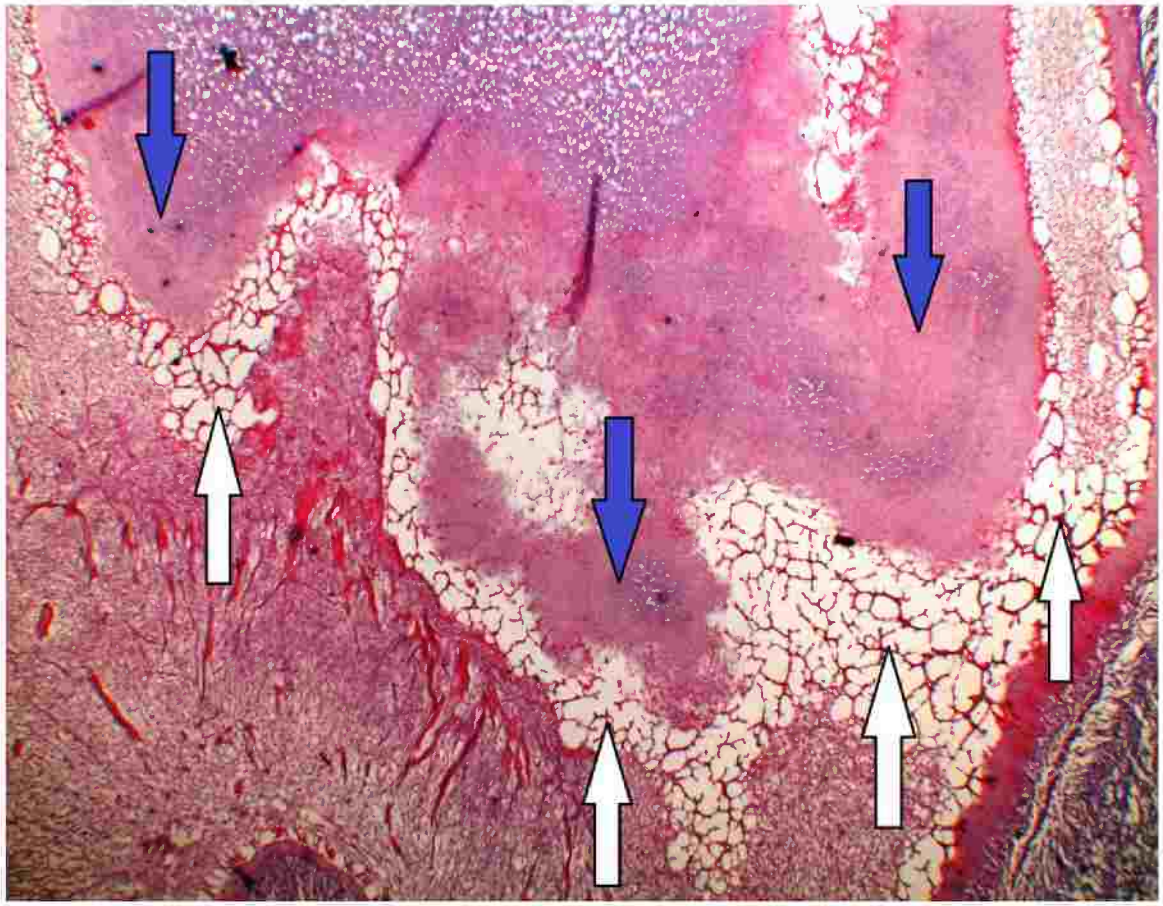


Figure (15): Photomicrograph of dental pulp of hypertensive case in diabetic group showing characteristic vaculation (white arrows) and diffuse calcification (blue arrows) (H&E × 40)

