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Research Article

Nutritional Status Evaluation of Edentulous Patients at Pre- and Post-Insertion of Complete Denture: A Before and After Comparison Groups Study

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Abstract

Aim: To evaluate the nutritional status of edentulous patients before and after insertion of complete denture (CD).

Methods: 30 patients were selected to evaluate change in nutritional status of edentulous patients before insertion and 3, 6 and 12 months after CD through body mass index (BMI) and blood analysis for calcium, protein, cholesterol, high density lipoprotein (HDL) and hemoglobin (Hb). Data were summarized as mean ± SD. Student's t-test, paired t-test, Wilcoxon signed rank statistic and bivariate correlation were used for statistical analysis. Statistical significance was set at $p \leq 0.05$.

Results: Mean blood calcium, protein, cholesterol, HDL, Hb and BMI were 8.23 ± 0.16 mg/dl, 6.87 ± 0.32 g/dl, 147.28 ± 11.40 mg/dl, 37.96 ± 1.19 mg/dl, 12.18 ± 0.44 g/dl and 19.68 ± 2.10 kg/m^2 at baseline; which changed to 8.37 ± 0.27, 8.57 ± 0.35 and 8.95 ± 0.35 mg/dl for calcium; 7.07 ± 0.35, 7.32 ± 0.39 and 7.60 ± 0.57 g/dl for protein; 150.99 ± 9.72, 158.18 ± 9.63 and 165.96 ± 9.74 mg/dl for cholesterol; 38.71 ± 1.26, 40.03 ± 1.22 and 41.45 ± 1.22 mg/dl for HDL; 12.31 ± 0.48, 12.70 ± 0.53 and 12.99 ± 0.61 g/dl for Hb; and 19.98 ± 2.11, 20.39 ± 2.07 and 20.97 ± 2.09 kg/m^2 for BMI; at 3, 6 and 12 months post-rehabilitation respectively. The change in calcium, protein, cholesterol, HDL, Hb and BMI were statistically significant ($p < 0.001$).

Except for mild correlation between Hb and calcium and moderate correlation between calcium and protein, all other nutrients showed weak or statistically non-significant correlation.

Conclusion: All nutrients were found below normal range in edentulous patients suggesting that loss of teeth has definite impact on their blood levels. There was significant improvement in all parameters when rehabilitated with CD suggesting that rehabilitation with CD may lead to increasing all parameters.

Keywords: *Diet; Elderly People; Food; Nutrients; Prosthetic Rehabilitation*

Introduction

Improving health by restoring oral function is one of the goals in rehabilitating edentulous patients. Denture wearers have lower masticatory performance compared to the dentate subjects. Decreased masticatory performance may restrict the selection of food which is difficult to chew [1].

The old age patients require more demand of health care. Old people have more chances of attached by disease because they become weak and careless about self careness [2]. During last decades, research and interest related to public are on top which are associated with nutrition for maintenance, management, treatment and rehabilitation of old aged people health, conditions, illness and functional limitations [2-5]. Health promotional approaches for old aged population are healthy eating and exercise. Lack of healthy eating led to loss of muscle mass, loss of function; and initiation and progression of disease in old persons [6]. The factors which influenced nutritional status are medical, dental, psychological and social well-being. Motivation to healthy nutrition and exercise is costly for decreasing initiation and progression of old age related disease [4,7]. In old age, proper/healthy nutrition maintain health, physical activity, psychological and social well-being [8-10].

It has been studied that individuals who have had partial or complete loss of natural teeth have poor masticatory function when compared to individuals who have a complete healthy natural dentition. This does not allow old age people to eat various types of food which results into hamperness of nutritional status. The extent to which the dental status is associated with the intake of nutritious foods has been little studied despite the edentulous reporting chewing problems [11-15].

Aim of the Study

This study aimed to evaluate the effect of edentulousness and prosthetic rehabilitation on the nutritional status of patients, to determine whether loss of teeth was associated with reduced levels of blood calcium, protein, cholesterol, HDL, Hb and BMI status and whether the rehabilitation with CD lead to an improvement in the blood calcium, protein, cholesterol, HDL, Hb and BMI status.

Materials and Methods

30 patients were selected from the outdoor patient department of Prosthodontics, Chandra Dental College and Hospital, Barabanki, Uttar Pradesh, India after a proper clinical examination and diagnosis. Inform consent was taken from all patients. Criteria for selection were that patients should completely edentulous, free from any local, systemic or debilitating disease and not under any medication; first time denture wearers; and belonged to the same socio economic-condition.

Equipment used for analysis were ESR vial (Ajosha Bio Teknik Pvt. Ltd, Mumbai, Maharastra, India) for collection of blood sample for Hb estimation (Figure 1), Plain vial (Ajosha Bio Teknik Pvt. Ltd, Mumbai, Maharastra, India) for collection of blood sample for calcium, protein, cholesterol and HDL estimation (Figure 2), VITROS 250 machine (Przezmierowo, Poland) for estimation of blood calcium and protein (Figure 3), Photoelectric colorimeter (CLONE BIO SYSTEM PVT LTD, India) for estimation of blood Hb (Figure 4).

Figure 1: *ESR vial.*

Figure 2: *Plain vial.*

Figure 3: *VITROS 250 machine.*

Figure 4: *Colourimeter.*

Spectrophotometry is the method for measurement of reflection density of colored complex after incubation period. The calcium concentration in the sample is proportional to the amount of colored complex formed.

