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Study of trace elements like zinc & magnesium in the uncomplicated and complicated cases of type 2 diabetes mellitus

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Abstract
Background: Hyperglycemia, the characteristic feature of diabetes, appears to damage tissue by causing both acute irreversible changes in cellular metabolism and cumulative, irreversible alterations in the stable macromolecules such as extracellular matrix components and nucleic acids.
Objectives: The objectives of the study is to estimate the level of Trace Elements like Zinc & Magnesium in the Uncomplicated and Complicated cases of Type 2 Diabetes Mellitus**.**
Materials and Methods: The work encloses clinical study on Type 2 Diabetes Mellitus. It is broadly categorized into two parts. The first part comprises of Control group study conducted on 100 healthy control subjects. The second part comprises of Clinical Study, further subdivided into two groups. The first group (Group 1) comprises of 100 newly diagnosed or Uncomplicated Type 2 Diabetic cases and the second group (Group 2) comprises of 100 Complicated (Micro vascular or Macro vascular) Type 2 Diabetic cases. Patients and controls were selected from the outdoor and indoor area of Endocrinology and Medicine Department of M.B. Hospital, R.N.T. Medical College, Udaipur. Subjects of both Group I and II along with control group were analyzed for serum Magnesium, S.Zinc, FBS, PPBS, HbA_1C, Lipid Profile and Kidney Function Test. After assessing all the values, Mean and standard deviation of all subjects and parameters are analyzed. Statistical analysis is performed with SPSS software. Comparison of categorical variables (among category comparison) is done using Chi-Square Test. Comparison between cases and control is done by independent student's t test. By using t value P value is calculated. P value less than 0.05 ($P<0.05$) is considered significant.
Results: Type 2 Diabetic cases (Uncomplicated and Complicated) when compared to Control reflected low significance for Zinc and Magnesium, poor glycemic control, elevated lipid parameters, deranged kidney functions. Males and Females appears to share equal risk of Type 2 DM and its vascular complications picturing the unbigoted nature of the disease. Type 2 DM also attenuates the protective effect of the female sex in the development of cardiac diseases.
Conclusion: Our study clearly indicates significant decline in Zinc and Magnesium levels in Type 2 Diabetes and its associated complications. Faulty lifestyle, altered food habits & diminished physical activity culpable for obesity aggravates the pre-existing insulin resistance state. Therefore timely assessing of various minerals at the start and even before the onset of diabetes will be certainly supportive in diabetes management. Towering figure of this epidemic demands varied biochemical approach along with conventional glucose monitoring goals. Hence, our study strongly advocates the regular assessment of Minerals for beforehand diagnosis of the diabetes and its vascular adversities.

Keywords: vitamin d, dm, minerals, magnesium, phosphorus

Introduction

The antioxidant role of Zinc in Type 2 DM, refers to its ability to compete with iron and copper for binding site on cell membrane. The iron and copper ions can catalyze the production of lipid peroxides and the replacement of these metals in the plasma membrane could prevent lipid peroxidation in diabetic patients [1]. Zinc has insulin-"mimetic" and anti-diuretic effects in cells of Type 1 and Type 2 diabetic individuals. The molecular mechanism responsible for the insulin mimetic effects of zinc includes the activation of several key signaling molecules of the insulin signaling pathway as the extracellular signal regulated kinase-½ (ERK-1/2) and phosphatidylinositol-3 kinase (PI3-K)/protein kinase B/Akt (PKB/Akt) pathways [2]. Moreover, disturbances of Zinc homeostasis are associated with several disease states including diabetes, liver cirrhosis, cancer and impaired function of the immune system.

Type 2 Diabetes accounts for approximately 90% to 95% of all diagnosed cases of diabetes. In addition to hyperosmolar coma and ketoacidosis, patients with Type 2 DM may have cardiovascular disease, retinopathy, nehropathy and polyneuropathy [3]. The treatment of diabetic patients require a multi-disciplinary approach whereby every potential complicating factor must be monitored closely and treated. Low serum Magnesium (Mg) have been reported in individuals with poor glycemic control, coronary artery disease, hypertension, diabetic retinopathy, nephropathy and neuropathy [4]. Many studies have observed that hypomagnesemia may induce altered glucose transport, reduced pancreatic insulin secretion, defective post receptor insulin signaling and or altered insulin-insulin interactions. Hypomagnesemia is of clinical importance because the Mg^{+2} is a crucial co- factor in more than 300 enzymatic reactions involving energy metabolism and protein and nucleic acid synthesis.

Material and methodology

The work encloses clinical study on Type 2 Diabetes Mellitus. It is broadly categorized into two parts.