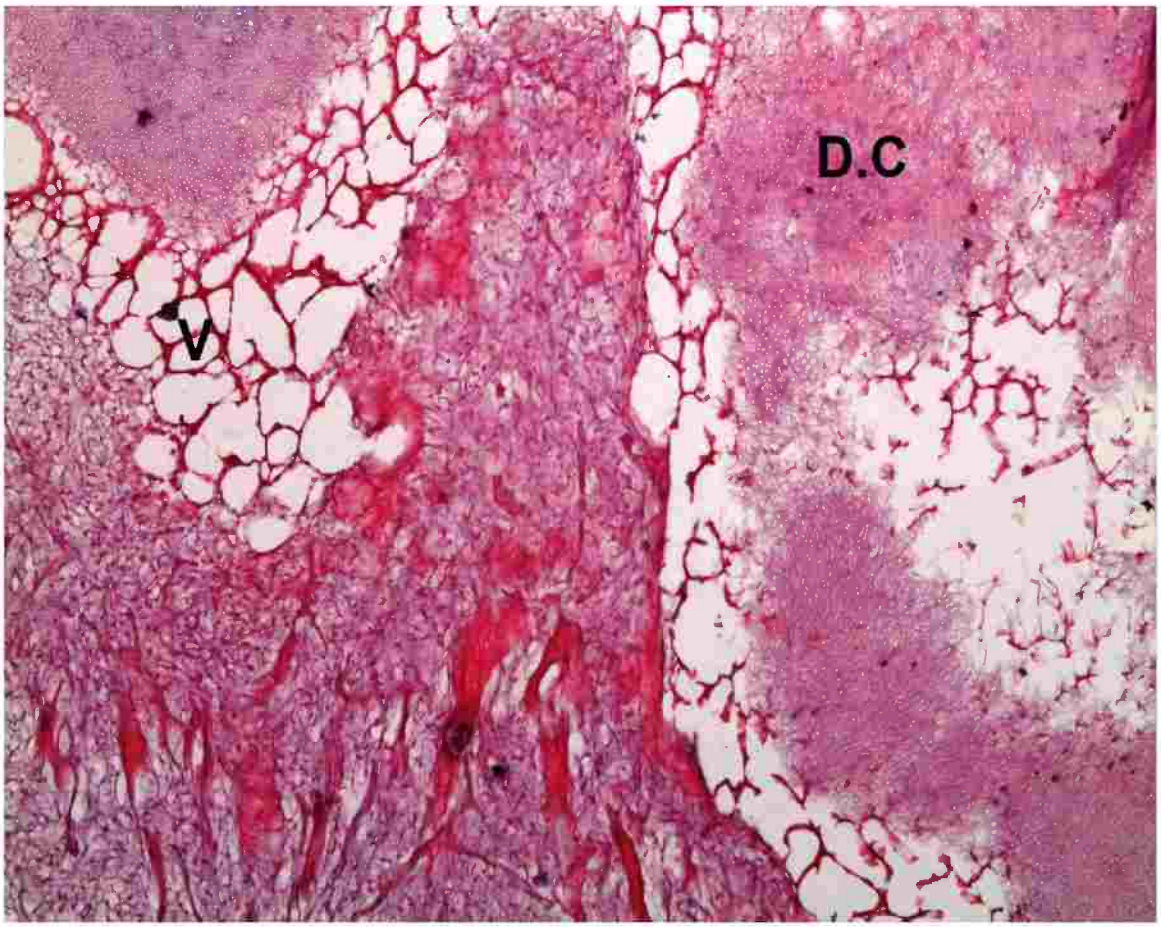


Figure (16): Photomicrograph of dental pulp of case in diabetic group having hypertension showing characteristic vaculation (V) and diffuse calcification (D.C) with higher magnification (H&E × 100)

B. Statistical analysis:

a) Comparison between the two groups:

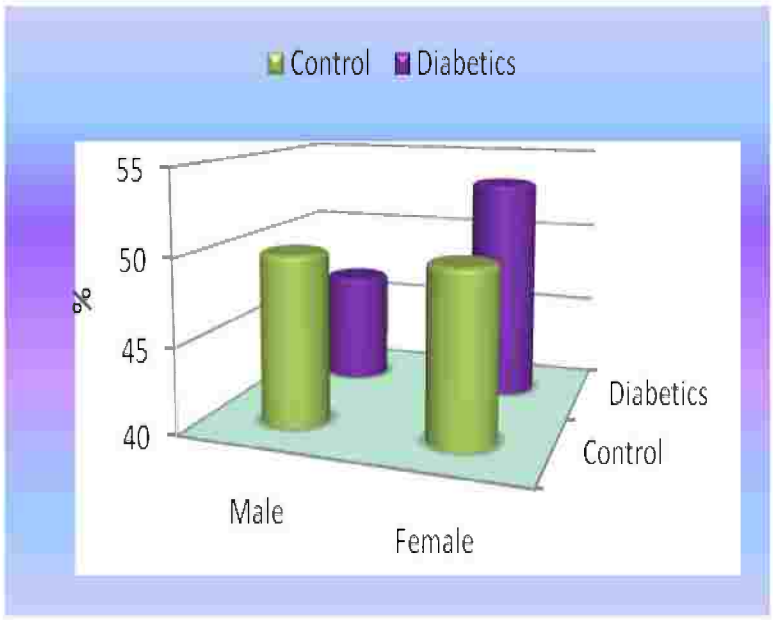
i. Demographic data:

There was no statistically significant difference between gender distributions in the two groups as shown in table (6) and graph (3).

Table (6): Descriptive statistics, results of Student's t-test and chi-square test for comparisons between demographic data in the two groups

Parameters	*Control (n=20)*	*Diabetics (n=45)*	*P-value*
Gender n (%)			
Male	10 (50)	21 (46.7)	0.804
Female	10 (50)	24 (53.3)	

Significant at $P \leq 0.05$



Graph (3): Bar chart representing gender distributions in the two groups

ii. Medical history and habits:

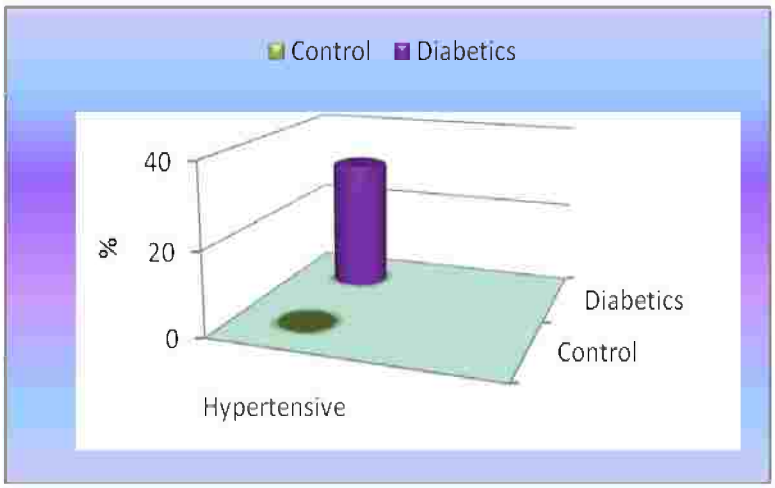
Diabetic group showed statistically significant higher prevalence of hypertensive patients than control group as shown in table (7) and graph (4).