Methodology

BMI evaluated by the formula: BMI= (Body weight/ Body height x Body height) x 10000 kg/cm^2.

Biochemical analyses for blood calcium, protein, cholesterol, HDL; and hematological investigation for blood Hb levels were carried out before insertion and after 3, 6 and 12 months insertion of CD.

Measurement of serum calcium

The method used for measurement of serum calcium is the VITROS Ca slide method which is done with the help of vitros Ca slides and the vitros chemistry products calibrator kit 1 on vitros chemistry systems.

One drop of the patient sample is placed on the slide and is equally distributed by the spreading layer by layers. The calcium which is bound to protein, become separated and penetrated into the reagent layer. There is shift in the absorption maximum because arsenazo 3 dye forms a complex with calcium. Reagent (reactive ingredients per cm^2) used was arsenazo 3 dye 60 microgram; and other ingredients were pigment, binders, surfactants, buffer, cross linking agent and mordant.

Test type and conditions

Test type	VITROS system	Approx incubation time	Temperature	Wavelength	Sample drop volume
Colorimetric	5, 1 FS, 950, 750, 550, 250	5 min	37deg C	680 nm	10

Measurement of total protein

The VITROS TP (total protein) slide is a multilayered slide in which analytical element coated on a polyester base. The method of analysis is based on the biuret reaction which produces a violet complex when protein reacts with cupric ion in an alkaline medium.

One drop of the patient sample is placed on the slide and is equally distributed by the spreading layer by layers. Reagent reacts with protein when fluid penetrates reagent layer and reagent diffuses upto the spreading layer. The reaction between protein and copper tartrate takes place largely in the spreading layer where the protein is confirmed because of its high molecular weight. The amount total protein present in the sample is measured by reflectance spectrophotometry which is proportional to the amount of colored complex formed. Reagents (reactive ingredients per cm^2) used were copper sulfate 0.9 mg, tartaric acid 1.2 mg, lithium hydroxide 1.3 mg and other ingredients were polymer beads, binders, and surfactants.

Test type and conditions

Test type	VITROS system	Approx incubation time	Temperature	Wavelength	Sample drop volume
Colorimetric	5, 1FS, 950, 750, 550, 250	5 min	37 deg C	540 nm	10 mic litre

Measurement of serum cholesterol

The VITROS CHOL Slide method is done with the help of the VITROS CHOL Slides and the VITROS Chemistry Products Calibrator Kit 2 on VITROS 250/350/950/5,1 FS and 4600 Chemistry Systems and the VITROS 5600 Integrated System. The multilayered VITROS CHOL Slide contains analytical element which is coated on a polyester base. This is the enzymatic based method similar to Allain., *et al*. method [16]. One drop of the patient sample is placed on the slide and is equally distributed by the spreading layer by layers. The Triton X-100 (TX100) surfactant which is present in the spreading layer helps in the cholesterol and cholesterol esters dissociation from lipoprotein complexes. Cholesterol ester hydrolase catalyzed the hydrolysis of the cholesterol esters to cholesterol. In the presence of cholesterol oxidase oxidation of free cholesterol to cholestenone and hydrogen peroxide occurs. Finally, in the presence of peroxidase, colored dye is formed because hydrogen peroxide oxidizes leuco dye. The density of dye formation is proportional to the cholesterol concentration of the sample which is measured by reflectance spectrophotometry. Reagents (reactive Ingredients per cm^2) used were Triton X-100 0.81 mg; cholesterol oxidase (*Cellulomonas*, E.C.1.1.3.6) 0.4 U; cholesterol ester hydrolase (*Pseudomonas*, E.C.3.1.1.13) 2.0 U; peroxidase (horseradish root, E.C.1.11.1.7) 5.3 U; and 2-(3,5-dimethoxy- 4- hydroxyphenyl)-4, 5-bis-(4-dimethylaminophenyl) imidazole (leuco dye) 0.17 mg; and other ingredients taken were pigment, binder, buffer, surfactants, stabilizers and cross-linking agent.

Test type and conditions

Test type	VITROS system	Approx incubation time	Temperature	Wavelength	Sample drop volume
Colorimetric	5600, 4600, 5,1 FS, 950, 250/350	5min.	37 °C (98.6 °F)	540 nm	5.5 µL

Measurement of HDL

The VITROS dHDL Slide method is done with the help of the VITROS dHDL Slides and the VITROS Chemistry Products Calibrator Kit 25 on VITROS 250/350/950/5,1 FS and 4600 Chemistry Systems and the VITROS 5600 Integrated System. The multilayered VITROS