The first part comprises of Control group study conducted on 100 healthy control subjects. The second part comprises of Clinical Study, further subdivided into two groups. The first group (Group 1) comprises of 100 newly diagnosed or Uncomplicated Type 2 Diabetic cases and the second group (Group 2) comprises of 100 Complicated (Micro vascular or Macro vascular) Type 2 Diabetic cases. Patients and controls were selected from the outdoor and indoor area of Endocrinology and Medicine Department of M.B. Hospital, R.N.T. Medical College, Udaipur.

Subjects of both Group I and II along with control group were analyzed for serum Magnesium, S.Zinc, FBS, PPBS, HbA_1C, Lipid Profile and Renal Function Test.

Exclusion criteria

Cancer, Renal Osteodystrophy patients**,** Patients having anemia of any cause, serious infections, chronic liver disease or on corticosteroid therapy. Patients receiving medications that affect vitamin D metabolism/ absorption (phenytoin, rifampin, isoniazid, ketocanazole). Patients receiving vitamin D and Calcium supplementation 10 ml of blood from the Control group and Clinical group was drawn from an antecubital vein and collected in plain vial. Serum was separated by centrifugation of blood sample and following parameters were estimated in both Control and Clinical study group.

1. **Zinc:** Done by colorimetric Nitro-PAPS method

2. **Magnesium-Done by:** Colorimetric endpoint method on Cobas 6000 autoanalyzer

3. **Blood sugar:** hexokinase-glucose-6 phosphate dehydrogenase method on Siemens Dimension R_xL Clinical Chemistry System

4. **HbA1C:** HbA_1C values are taken from the patient medical record.

5. **Lipid profile:** S. cholesterol: enzymatic method on Siemens Dimension R_xL Clinical Chemistry System -S. Triglyceride: enzymatic method on Siemens Dimension R_xL Clinical Chemistry System-S.HDL: enzymatic method on Siemens Dimension R_xL Clinical Chemistry System-S.LDL: enzymatic method on Siemens Dimension R_xL Clinical Chemistry System -S.VLDL: The value of VLDL-cholesterol is calculated by friedwald's formula. VLDL-cholesterol = Triglyceride/5

6. **Renal function test:** S.Creatinine: Modified kinetic Jaffe's method on Siemens Dimension R_xL Clinical Chemistry System-B.Urea IFCC: urease/glumate dehydrogenase coupled enzymatic technique on Siemens Dimension R_xL Clinical Chemistry System-S. Uric Acid: Modified Uricase method on Siemens Dimension R_xL Clinical Chemistry System. BMI, Waist circumference (WC), Waist -Hip ratio (W/HR) is measured as per WHO guidelines (WHO, 2014).

Statistical Analysis

After assessing all the values, Mean and standard deviation of all subjects and parameters are analyzed. Statistical analysis is performed with SPSS software. Comparison of categorical variables (among category comparison) is done using Chi-Square Test.

Comparison between cases and control is done by independent student's t test. By using t value P value is calculated. P value less than 0.05 ($P<0.05$) is considered significant.

Multiple comparisons are done by Post Hoc Analysis of Variance (ANOVA) and Least Significant Difference (LSD) is calculated using Fisher's LSD Method. Using LSD, t and P values are calculated.

Results and Discussion

Table 1: Age wise distribution of participants

					Group		
						Complicated	
					Uncomplicated	Type 2	
					Type 2	Diabetes	
				Controls	Diabetes Cases	Cases	Total
Age (years)	30-45	Count		73	26	5	104
		% within Group		73.0%	26.0%	5.0%	34.7%
	46-60	Count		16	41	40	97
		% within Group		16.0%	41.0%	40.0%	32.3%
	61-80	Count		11	33	55	99
		% within Group		11.0%	33.0%	55.0%	33.0%
Total		Count			100	100	100 300
		% within Group			100.0%	100.0%	100.0% 100.0%
			Value	df	P		
Pearson Chi-Square			1.117	4	0.000		

Table 1 presents the comparison of age group which is divided into three sub group; 30-45 years, 46-60 years and 61-80 years showed valid percentage of 73.0%, 16.0% and 11.0% respectively in Controls, 26.0%, 41.0% and 33.0%

respectively in Uncomplicated Type2.
Diabetes Cases and 5.0%, 40.0% and 55.0% respectively in Complicated Type2.

Diabetes Cases. The value obtained from Pearson Chi-Square test is 1.117 which is statistically significant (P<0.000).