There was no statistically significant difference between prevalence of smoking and bruxism in the two groups as shown in table (7) and graphs (5-6).

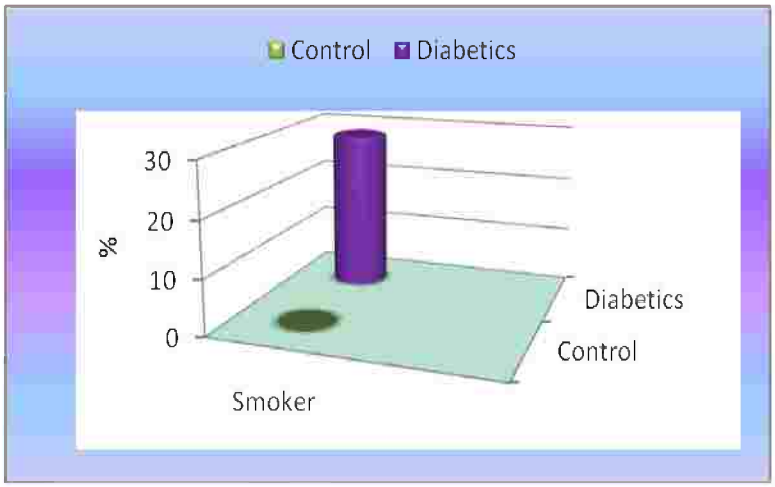
Table (7): Descriptive statistics and results of chi-square test for comparisons between medical history and habits in the two groups

Parameters	*Control (n=20)*	*Diabetics (n=45)*	*P-value*
Hypertension n (%)	0 (0)	14 (31.1)	0.02*
Smoking n (%)			
Smoker	0 (0)	13 (28.8)	0.157
Non-smoker	20 (100)	32 (71.1)	
Bruxism n (%)	0 (0)	5 (11.1)	
Bruxism	20 (100)	40 (88.9)	0.121
No bruxism			

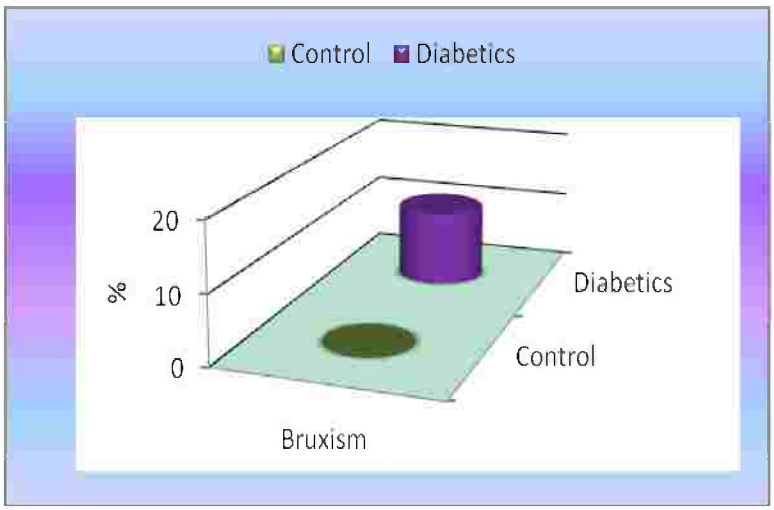
** Significant at $P \leq 0.05$*



Graph (4): Bar chart representing prevalence of hypertension in the two groups



Graph (5): Bar chart representing prevalence of smoking in the two groups



Graph (6): Bar chart representing prevalence of Bruxism in the two groups

iii. Laboratory investigation:

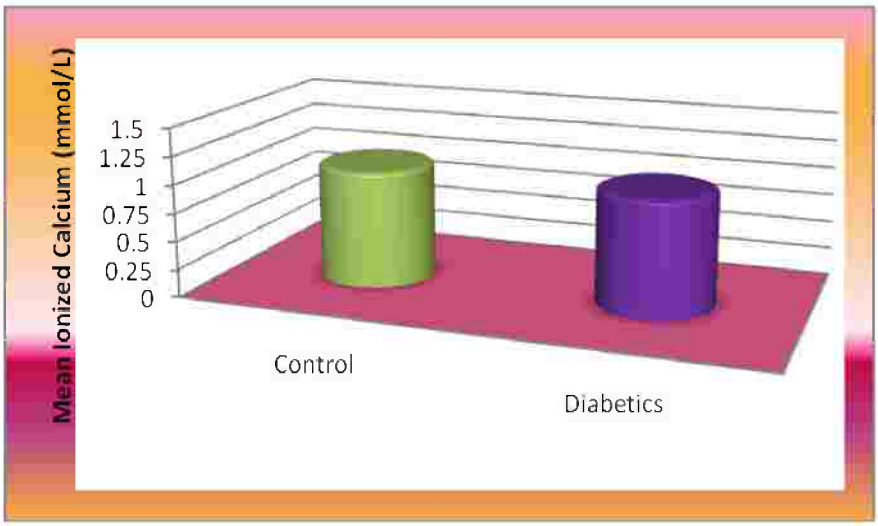
There was no statistically significant difference between mean ionized Calcium, ALP, RBC, PLT, PTT, INR and HGB levels in the two groups as shown in table (8) and graphs (7-13).

Diabetic group showed statistically significant higher mean fasting blood glucose, HbA1c and WBC than control group as shown in table (8) and graph (14-16).