dHDL Slide contains analytical element which is coated on a polyester base. The method is non-HDL precipitation method which is similar to Burstein., *et al*. method [17], followed by enzymatic detection similar to Allain., *et al*. method [16]. One drop of the patient sample is placed on the slide and is equally distributed by the spreading layer by layers. In the spreading layer, precipitation of non-High Density Lipoproteins (non-HDL) occurs with the help of phosphotungstic acid and magnesium chloride as a result HDL becomes separated. The Emulgen B-66 surfactant which is present in the spreading layer helps in the cholesterol and cholesterol esters dissociation from the HDL lipoprotein complexes. Cholesterol ester hydrolase catalyzed the hydrolysis of the HDL-derived cholesterol ester to cholesterol. In the presence of cholesterol oxidase oxidation of free cholesterol to cholestenone and hydrogen peroxide occurs. Finally, in the presence of peroxidase, colored dye is formed because hydrogen peroxide oxidizes leuco dye. The density of dye formation is proportional to the cholesterol concentration of the sample which is measured by reflectance spectrophotometry. Reagents (reactive ingredients per cm^2) used were emulgen B-66 0.7 mg; phosphotungstic acid (PTA) 0.3 mg; magnesium chloride ($MgCl_2$) 0.2 mg, cholesterol oxidase (*Cellulomonas*, E.C.1.1.3.6) 0.8 U; cholesterol ester hydrolase (*Candida rugosa*, E.C.3.1.1.3) 1.2 U; peroxidase (horseradish root, E.C.1.11.1.7) 2.2 U; and 2- (3,5-dimethoxy-4-hydroxyphenyl)-4,5-bis-(4- dimethylaminophenyl) imidazole (leuco dye) 0.02 mg; and other ingredients taken were pigment, binders, buffer, surfactants, stabilizers, scavenger, and cross-linking agent.

Test type and conditions

Test Type	Vitros System	Approximate incubation time	Temperature	Wavelength	Reaction sample volume
Colorimetric	5600, 4600, 5,1 FS, 950, 250/350	5 minutes	37°C (98.6°F)	670 nm	6 µL

Hb estimation

Standard operating procedure: Hb is a conjugated protein present in the RBC and is responsible for the oxygen and carbon dioxide transportation. Materials required to perform the test were photoelectric colorimeter or spectrophotometers, pipette (Hb pipette .02 ml, 5 ml graduated pipette), test tubes and drabkins solution.

Statistical analysis

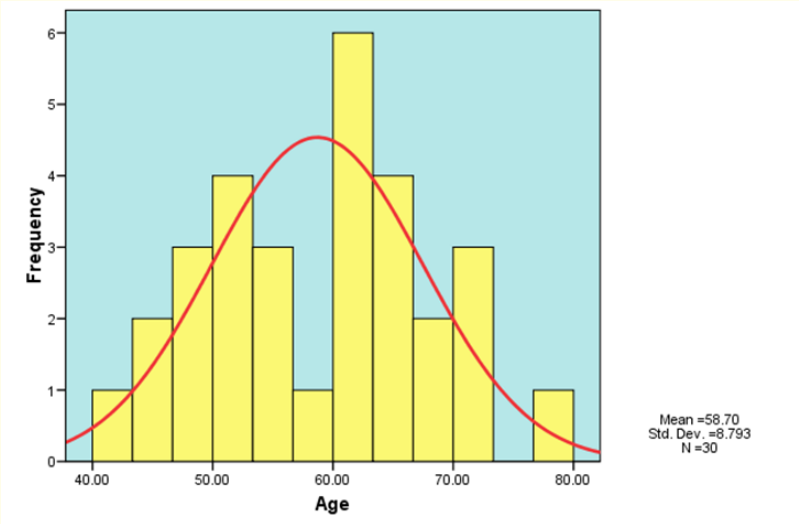
The statistical analysis was done with the help of Statistical Package for Social Sciences software windows version 17.0 (SPSS Inc., Chicago, Illinois, USA). The values were represented in Number (%) and Mean ± SD. Student's t-test, paired t-test, Wilcoxon signed rank statistic and bivariate correlation were used for statistical analysis. Statistical significance was set at $p \leq 0.05$.

Results

At enrolment, ages of patients were 43 years to 77 years with average age of 58.7 ± 8.79 years. A total of 16 (53.3%) patients were aged ≤ 60 years while remaining 14 (46.7%) were aged > 60 years (Table 1 and graph 1). All the patients participated in the study were males. The period of edentulous status ranged from 4 months to 12 months with average of 6.83 ± 2.00 months. S. calcium, S. protein, S. Cholesterol, S. HDL and mean Hb, values were 8.23 ± 0.16 mg/dl, 6.87 ± 0.32 g/dl, 142.3 ± 11.4 mg/dl, 37.96 ± 1.19 mg/dl and 12.18 ± 0.44 g/dl respectively. On evaluating nutritional status in terms of BMI, the BMI of patients ranged from 15.89 to 23.84 kg/m^2 with a mean value of 19.68 ± 2.10 kg/m^2. 23 patients were in normal weight category (76.7%) and 7 patients were underweight (23.3%) (Table 1).

SN	Characteristic	Statistic
1.	**Age**	
	≤ 60 Years	16 (53.3%)
	> 60 Years	14 (46.7%)
	Mean Age ± SD (Range) in years	58.7 ± 8.79 (43 - 77)
2.	**Gender**	
	Male	30 (100%)
3.	Duration since edentulous	
	≤ 6 months	14 (46.7%)
	7-12 months	16 (53.3%)
	Mean duration ± SD (Range) in months	6.83 ± 2.00 (4 - 12)
4.	Mean S. Calcium ± SD (Range) mg/dl	8.23 ± 0.16 (8.05 - 8.56)
5.	Mean S. Protein ± SD (Range) g/dl	6.87 ± 0.32 (6.16 - 7.36)
6.	Mean S. Cholesterol ± SD (Range) mg/dl	142.3 ± 11.4 (128.9 - 161.4)
7.	Mean Haemoglobin ± SD (Range) g/dl	12.18 ± 0.44 (11.4 - 13.2)
8.	Mean S. High Density Lipoprotein ± SD (Range) mg/dl	37.96 ± 1.19 (36.18 - 39.47)
9.	BMI Status	
	Underweight (< 18.5 kg/m^2)	7 (23.3%)
	Normal weight (18.5 - 25.0 kg/m^2)	23 (76.7%)
	Mean BMI ± SD (Range) in kg/m^2	19.68 ± 2.10 (15.89 - 23.84)