Table 2: sex wise distribution of participants

						Group		
							Complicated	
						Uncomplicated	**Type 2**	
						Type 2 Diabetes	**Diabetes**	
					Controls	Cases	Cases	Total
Sex	Male	Count			64	40	53	157
		% within Group			64.0%	40.0%	53.0%	52.3%
	Female	Count			36	60	47	143
		% within Group			36.0%	60.0%	47.0%	47.7%
Total		Count			100	100	100	300
		% within Group			100.0%	100.0%	100.0%	100.0%
		Value	df	P				
Pearson Chi-Square			11.572	2	0.003			

Table 2 represents the Sex group (Male & Female) comparison of Cases and Controls with valid percentage of 64.0% and 36.0% respectively in Controls, 40.0% and 60.0%.

Respectively in Uncomplicated Type2 Diabetes Cases and 53.0% and 47.0% respectively in Complicated Type2 Diabetes Cases. Chi-Square test yielded a statistically significant value of 11.572 (P<0.003).

Table 3: comparison of BMI between case and control

				Group		
					Complicated	
				Uncomplicated	**Type 2**	
				Type 2 Diabetes	**Diabetes**	
			Controls	**Cases**	**Cases**	**Total**
BMI	Normal	Count	67	35	61	163
		% within Group	67.0%	35.0%	61.0%	54.3%
	Over-	Count	24	41	33	98
	weight					
		% within Group	24.0%	41.0%	33.0%	32.7%
	Obese	Count	9	24	6	39
		% within Group	9.0%	24.0%	6.0%	13.0%
Total		Count		100	100 100	300
		% within Group		100.0%	100.0% 100.0%	100.0%
		Value	df	P	s	
Pearson Chi-Square		29.387	4	0.000		

Table 3 represents comparison of BMI groups categorized into Normal, Overweight and Obese with valid percentage of 67.0%, 24.0% and 9.0% respectively in Controls, 35.0%, 41.0%.

and 24.0% respectively in Uncomplicated Type2 Diabetes Cases and 61.0%, 33.0% and 6.0% respectively in Complicated Type2 Diabetes Cases. Chi-Square value obtaisned is 29.387 with a significant P value (P<0.000).

Table 4: Statistical Evaluation of Vitamin D, Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters among Uncomplicated Type 2 Diabetes cases (Intra group) for the Disease Duration (Years)

	0-1 Vs >1-5		**0-1 Vs >5-10**		**0-1 Vs >10+**		**>1-5 Vs**		**>1-5 Vs**			**>5-10 Vs**
Parameters							**>5-10**		**>10+**		**>10+**	
Vitamin D (ng/ml)	**t**	**signi**	**t**	**signi**	**t**	**signi**	**t**	**signi**	**t**	**signi**	**t**	**signi**
	2.20	0.05	1.99	0.05	2.33	0.05	5.20	0.05	2.88	0.05	1.89	0.05
Calcium (mg/dl)	2.56	0.05	3.23	0.05	5.12	0.01	2.32	0.05	2.43	0.05	1.11	N.S
Phosphorus (mg/dl)	0.12	N.S	0.18	N.S	0.16	N.S	0.06	N.S	0.04	N.S	0.02	N.S
FBS (mg/dl)	0.81	N.S	5.15	0.01	4.73	0.05	2.33	0.05	1.91	0.05	0.41	N.S
PPBS (mg/dl)	2.20	0.05	6.94	0.01	9.32	0.001	6.74	0.01	8.12	0.005	6.38	0.01

HbA_1C (%)	0.14	N.S	0.60	N.S	1.95	0.001	0.45	N.S	1.89	0.05	1.88	0.05
T.Cholesterol (mg/dl)	0.29	N.S	2.47	0.05	16.75	0.000	1.18	N.S	16.46	0.000	14.28	0.000
Triglycerides (mg/dl)	0.71	N.S	1.33	N.S	2.40	0.05	0.61	N.S	2.33	0.05	2.73	0.05
HDL-C (mg/dl)	0.80	N.S	2.55	0.05	3.40	0.05	0.25	N.S	3.20	0.05	0.95	N.S
LDL-C (mg/dl)	2.83	0.05	3.96	0.05	7.80	0.01	1.79	0.05	6.96	0.01	5.76	0.01
VLDL-C (mg/dl)	0.14	N.S	1.26	N.S	2.68	0.05	1.12	N.S	2.82	N.S	2.94	0.05
SGOT (U/L)	0.57	N.S	0.45	N.S	0.97	N.S	1.02	N.S	1.40	N.S	1.43	N.S
SGPT (U/L)	0.64	N.S	1.38	N.S	1.24	N.S	1.73	N.S	0.88	N.S	0.62	N.S
Alk.Phosphatase (U/L)	0.67	N.S	2.45	0.04	1.51	N.S	1.77	N.S	0.84	N.S	0.21	N.S
Total Protein (g/dl)	1.35	N.S	2.15	0.05	2.47	0.05	3.51	0.05	4.11	0.05	0.62	N.S
Albumin (g/dl)	0.11	N.S	2.07	0.05	2.42	0.05	0.84	N.S	1.88	0.05	0.01	N.S

Table 4 represents the comparison of Duration of Disease divided into 0-1year, >1-5Years, >5-10years and >10+years with valid percentage of 34.0%, 49.0%, 12.0% and 5.0% respectively in Uncomplicated Type2 Diabetes Cases and 13.0%, 35.0%, 26.0% and 26.0% respectively in Complicated Type2 Diabetes Cases. Chi- square value obtained in total 200 subjects is 3.467 and a statistically significant P value (P<0.000).