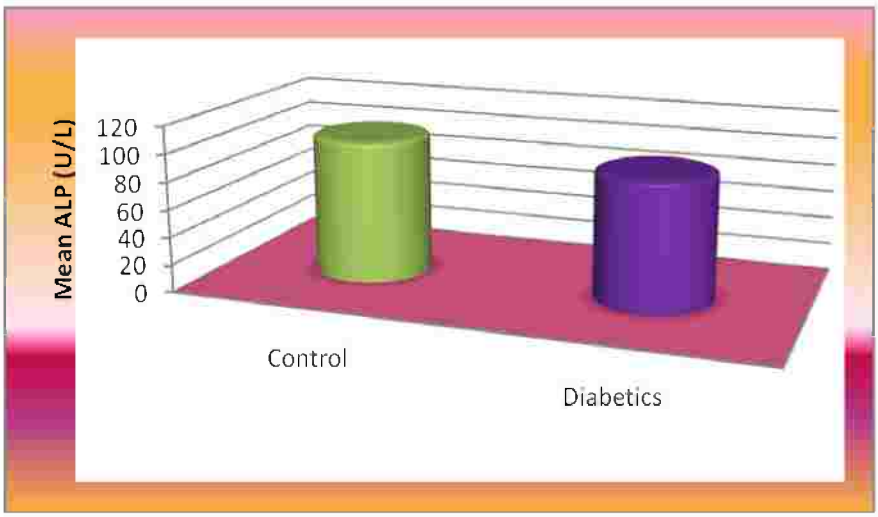
Table (8): Descriptive statistics and results of Student's t-test or Mann-Whitney U test for comparisons between laboratory investigations in the two groups

Laboratory investigations	*Control (n=20)*	*Diabetics (n=45)*	*P-value*
Ionized Calcium (Ca^{2+}) (mmol/L) Mean ± SD	1.05 ± 0.11	1.03 ± 0.14	0.531
Alkaline phosphatase (ALP) (U/L) Mean ± SD	103.5 ± 66.2	92.9 ± 38.2	0.824
Red blood cells (RBCs) (M/ml) Mean ± SD	5 ± 0.4	5 ± 0.5	0.917
Platelets (PLT) (K/ml) Mean ± SD	236.6 ± 63.4	279.3 ± 82.9	0.082
Prothrombin time (PTT) (seconds) Mean ± SD	25.5 ± 5.1	25.8 ± 3.7	0.816
INR Mean ± SD	1.01 ± 0.03	1.01 ± 0.03	0.675
Hemoglobin (HGB) (g/dl) Mean ± SD	13.4 ± 1.5	13.7 ± 1.3	0.568
Fasting Blood Glucose (mg/dl) Mean ± SD	96 ± 9.9	168.2 ± 41	<0.001*
Glycated hemoglobin (HbA1c) (%) Mean ± SD	5.7 ± 0.3	8.6 ± 1.8	<0.001*
White blood cells (WBCs) (K/ml) Mean ± SD	5.6 ± 1.5	7.5 ± 2.3	0.006*

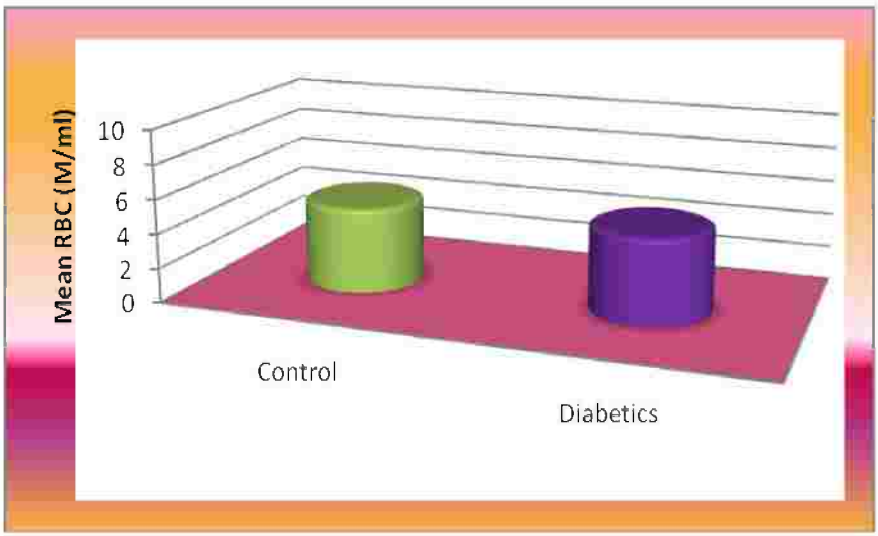
**: Significant at $P \leq 0.05$*



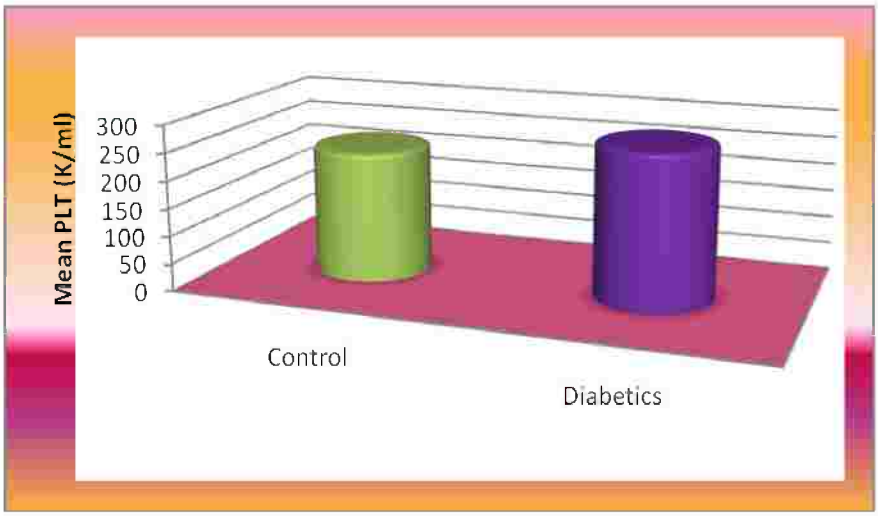
Graph (7): Bar chart representing mean ionized Calcium levels in the two groups