Table 1: *Profile of patients enrolled in the study and baseline characteristics.*

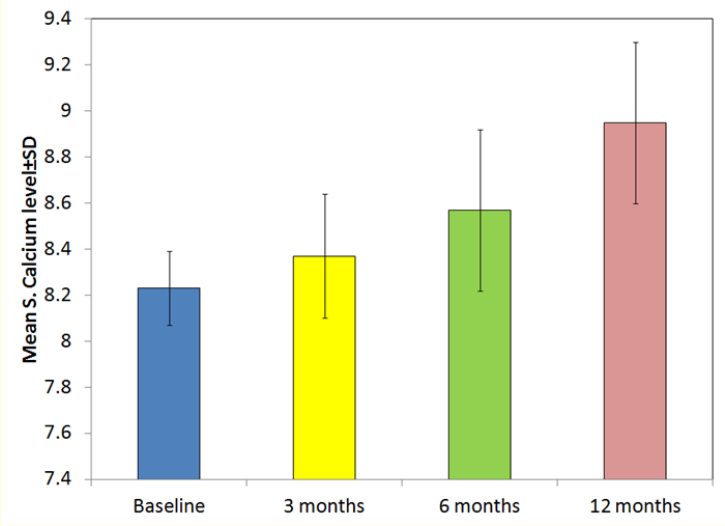


Graph 1: *Evaluation of edentulousness with age.*

Mean serum calcium level was 8.23 ± 0.16 mg/dl at baseline which changed to reach at 8.37 ± 0.27, 8.57 ± 0.35 and 8.95 ± 0.35 mg/dl respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 1.66, 4.20 and 8.82% respectively at the corresponding intervals. On comparing the data statistically, the change in calcium levels was significant statistically at all the time intervals ($p < 0.001$) (Table 2 and graph 2).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	8.23	0.16					
2.	3 months	8.37	0.27	0.14	0.20	1.66	-3.724	0.001
3.	6 months	8.57	0.35	0.35	0.32	4.20	-5.967	< 0.001
4.	12 months	8.95	0.35	0.73	0.31	8.82	-12.616	< 0.001

Table 2: *Evaluation of change in serum calcium levels at different time intervals. Paired 't'-test.*



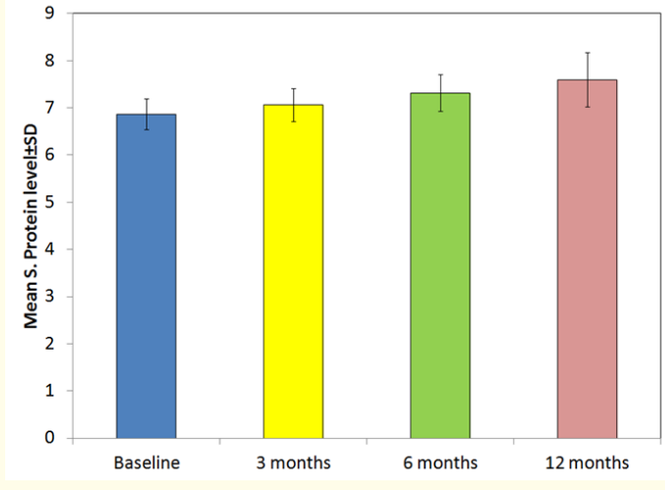
Graph 2: *Evaluation of change in serum calcium levels at different time intervals.*

Mean serum protein level was 6.87 ± 0.32 g/dl at baseline which changed to reach at 7.07 ± 0.35, 7.32 ± 0.39 and 7.60 ± 0.57 g/dl respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 2.94, 6.56 and 10.73% respectively at the corresponding intervals. On comparing the data statistically, the change in protein levels was significant statistically at all the time intervals ($p < 0.001$) (Table 3 and graph 3).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	6.87	0.32					
2.	3 months	7.07	0.35	0.20	0.13	2.94	-8.560	< 0.001
3.	6 months	7.32	0.39	0.45	0.22	6.56	-11.433	< 0.001
4.	12 months	7.60	0.57	0.74	0.43	10.73	-9.391	< 0.001

Table 3: *Evaluation of change in serum protein levels at different time intervals.*

Paired 't'-test.



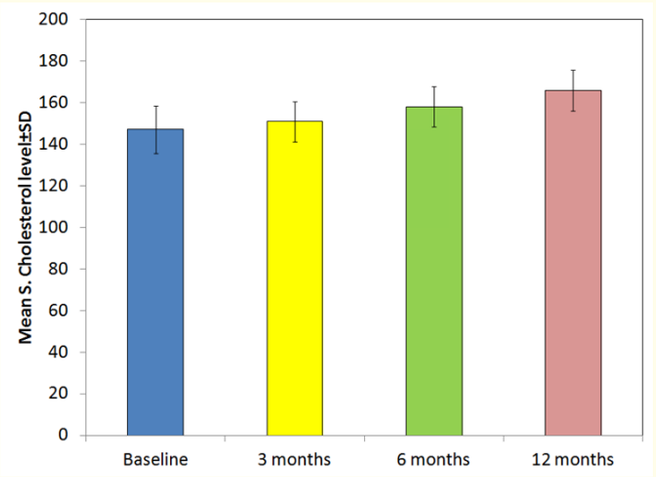
Graph 3: *Evaluation of change in serum protein levels at different time intervals.*