Table 5: Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters in Uncomplicated Type 2 Diabetes Cases; According to Gender and Inhabitance

Parameters	Total Cases		Gender				Inhabitance			
	Total (N=100)		Male (N=40)		Female (N=60)		Urban (N=33)		Rural (N=67)	
	Mean	±S.D.	Mean	±S.D	Mean	±S.D.	Mean	±S.D	Mean	±S.D
Zinc (µg/dl)	84.05	11.27	87.59	10.36	80.35	8.45	83.69	16.49	80.78	10.38
Magnesium (mg/dl)	1.80	0.10	1.85	0.10	1.90	0.11	1.78	0.29	1.81	0.16
Calcium (mg/dl)	9.75	1.93	8.81	1.13	8.04	0.19	9.76	0.63	8.61	0.19
FBS (mg/dl)	157.89	38.69	155.10	22.42	159.75	36.64	155.37	33.91	163.00	28.30
PPBS (mg/dl)	201.53	54.69	188.50	43.88	210.22	44.58	199.37	23.11	205.91	38.78
HbA_1C (%)	7.24	1.20	7.13	1.17	7.32	1.23	7.22	1.13	7.29	1.36
T.Cholesterol (mg/dl)	186.96	55.32	180.15	48.93	161.50	36.66	174.84	45.70	211.58	151.23
Triglycerides (mg/dl)	134.06	67.92	135.02	66.24	133.42	69.63	129.57	60.70	143.18	81.00
HDL-C (mg/dl)	44.39	5.92	44.36	8.55	44.42	10.57	45.01	11.61	43.13	9.39
LDL-C (mg/dl)	107.90	33.07	112.32	27.98	104.95	35.99	109.49	31.23	104.67	36.82
VLDL-C (mg/dl)	26.81	13.59	27.00	13.24	26.68	13.92	25.91	12.14	28.63	16.20
Urea (mg/dl)	28.01	10.32	29.58	11.51	26.97	9.41	26.86	10.72	30.37	9.16
Creatinine (mg/dl)	1.58	0.30	1.12	0.44	0.92	0.32	1.804	0.03	0.98	0.37
Uric acid (mg/dl)	5.37	1.82	6.02	1.10	4.93	1.74	4.66	1.26	6.80	1.10

Table 6: Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters in Uncomplicated Type 2 Diabetes Cases; According to Religion and Tribal Vs Non-Tribal

Parameters	Religion						Tribal Vs Non-Tribal			
	Hindu (N=77)		Muslim (N=16)		Christian (N=7)		Tribal (N=52)		Non-Tribal (N=48)	
	Mean	± S.D.	Mean	±S.D	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Zinc (µg/dl)	78.71	6.71	89.62	9.64	75.15	4.52	80.73	6.52	86.22	6.73
Magnesium (mg/dl)	1.90	0.66	1.91	0.40	1.83	0.22	1.79	0.45	1.99	0.20
Calcium (mg/dl)	9.16	1.08	8.50	0.96	9.11	0.26	8.49	0.56	9.70	0.32
FBS (mg/dl)	151.09	24.02	156.62	22.78	139.86	29.82	172.58	74.20	141.98	58.87
PPBS (mg/dl)	195.23	39.61	218.50	17.14	232.00	16.61	219.37	77.69	182.21	66.85
HbA_1C (%)	7.13	1.09	7.55	1.59	7.81	1.37	7.48	1.29	6.99	1.05
T.Cholesterol (mg/dl)	188.48	56.62	179.69	47.45	186.86	11.00	193.60	83.50	179.77	49.86
Triglycerides (mg/dl)	137.68	53.74	148.44	42.57	130.00	44.13	129.79	72.38	138.69	63.26
HDL-C (mg/dl)	40.66	7.20	39.19	8.86	34.22	4.56	37.32	10.46	46.65	11.06
LDL-C (mg/dl)	137.03	34.82	109.25	27.60	144.43	26.80	103.88	33.12	112.25	32.81
VLDL-C (mg/dl)	27.53	14.74	23.68	8.51	26.00	8.82	25.95	14.47	27.73	12.65
Urea (mg/dl)	27.23	8.70	28.72	8.19	35.07	13.76	28.34	8.59	27.66	12.01
Creatinine (mg/dl)	0.94	0.27	1.70	0.74	1.24	0.73	1.30	0.06	1.01	0.35
Uric acid(mg/dl)	5.39	2.47	5.15	1.19	5.64	1.26	5.83	3.58	4.87	1.24