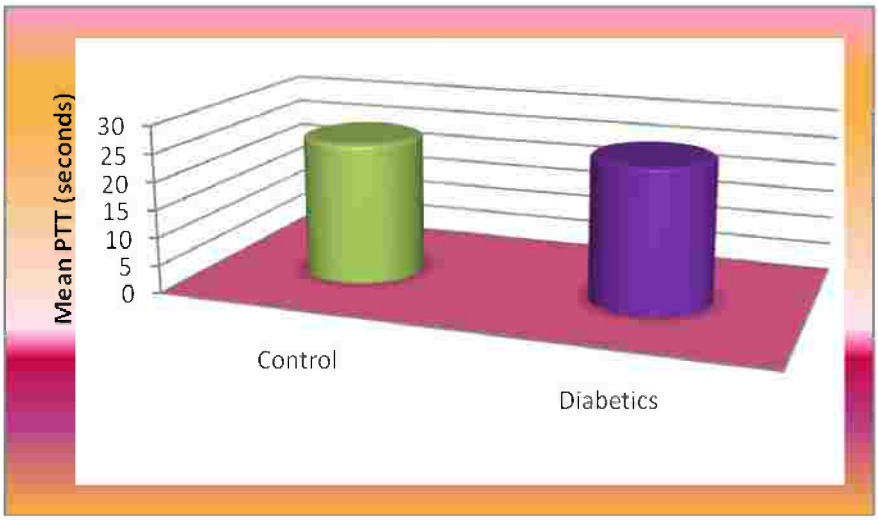
Graph (8): Bar chart representing mean ALP levels in the two groups



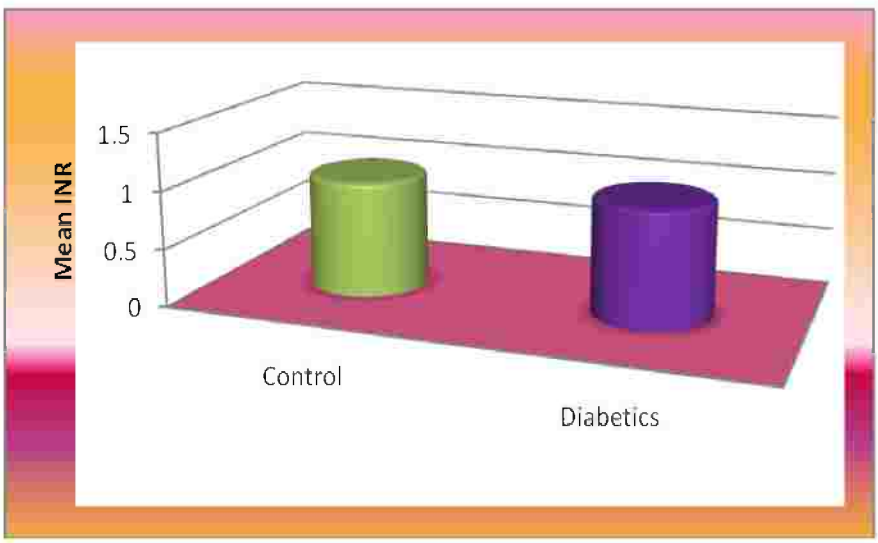
Graph (9): Bar chart representing mean RBC in the two groups



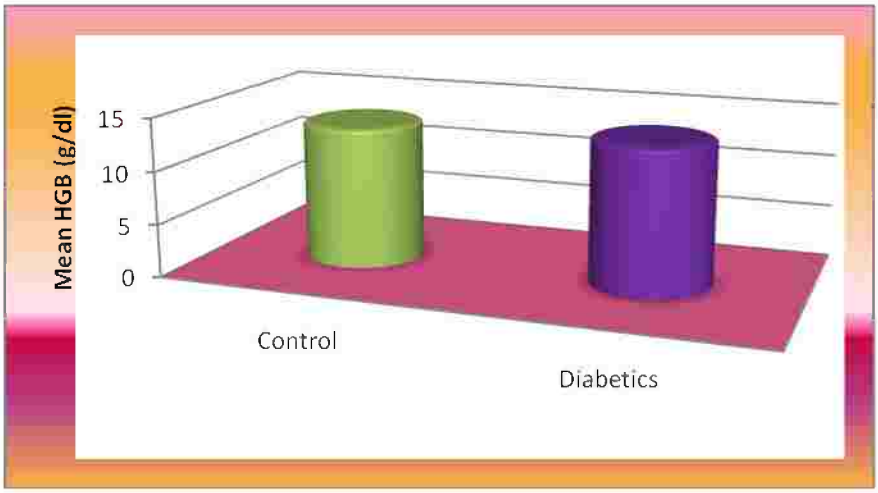
Graph (10): Bar chart representing mean PLT in the two groups