Mean serum cholesterol level was 147.28 ± 11.40 mg/dl at baseline which changed to reach at 150.99 ± 9.72, 158.18 ± 9.63 and 165.96 ± 9.74 mg/dl respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 2.52, 7.40 and 12.68% respectively at the corresponding intervals. On comparing the data statistically, the change in cholesterol levels was significant statistically at all the time intervals ($p < 0.001$) (Table 4 and graph 4).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	147.28	11.40					
2.	3 months	150.99	9.72	3.71	2.40	2.52	-8.49	< 0.001
3.	6 months	158.18	9.63	10.90	4.49	7.40	-13.29	< 0.001
4.	12 months	165.96	9.74	18.68	5.26	12.68	-19.43	< 0.001

Table 4: *Evaluation of change in serum cholesterol levels at different time intervals.*

Paired 't'-test.



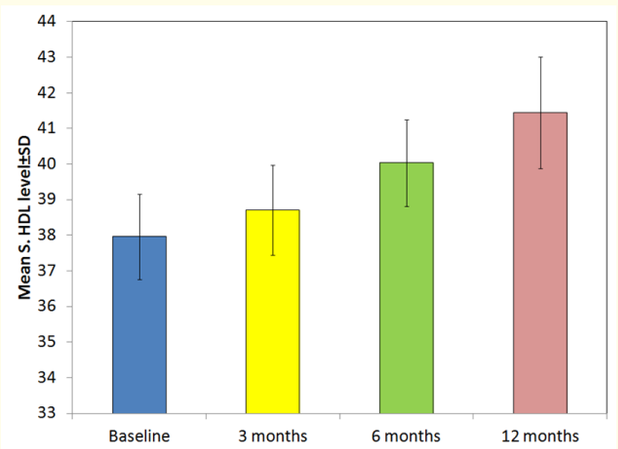
Graph 4: *Evaluation of change in serum cholesterol levels at different time intervals.*

Mean serum HDL level was 37.96 ± 1.19 mg/dl at baseline which changed to reach at 38.71 ± 1.26, 40.03 ± 1.22 and 41.45 ± 1.22 mg/dl respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 1.99, 5.46 and 9.19% respectively at the corresponding intervals. On comparing the data statistically, the change in HDL levels was significant statistically at all the time intervals ($p < 0.001$) (Table 5 and graph 5).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	37.96	1.19					
2.	3 months	38.71	1.26	0.75	0.44	1.99	-9.3	< 0.001
3.	6 months	40.03	1.22	2.07	0.60	5.46	-18.96	< 0.001
4.	12 months	41.45	1.57	3.49	1.27	9.19	-15.03	< 0.001

Table 5: *Evaluation of change in serum HDL levels at different time intervals.*

Paired 't'-test.

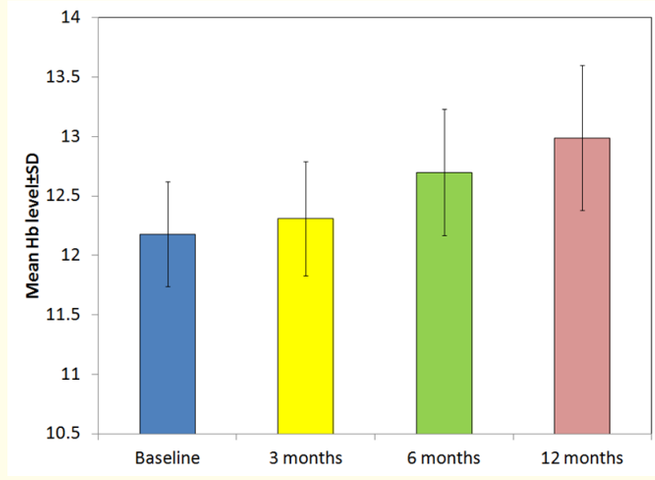


Graph 5: *Evaluation of change in serum HDL levels at different time intervals.*

Mean Hb level was 12.18 ± 0.44 g/dl at baseline which changed to reach at 12.31 ± 0.48, 12.70 ± 0.53 and 12.99 ± 0.61 g/dl respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 1.06, 4.27 and 6.66% respectively at the corresponding intervals. On comparing the data statistically, the change in Hb levels was significant statistically at all the time intervals ($p < 0.001$) (Table 6 and graph 6).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	12.18	0.44					
2.	3 months	12.31	0.48	0.13	0.12	1.06	-5.682	< 0.001
3.	6 months	12.70	0.53	0.52	0.29	4.27	-9.954	< 0.001
4.	12 months	12.99	0.61	0.81	0.41	6.66	-10.865	< 0.001

Table 6: *Evaluation of change in haemoglobin status at different time intervals. Paired 't'-test.*