Table 7: Statistical Evaluation of Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters among Control Vs Uncomplicated Type 2 Diabetes cases for Religion and Tribal Vs Non-Tribal

Parameters	Religion						Tribal Vs Non-Tribal			
	Hindu		Muslim		Christian		Tribal		Non-Tribal	
	t	signi	t	signi	t	signi	t	signi	t	signi
Zinc (µg/dl)	0.12	N.S	4.34	0.001	0.35	N.S	4.36	0.000	3.88	0.00
Magnesium (mg/dl)	1.14	N.S	0.63	N.S	2.20	0.05	1.99	0.05	0.94	N.S
FBS (mg/dl)	41.88	0.000	44.06	0.005	43.21	0.00	23.59	0.000	19.98	0.000
PPBS (mg/dl)	66.65	0.000	63.74	0.005	53.95	0.005	44.11	0.000	29.50	0.000
HbA_1C (%)	153.04	0.000	148.67	0.001	145.41	0.005	101.39	0.000	67.71	0.000
T.Cholesterol (mg/dl)	1.54	N.S	0.33	N.S	1.62	N.S	2.44	0.05	0.28	N.S
Triglycerides (mg/dl)	2.73	0.05	2.05	0.05	0.38	N.S	1.02	N.S	0.90	N.S
HDL-C (mg/dl)	0.94	N.S	0.10	N.S	2.50	0.05	1.97	0.05	0.20	N.S
LDL-C (mg/dl)	3.43	0.05	0.34	N.S	1.13	N.S	1.83	N.S	1.29	N.S
VLDL-C (mg/dl)	2.73	0.05	2.05	0.05	0.38	N.S	1.02	N.S	0.90	N.S
Urea (mg/dl)	1.70	N.S	1.81	N.S	0.53	N.S	1.17	N.S	2.67	0.010
Creatinine (mg/dl)	1.59	N.S	0.47	N.S	0.15	N.S	0.90	N.S	1.02	N.S
Uric acid(mg/dl)	1.24	N.S	0.22	N.S	0.27	N.S	2.15	0.05	1.14	N.S

Table 8: Statistical Evaluation of Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters among Control Vs Uncomplicated Type 2 Diabetes cases for Socioeconomic Status and Family History

Parameters	Socioeconomic Status						Family History			
	Lower		Middle		Upper Middle		Yes		No	
	t	signi	t	signi	t	signi	t	signi	t	signi
Zinc (µg/dl)	5.98	0.005	0.67	N.S	0.79	N.S	1.25	N.S	1.49	N.S
Magnesium (mg/dl)	1.39	N.S	2.52	0.05	0.29	N.S	1.60	N.S	0.73	N.S
FBS (mg/dl)	4.64	0.01	30.39	0.000	10.35	0.000	6.43	0.001	32.38	0.000
PPBS (mg/dl)	8.95	0.000	45.99	0.000	12.82	0.000	7.63	0.001	62.71	0.000
HbA_1C (%)	24.26	0.000	109.39	0.000	27.19	0.000	20.78	0.001	141.93	0.000
T.Cholesterol (mg/dl)	0.02	N.S	1.62	N.S	0.93	N.S	1.12	N.S	0.76	N.S
Triglycerides (mg/dl)	0.82	N.S	1.69	N.S	0.79	N.S	2.77	0.05	1.34	N.S
HDL-C (mg/dl)	1.43	N.S	0.18	N.S	0.05	N.S	0.80	N.S	1.57	N.S
LDL-C (mg/dl)	3.22	0.05	3.03	0.05	2.92	0.05	0.26	N.S	1.95	0.005
VLDL-C (mg/dl)	0.82	N.S	1.69	N.S	0.79	N.S	2.77	0.05	1.34	N.S
Urea (mg/dl)	0.91	N.S	2.74	0.000	3.31	0.05	8.52	0.000	13.49	0.000
Creatinine (mg/dl)	0.70	N.S	0.83	N.S	0.27	N.S	3.54	0.05	0.83	N.S
Uric acid(mg/dl)	2.30	0.05	1.20	N.S	0.88	N.S	1.50	N.S	2.66	0.05

Table 9: Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters in Uncomplicated Type 2 Diabetes cases; According to Exercise Habits