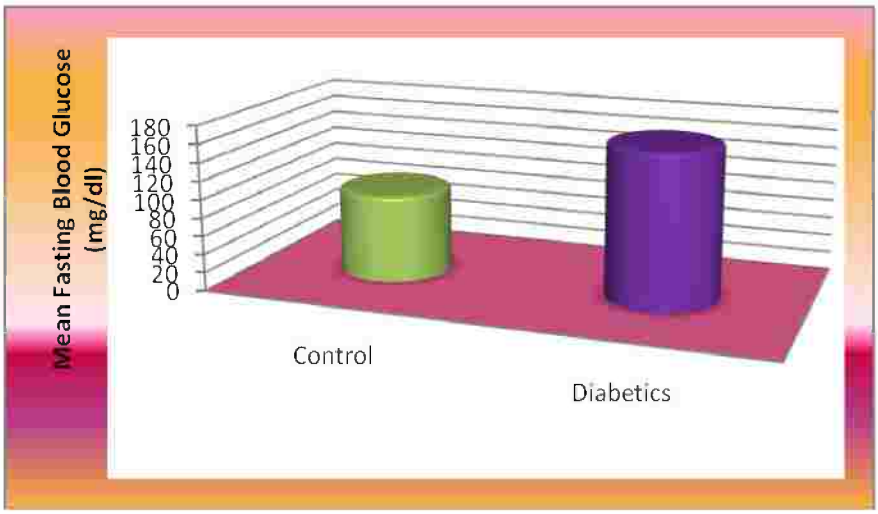
Graph (11): Bar chart representing mean PTT in the two groups



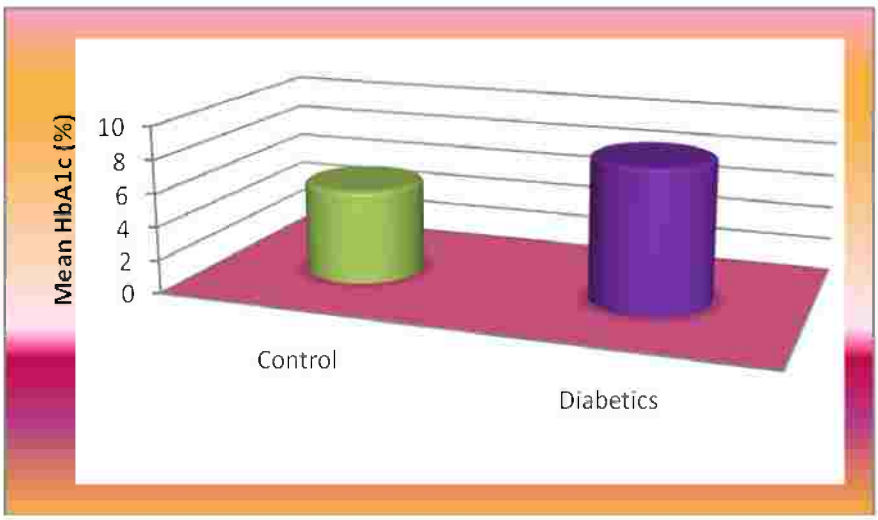
Graph (12): Bar chart representing mean INR in the two groups



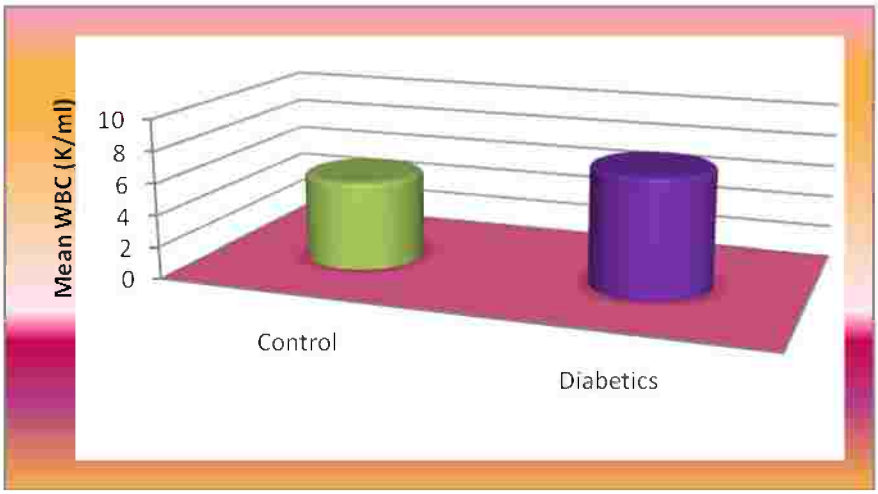
Graph (13): Bar chart representing mean HGB levels in the two groups



Graph (14): Bar chart representing mean fasting blood glucose levels in the two groups



Graph (15): Bar chart representing mean HbA1c levels in the two groups



Graph (16): Bar chart representing mean WBC in the two groups

b) Correlation between stone areas and different variables in diabetic group:

i. Demographic data:

There was no statistically significant correlation between stone areas and age as shown in table (9). Females showed statistically significant higher mean stone areas than males as shown in table (10) and graph (17).