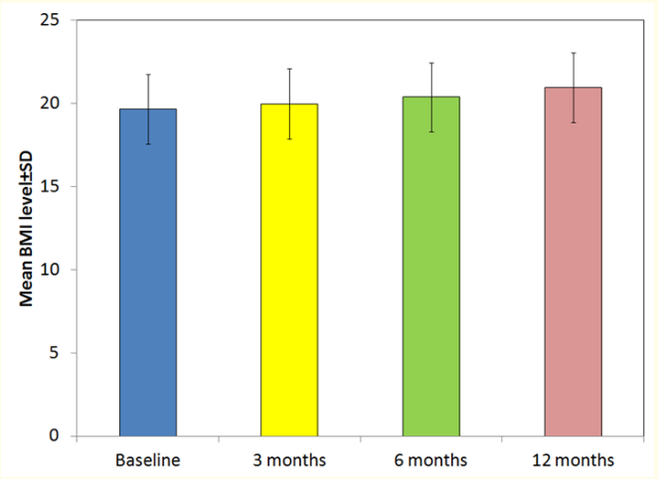
Graph 6: *Evaluation of change in haemoglobin status at different time intervals.*

Mean body mass index was 19.68 ± 2.10 kg/m^2 at baseline which changed to reach at 19.98 ± 2.11, 20.39 ± 2.07 and 20.97 ± 2.09 kg/m^2 respectively at 3 months, 6 months and 12 months post-rehabilitation intervals, thereby showing a % increase of 1.52, 3.62 and 6.57% respectively at the corresponding intervals. On comparing the data statistically, the change in BMI was significant statistically at all the time intervals ($p < 0.001$) (Table 7 and graph 7).

SN	Time interval	Mean	SD	Change from Baseline			't'	'p'
				Mean	SD	% Change		
1.	Baseline	19.68	2.10					
2.	3 months	19.98	2.11	0.30	0.22	1.52	-7.50	< 0.001
3.	6 months	20.39	2.07	0.71	0.26	3.62	-14.95	< 0.001
4.	12 months	20.97	2.09	1.29	0.44	6.57	-16.11	< 0.001

Table 7: *Evaluation of change in BMI at different time intervals.*

Paired 't'-test.



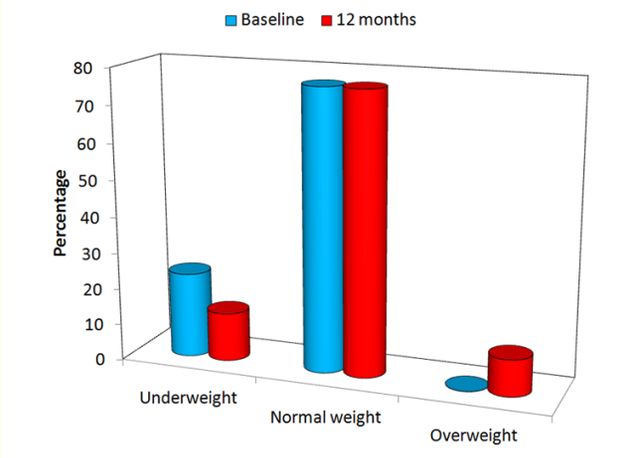
Graph 7: *Evaluation of change in BMI at different time intervals.*

At baseline 7 (23.3%) patients were underweight and remaining 23 (76.7%) were in normal weight category. However, at 12 months follow up, 4 (13.3%) were underweight, 23 (76.7%) were normal weight and 3 (10%) were in overweight category. Statistically, there was a significant change in nutritional status of patients 12 months after rehabilitation ($p < 0.001$) (Table 8 and graph 8).

SN	BMI Status	Baseline		12 months Follow up	
		No.	%	No.	%
1.	Underweight (<18.5 kg/m^2)	7	23.3	4	13.3
2.	Normal weight (18.5 - 25 kg/m^2)	23	76.7	23	76.7
3.	Overweight (≥ 25 kg/m^2)	0	0	3	10.0

Table 8: *Comparison of shift in BMI status during the study period.*

$z = 4.725$; $p < 0.001$ (Wilcoxon signed rank test).



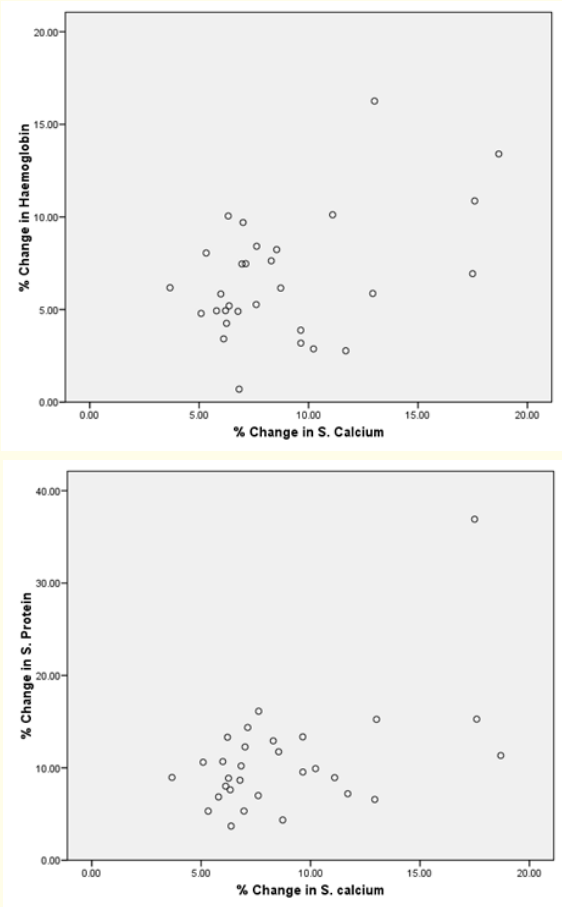
Graph 8: *Comparison of shift in BMI status during the study period.*

Except for a mild correlation between Hb and serum calcium; and a moderate correlation present between serum Calcium and serum Protein, all the other nutrients showed a weak or statistically non-significant correlation (Table 9 and graph 9).