Parameters	Exercise Habits					
	No Exercise (N=36)		Light (N=50)		Moderate (N=14)	
	Mean	±S.D	Mean	±S.D	Mean	±S.D
Zinc (µg/dl)	81.53	9.28	91.84	10.60	87.22	13.98
Magnesium (mg/dl)	2.00	0.37	1.99	0.10	1.90	0.31
FBS (mg/dl)	166.03	76.01	151.54	61.69	165.46	75.17
PPBS (mg/dl)	206.50	79.32	202.48	76.17	189.77	57.53
HbA_1C (%)	7.32	1.24	7.32	1.24	7.54	1.03
T.Cholesterol (mg/dl)	173.56	58.61	179.12	40.77	148.23	29.74
Triglycerides (mg/dl)	136.50	72.99	130.92	63.93	131.23	69.78
HDL-C (mg/dl)	42.39	11.15	45.59	11.06	46.02	9.70
LDL-C (mg/dl)	106.72	34.06	107.12	31.51	112.62	39.02
VLDL-C (mg/dl)	27.30	14.59	26.18	12.78	26.24	13.95
Urea (mg/dl)	28.57	9.24	27.49	11.48	28.49	9.49
Creatinine (mg/dl)	0.96	0.38	1.43	0.40	1.00	0.19
Uric acid(mg/dl)	5.80	3.53	5.22	3.98	4.70	1.39

Table 10: Statistical Evaluation of Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters among Uncomplicated Type 2 Diabetes cases (Intra group) for Exercise Habits

Parameters	Light Vs No Exercise		Light Vs Moderate		Moderate	Vs No Exercise
	t	signi	t	signi	t	signi
Zinc (µg/dl)	4.77	0.05	1.39	N.S	2.61	0.05
Magnesium (mg/dl)	0.96	N.S	0.81	N.S	1.11	N.S
FBS (mg/dl)	1.67	N.S	1.74	N.S	0.24	N.S
PPBS (mg/dl)	0.78	N.S	1.92	0.05	2.10	0.05
HbA_1C (%)	0.07	N.S	0.21	N.S	0.62	N.S

T.Cholesterol (mg/dl)	0.62	N.S	2.81	0.05	2.67	0.05
Triglycerides (mg/dl)	0.74	N.S	0.08	N.S	0.69	N.S
HDL-C (mg/dl)	1.12	N.S	0.74	N.S	1.66	N.S
LDL-C (mg/dl)	0.32	N.S	0.59	N.S	1.10	N.S
VLDL-C (mg/dl)	0.74	N.S	0.08	N.S	0.69	N.S
Urea (mg/dl)	0.21	N.S	1.10	N.S	0.04	N.S
Creatinine (mg/dl)	1.31	N.S	0.24	N.S	0.66	N.S
Uric acid (mg/dl)	2.78	0.05	1.16	N.S	3.34	0.05

Table 11: Vitamin D, Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters in Complicated Type 2 Diabetes Cases; According to Religion and Tribal Vs Non-Tribal

Parameters	Religion						Tribal Vs Non-Tribal			
	Hindu (N=80)		Muslim (N=16)		Christian (N=4)		Tribal (N=50)		Non-Tribal (N=50)	
	Mean	± S.D.	Mean	±S.D	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Zinc (µg/dl)	72.33	7.52	94.89	4.97	73.63	5.91	76.58	6.21	81.11	5.58
Magnesium (mg/dl)	1.56	0.11	1.96	0.53	1.70	0.20	1.92	0.31	1.93	0.14
FBS (mg/dl)	181.68	82.35	135.45	50.83	180.33	35.50	182.22	86.55	167.30	69.47
PPBS (mg/dl)	214.89	72.32	192.31	61.90	212.67	48.05	225.16	75.57	197.90	61.45
HbA_1C (%)	7.82	1.25	7.51	1.03	7.70	0.62	7.99	1.15	7.55	1.00
T.Cholesterol (mg/dl)	200.72	53.14	185.06	70.48	210.00	55.50	199.16	53.21	198.02	58.34
Triglycerides (mg/dl)	165.44	50.72	167.31	89.11	156.00	51.79	164.10	73.78	150.40	71.46
HDL-C (mg/dl)	34.48	7.58	34.62	6.19	41.30	8.23	32.85	8.89	35.97	7.37
LDL-C (mg/dl)	140.80	38.78	125.31	32.50	158.33	40.43	151.00	39.13	128.06	38.83
VLDL-C (mg/dl)	33.08	10.14	33.46	17.82	31.20	10.35	32.82	14.75	30.08	14.29
Urea (mg/dl)	35.19	16.67	41.86	13.13	28.67	10.50	34.60	15.59	38.26	24.08
Creatinine (mg/dl)	1.63	1.25	2.45	1.86	2.02	0.16	1.19	0.49	2.31	0.35
Uric acid(mg/dl)	7.98	2.92	8.38	1.40	5.40	1.55	7.24	2.05	6.55	1.78