Table (9): Results of Spearman's correlation coefficient for the correlation between stone area and age

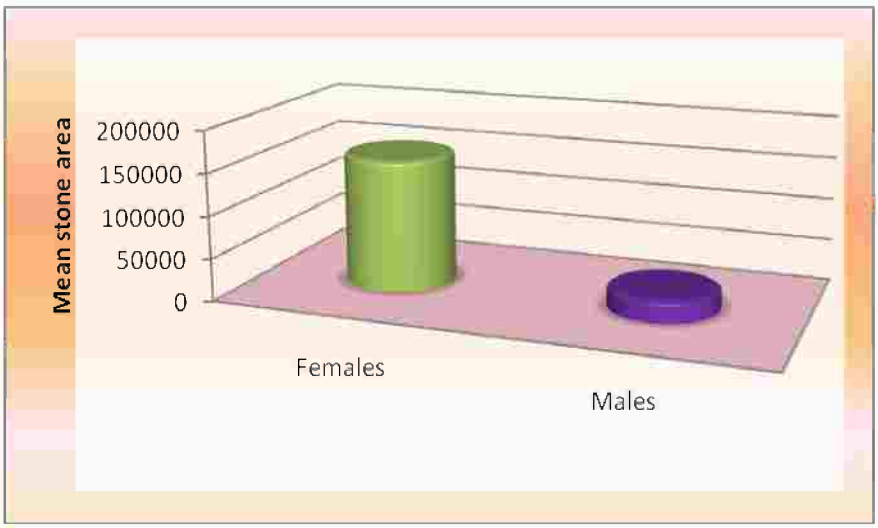
	Correlation coefficient	***P-value***
Stone are and age	-0.202	0.551

Significant at $P \leq 0.05$

Table (10): Descriptive statistics and results of Mann-Whiteny U test for the comparison between stone areas in females and males

	Females	*Males*	*P-value*
Stone area Mean ± SD	157194.1 ± 149271.9	25393.4 ± 37300.8	0.030*

**: Significant at $P \leq 0.05$*



Graph (17): Bar chart representing mean stone areas in females and males

ii. <u>Medical history and habits:</u>

There was no statistically significant correlation between stone areas and diabetes duration as shown in table (11). There was no statistically significant difference between mean stone areas in hypertensive and none hypertensive subjects as shown in table (12). Non-smokers showed statistically significantly higher mean stone areas than smokers, as shown in table (13) and graph (18). There was no statistically significant difference between mean stone areas in subjects with and without bruxism as shown in table (14).

Table (11): Results of Spearman's correlation coefficient for the correlation between stone area and diabetes duration

	Correlation coefficient	*P-value*
Stone area and diabetes duration	0.229	0.499

Significant at P ≤ 0.05

Table (12): Descriptive statistics and results of Mann-Whiteny U test for the comparison between stone areas in hypertensive and none Hypertensive subjects

	Hypertensive	*None Hypertensive*	*P-value*
Stone area Mean ± SD	14209.4 ± 10129.8	111962.9 ± 132237.7	0.194

Significant at P ≤ 0.05

Table (13): Descriptive statistics and results of Mann-Whiteny U test for the comparison between stone areas in smokers and non-smokers

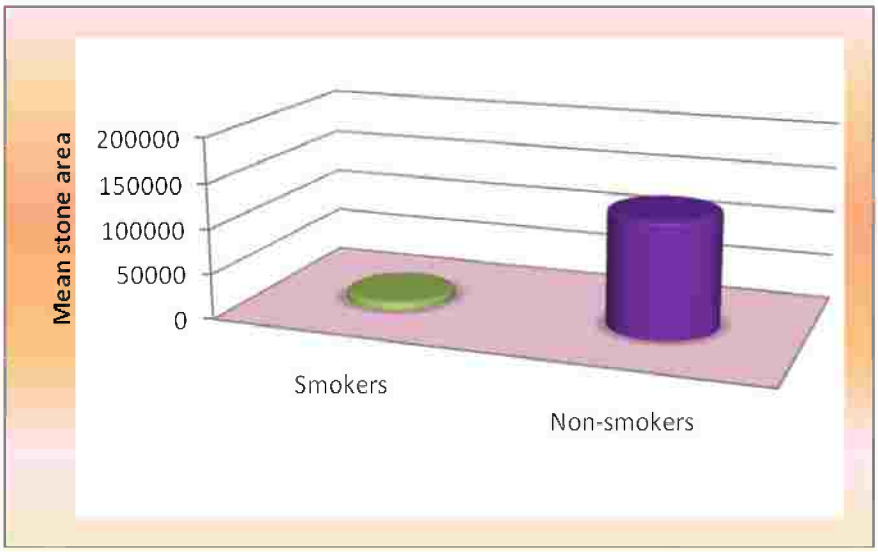
	Smokers	*Non-smokers*	*P-value*
Stone area Mean ± SD	9484.2 ± 9848.3	128627.8 ± 133565	0.012*

*: *Significant at P ≤ 0.05*

Table (14): Descriptive statistics and results of Mann-Whiteny U test for the comparison between stone areas in subjects with and without bruxism

	Bruxism	*No bruxism*	*P-value*
Stone area Mean ± SD	84609.5	85372.2 ± 126254.3	0.727