	S. Ca		S. Protein		S. Cholesterol		S. HDL		BMI	
	r'	p'	r'	p'	r'	p'	r'	p'	r'	p'
Hb	0.440		0.218	0.246	-0.037	0.844	0.083	0.665	0.037	0.846
S. Ca			0.506	0.004	-0.173	0.361	-0.285	0.127	-0.101	0.595
S. Protein					-0.210	0.266	-0.077	0.685	-0.071	0.711
S. Cholesterol							-0.314	0.091	0.014	0.943
S.HDL									0.112	0.556

Table 9: *Correlation of % change in different nutritional status markers at 12 months.*

Pearson Correlation Coefficient.

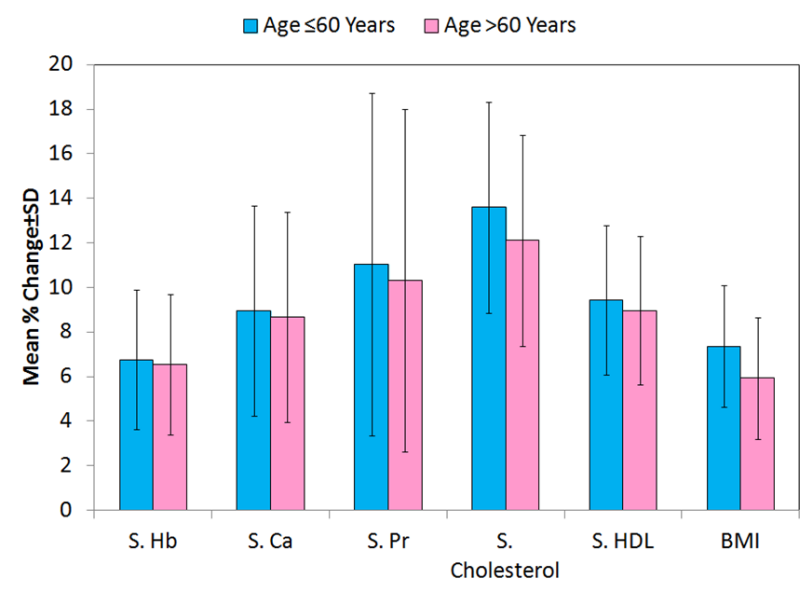


Graph 9: *Correlation of % change in different nutritional status markers at 12 months.*

For all the parameters, the mean percentage change was higher among those aged ≤60 years as compared to those aged > 60 years, however, the difference was not significant statistically (Table 10 and graph 10).

SN	Nutritional status marker	Age ≤60 Years (n = 16)		Age >60 Years (n = 14)		't'	'p'
		Mean	SD	Mean	SD		
1.	S. Hb	6.76	3.14	6.54	3.61	0.179	0.859
2.	S. Ca	8.95	4.70	8.67	2.67	0.199	0.844
3.	S. Pr	11.05	7.69	10.31	3.28	0.333	0.742
4.	S. Cholesterol	13.60	4.74	12.11	3.78	0.939	0.356
5.	S. HDL	9.44	3.34	8.97	3.58	0.373	0.712
6.	BMI	7.36	2.72	5.93	2.23	1.557	0.131

Table 10: *Association between age and % change in different nutrients at 12 months.*

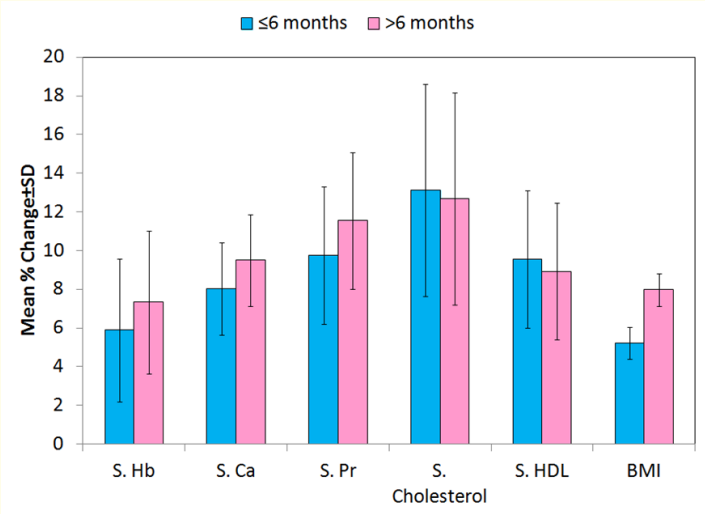


Graph 10: *Association between age and % change in different nutrients and BMI at 12 months.*

% BMI change in those with 7 - 12 months of edentulous status was significantly higher as compared to those with ≤ 6 months of edentulous status (p = 0.002). For other nutritional status markers, the association was not significant statistically (Table 11 and graph 11).