Table 12: Statistical Evaluation of Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters among Complicated Type 2 Diabetes cases (Intra group) for Gender, Inhabitance and Religion

Parameters	Male Vs Female		Urban Vs Rural		Hindu Vs Muslim		Hindu Vs Christian		Muslim Vs Christian	
	t	signi	t	signi	t	signi	t	signi	t	signi
Zinc (µg/dl)	1.91	0.05	3.19	0.05	3.33	0.05	0.76	N.S	3.72	0.05
Magnesium (mg/dl)	1.03	N.S	1.91	0.05	1.77	N.S	1.00	N.S	0.89	N.S
FBS (mg/dl)	0.54	N.S	1.48	N.S	4.78	0.05	0.72	N.S	4.74	0.05
PPBS (mg/dl)	0.35	N.S	1.57	N.S	3.54	0.05	0.61	N.S	1.01	N.S
HbA_1C (%)	0.42	N.S	1.74	N.S	0.31	N.S	0.54	N.S	0.36	N.S
T.Cholesterol (mg/dl)	1.93	0.05	0.45	N.S	1.40	N.S	0.29	N.S	2.10	0.05
Triglycerides (mg/dl)	1.96	0.05	0.18	N.S	0.12	N.S	1.00	N.S	0.94	N.S
HDL-C (mg/dl)	2.10	0.05	2.50	0.010	0.09	N.S	0.74	N.S	0.81	N.S
LDL-C (mg/dl)	3.00	0.05	0.25	N.S	2.29	0.05	1.91	0.05	2.67	0.05
VLDL-C (mg/dl)	1.96	0.05	0.18	N.S	0.12	N.S	0.78	N.S	0.78	N.S
Urea (mg/dl)	0.08	N.S	0.46	N.S	1.69	N.S	2.55	0.05	2.19	0.05
Creatinine (mg/dl)	0.84	N.S	0.91	N.S	2.36	0.05	0.75	N.S	1.89	0.05
Uric acid (mg/dl)	1.46	N.S	1.44	N.S	0.23	N.S	3.41	0.05	4.49	0.05

Table 13: Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters in Complicated Type 2 Diabetes cases; According to Waist Circumference Categories

Parameters	Waist Circumference Categories					
	Normal (N=69)		Overweight (N=24)		Obese (N=7)	
	Mean	±S.D	Mean	±S.D	Mean	±S.D
Vitamin D (ng/ml)	19.36	5.14	15.96	4.79	10.18	4.30
Zinc (µg/dl)	81.45	7.49	79.02	64.14	70.42	4.92
Magnesium (mg/dl)	1.52	0.37	1.32	0.20	1.24	0.20
Calcium (mg/dl)	8.47	0.57	8.89	0.12	8.42	0.13
Phosphorus (mg/dl)	2.26	0.28	2.82	0.56	2.37	0.47
FBS (mg/dl)	186.15	27.63	186.15	37.63	159.43	26.48
PPBS (mg/dl)	151.87	37.72	188.67	43.01	188.00	32.39
HbA_1C (%)	7.23	0.28	7.45	0.97	7.25	0.48
T.Cholesterol (mg/dl)	206.41	51.55	222.79	56.48	240.74	79.14
Triglycerides (mg/dl)	165.77	34.36	174.54	49.55	191.14	42.08
HDL-C (mg/dl)	33.19	5.28	29.32	4.29	29.57	3.80
LDL-C (mg/dl)	120.41	37.50	135.38	44.97	145.14	32.39
VLDL-C (mg/dl)	33.15	6.87	34.90	9.91	38.22	8.41
Urea (mg/dl)	35.91	7.94	35.19	7.57	45.80	8.83
Creatinine (mg/dl)	1.38	0.86	2.76	1.11	1.93	1.14

Uric acid (mg/dl)	7.10	1.25	7.37	1.79	7.70	1.86
SGOT (U/L)	37.64	16.37	37.88	16.99	42.00	16.12
SGPT (U/L)	45.41	18.36	40.29	21.90	40.50	18.28
Alk.Phosphatase (U/L)	106.83	44.92	107.04	33.52	98.00	29.17
Total Protein (g/dl)	6.64	0.42	5.99	0.75	5.90	0.22
Albumin (g/dl)	3.72	0.66	3.72	0.50	3.00	0.39

Table 14: Mineral Status, Glycemic Status, Lipid Profile and other Biochemical Parameters and their Statistical Evaluation in Complicated Type 2 Diabetes cases; According to Drug History