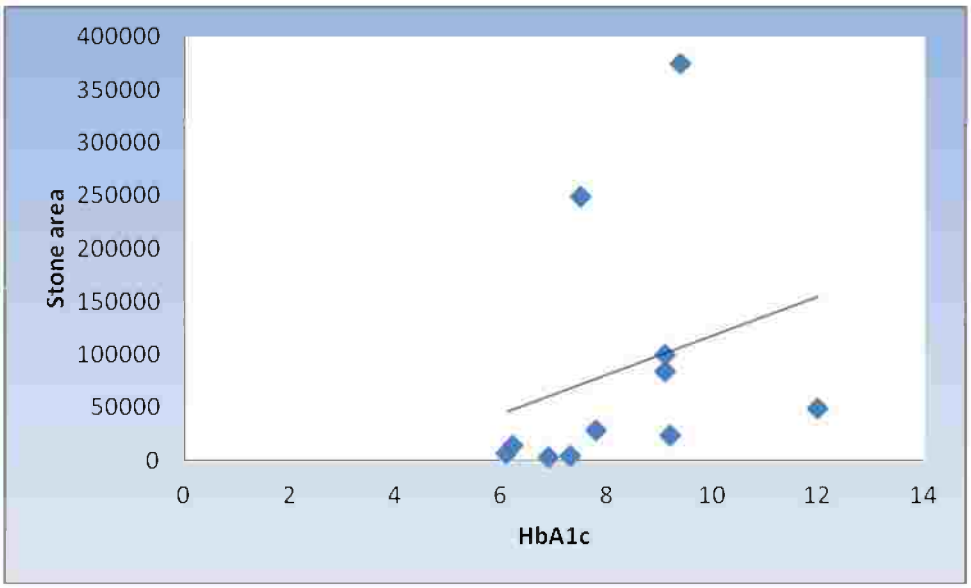
Significant at P ≤ 0.05



Graph (18): Bar chart representing mean stone areas in smokers and non-smokers

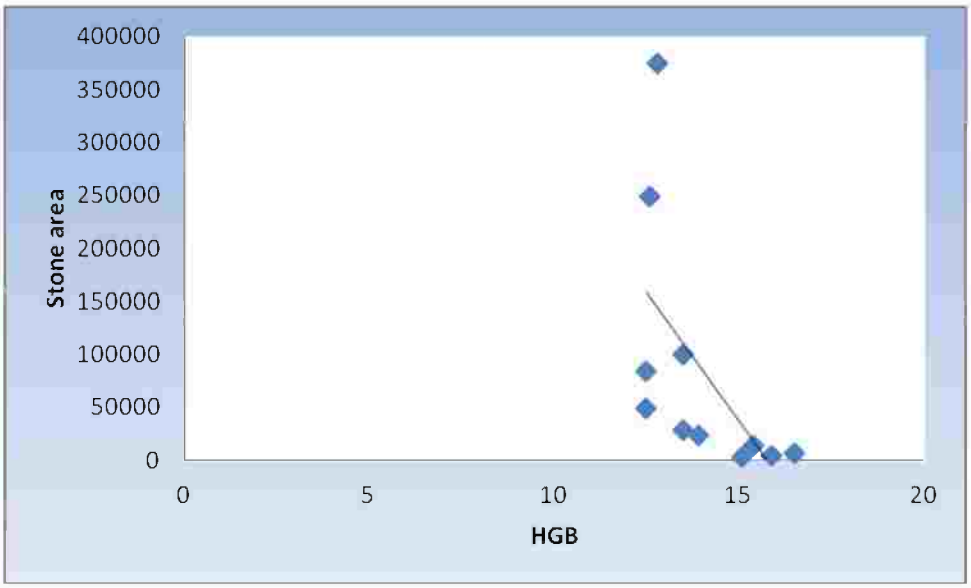
iii. Laboratory investigations:

There was a statistically significant positive (direct) correlation between stone areas and HbA1c i.e. an increase in HbA1c is associated with an increase in stone areas as shown in graph (19) and table (15).



Graph (19): Scatter diagram representing positive correlation between stone areas and HbA1c

There was a statistically significant negative (inverse) correlation between stone areas and HGB i.e. an increase in HGB is associated with a decrease in stone areas as shown in graph (20) and table (15).



Graph (20): Scatter diagram representing negative correlation between stone areas and HGB

Relation between ionized calcium in blood and calcifications and stones:

Ionized calcium test was made for all patients. Sixty percent (60%) of diabetic group range in a normal values (1.1-1.3 m mol/L). Forty percent (40%) of specimens were having low values (0.7-0.99 m mol/L). But there is no significant relation between ionized calcium values and degree of dental pulp calcification or stone formation. Ionized calcium has no relation neither existence nor size of stones as shown in table (15).

Relation between alkaline phosphatase in blood and calcifications and stones:

Alkaline phosphatase test was made for all patients. All patients have normal alkaline phosphatase values except 6 patients who are having high values (>135U/L), these patients are representing 13.3% of

diabetic group. Statistically there is no significant relation between alkaline phosphatase and degree of pulp calcification or stone formation as shown in table (15).

All patients had normal values of WBCs, RBCs, PLT, PTT and INR. There was no statistically significant correlation between stone areas and these laboratory investigations as shown in table (15).

Table (15): Results of Spearman's correlation coefficient for the correlation between stone area and different laboratory investigations

	Correlation coefficient	***P-value***
Stone area and Glycated hemoglobin HbA1c	0.651	0.030*
Stone area and Hemoglobin HGB	-0.776	0.005*
Stone area and Ionized Calcium	-0.105	0.759
Stone area and Alkaline phosphatase ALP	0.018	0.958
Stone area and Fasting Blood Glucose	0.469	0.145
Stone area and White blood cells WBC	-0.456	0.159
Stone area and Red blood cells RBC	-0.600	0.051
Stone area and Platelets PLT	0.136	0.689
Stone area and prothrombin time PTT	0.087	0.800
Stone area and INR	-0.200	0.555

**: Significant at $P \leq 0.05$*