SN	Nutritional status marker	≤ 6 months (n = 14)		7 - 12 months (n = 16)		't'	'p'
		Mean	SD	Mean	SD		
1.	S. Hb	5.89	3.69	7.33	2.89	-1.194	0.242
2.	S. Ca	8.03	2.37	9.51	4.73	-1.057	0.300
3.	S. Pr	9.75	3.54	11.55	7.51	-0.820	0.419
4.	S. Cholesterol	13.14	5.48	12.69	3.15	0.279	0.782
5.	S. HDL	9.56	3.55	8.93	3.35	0.496	0.624
6.	BMI	5.22	0.84	7.97	2.89	-3.432	0.002

Table 11: *Association between duration since edentulous and % change in different nutrients at 12 months.*



Graph 11: *Association between duration since edentulous and % change in different nutrients and BMI at 12 months.*

Discussion

Denture wearers consumed vegetables, whole meal bread and dietary fiber less often than those who had some natural teeth [18-22]. Tooth loss causes decreased chewing capability, hence, patients avoid hard foods including vegetables and non-vegetables, as a result their diet quality and nutritional status become poor. Some researchers, who focus on changes in eating habits and food selection, found that edentulous people consume softer food compared to dentate people [21-23]. The above and many more studies indicate that individuals with natural healthy dentition consumed a wider variety of nutritious food than those with partial or total loss of teeth and it can be assumed that these subjects have an overall better nutritional status than those with missing natural teeth.

There is direct relationship between tooth and food intake because teeth are responsible for shear, tear, mastication and mixing of food with saliva; which are affected by tooth loss. There is limitation of dietary intake which affects dietary diversity of patients. This limitation

of intake of all types of foods as carbohydrate, protein, fat, vitamins and fibers are adversely affected which results into dietary intake imbalance [24,25].

In denture bearers, nutritional status varies greatly among them. According to Albert Yurkstas some foods must be chewed so as swallowing become comfortable [26]. Joshipura KJ., *et al*. found that patients with more teeth in their mouth tend to consume more hard-to-chew foods [21]. If we accept that patients with significant tooth loss eat less fruits, vegetables and non-vegetables than fully dentate people, then we face another question whether this difference in vegetables and non-vegetables diets places edentulous patients at higher risk of malnutrition.

This question was addressed in Great Britain by Sheiham with the help of findings of the National Diet and Nutrition Survey (NDNS) [27]. The author found that independently and institutions living old people have notorious impact on their intake of essential nutrients. The protocol consists of dental examination, 4-day weighted diet diaries, blood and urine samples to determine selected nutrients levels expected to be affected by the changes in food intake due to edentulism. The effects of confounding factors as gender, age and many socio-economically variables on the association between dental status and nutrition levels were taken into consideration during data analysis. In independent living people intake of various nutrients such as vitamins, proteins, fibers, minerals and galactose sugar were higher in dentate compared to edentulous people. The average nutrients intakes as well as total energy intake were increased with number of teeth in dentate people. This finding showed a dose–response effect and a cause-and-effect relationship between number of teeth present and nutritional status. The authors stated that as a general, dentate people have greater amount of nutrients intake [28-30]. At the present time, it is well known that impairment of physical activity is due to poor oral health in old aged persons. Krall and others found that there is inverse relationship between natural dentition impairment and intake of food. As impairment of natural dentition increased, intake of food dropped off [22].

At insertion, the mean and standard deviation showed a lower than normal blood level for calcium, protein, cholesterol, HDL and Hb. As previously described the foods rich in calcium, protein, cholesterol, HDL and Hb are all tough foods which are difficult to chew and are directly related to the masticatory ability. The masticatory ability of completely edentulous patients is impaired which renders them incapable to eat a variety of foods and leading to malnutrition and affects the general health [14,24] and this further showed an increase in all five nutrients at the insertion of 3, 6 and 12 months. This may be directly related to the increased masticatory efficiency and the ability to eat a variety of foods that include all these essential nutrients.

The results showed that there was a continuous increase at successive time periods for all five nutrients and it is directly related to the increased masticatory efficiency and also to the ability to eat a variety of foods and even tough foods which are rich in calcium, protein, cholesterol, HDL and Hb apart from the soft foods containing carbohydrates which are essentially rich only in glucose.

The correlation of percentage change in different nutritional status markers at 12 months, except for mild correlation between Hb and serum Calcium and there was a moderate correlation present between serum Calcium and serum Protein; a weak or statistically non-significant correlation was present between all other nutrients. The improvement of these two nutrients in blood after acquiring complete dentures can be attributed to the fact that these patients can now eat a variety of foods that include tough foods such as vegetables, meat, cereals which are rich in both protein and calcium. Also due to better chewing efficiency food may be pulverized into smaller particles enhancing the absorption.

Conclusion

The blood calcium, cholesterol, HDL, protein and Hb levels were found to be below the normal range in completely edentulous patients without any prosthetic rehabilitation suggesting that loss of teeth has a definite impact on the levels of these essential nutrients in blood.

There was a significant improvement in the blood calcium, cholesterol, HDL, protein and Hb levels and BMI index when rehabilitated with CD at the end of 3, 6 and 12 months post-insertion suggesting that rehabilitation with CD may lead to an increased level of blood calcium and protein. There was mild correlation between Hb and S. calcium and a moderate correlation between S. Calcium and S. Protein, all the other nutrients showed a weak or statistically non-significant correlation.

The above study was conducted with a few parameters and further studies need to be directed towards evaluating the significance of parameters like the type of diet, sex, community and occupation. Other parameter that could be taken into consideration is whether the patients had worn a removable partial denture during the state of partial edentulousness. Also, this study had a follow up period of 12 months and further longitudinal studies can be conducted.

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