Parameters	OHA (N=81)		OHA + Insulin Therapy (N=19)		OHA Vs OHA+ Insulin Therapy	
	Mean	±S.D	Mean	±S.D	t	signi
Zinc (µg/dl)	84.863	8.82	71.52	3.46	5.38	0.01
Magnesium (mg/dl)	1.78	0.01	1.20	0.11	4.46	0.05
FBS (mg/dl)	165.81	49.48	242.91	72.43	2.41	0.05
PPBS (mg/dl)	203.47	38.00	245.89	69.02	2.44	0.05
HbA_1C (%)	7.59	1.16	8.51	1.08	3.14	0.05
T.Cholesterol (mg/dl)	196.83	56.56	206.11	51.81	0.65	N.S
Triglycerides (mg/dl)	156.11	73.72	162.11	69.26	0.32	N.S
HDL-C (mg/dl)	34.57	5.70	33.73	4.45	0.31	N.S
LDL-C (mg/dl)	115.96	37.21	154.74	42.79	1.92	0.05
VLDL-C (mg/dl)	31.22	14.74	32.42	13.85	0.32	N.S
Urea (mg/dl)	37.31	21.50	32.67	13.63	0.89	N.S
Creatinine (mg/dl)	1.87	0.47	2.12	0.35	0.81	N.S
Uric acid (mg/dl)	8.80	2.49	9.31	0.37	2.13	0.05

Discussion

Diabetes Mellitus is apparently one of oldest diseases known to man; reported about 3000 years ago in Egyptian manuscript. Type 2 Diabetes Mellitus (Type 2 DM) is a metabolic disorder characterized by the presence of chronic hyperglycemia accompanied by impairment in the metabolism of carbohydrates, lipids and proteins [5].

Type 2 DM with periodontitis can alter serum Zn, Mg, and lipid profile status. Perturbations in Zn and Mg metabolism are more pronounced in periodontitis subjects with DM. Zn metabolism is linked to periodontitis; in periodontitis patients, it is inversely related to triglycerides and Mg, whereas in type 2 DM with periodontitis, it is inversely related to serum glucose, triglycerides, and HDL-c and protects against hyperglycemia and insulin resistance [6]. A direct role of Zn as a prostatic antibacterial factor has been postulated due to its bactericidal activity against a variety of gram-positive and gram-negative bacteria. Increased values observed in total cholesterol, triglycerides, LDL-c, and Zn were related to increased values of metabolic risk factors like blood pressure, serum lipids, and hyperglycemia.

Acute diabetic complications occurring in the early stage of diabetes includes hypoglycemia, diabetic ketoacidosis, hyperosmolar hyperglycemic syndrome. Persisting hyperglycemia sources chronic diabetic complications including micro and macrovascular complications such as peripheral neuropathy, retinopathy, nephropathy, cardiovascular diseases. Diabetic complications are the repercussions of interactions among systemic metabolic changes like hyperglycemia, local tissue response to toxic metabolic and genetic modulations. Heightened insulin resistance, Oxidative stress, β-cell dysfunction actuates various vascular complications rumbling metabolism of numerous biomolecules and minerals as reflected in our study results. Our findings of decline in Vitamin D and various minerals are in concordance with the studies of Sarita Bajaj *et al*,2014, YY Luo *et al*,2015, G Prabhu *et al*, 2015 and Carlos Lorenzo *et al*, 2014 [7, 8, 9, 10]. Who reported inverse correlation of Vitamin D and minerals with the development of micro and macro vascular complications of Type 2 DM. Elevated lipids and lipoproteins are predictive biomarkers of vascular events in diabetes and play a critical role in the pathogenesis of macro and micro vascular complications of the disease. Diabetic dyslipidemia is characterized by quantitative and qualitative lipid abnormalities as reflected in our results and also reported by Arpita Basu *et al*, 2016. (11) Elevated liver enzymes are reported to be linked with hyperglycemia and insulin resistance and hepatic dysfunction. In Indian diabetes, deranged LFT's have been reported at a frequency of 50-70% as documented by Prabhudeva N *et al*, 2014 (12) and also reflected in our findings.

Conclusion

Our study clearly indicates significant decline in Vitamin D, Calcium and Phosphorus levels in Type 2 Diabetes and its associated complications.

Faulty lifestyle, altered food habits & diminished physical activity culpable for obesity aggravates the pre-existing insulin resistance state.

Therefore timely assessing of Vitamin D and various minerals at the start and even before the onset of diabetes will be certainly supportive in diabetes management. Towering figure of this epidemic demands varied biochemical approach along with conventional glucose monitoring goals. Hence, our study strongly advocates the regular assessment of Vitamin D and Minerals for beforehand diagnosis of the diabetes and its vascular adversities.

Authorship

All Authors have done Equal contribution for research work.

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Conflict of Intrest

Nil

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