Effect of Chewing Gum on Xerostomia, Thirst and Interdialytic Weight Gain in Patients on Hemodialysis

Hanan Said and Hanan Mohammed

Department of Medical-Surgical Nursing, Faculty of Nursing, Ain Shams University,
dr_hanan10@yahoo.com

Abstract: Background: Hemodialysis is a method for extracorporal removing waste products such as creatinine and urea, as well as free water from the blood when the kidneys are in renal failure. Xerostomia is a frustrating symptom for patients on hemodialysis; mechanisms that contribute to its development include low saliva flow. An increased intake of fluids secondary to xerostomia in patients on hemodialysis will result in excessive interdialytic weigh gain. Increased mastication, in the form of gum-chewing, can increase flow rates, especially in those with low salivary function, decrease Xerostomia, thirst and interdialytic Weight. **Aim of the study:** to examine the effect of using sugar-free chewing gum on xerostomia, thirst and interdialytic weight gain (IWG) in patients on hemodialysis. **Subjects and Methods**: The research ***design***: used is a quasi-experimental ***Setting***: Hemodialysis unit at Ain – Shams University Specialized Hospital. ***Subjects***: Consecutive 60 patients were randomly allocated to study and control groups, 30 subjects each. **Tools of data collection:** The following tools were used to collect data 1- Data Collection Sheet to assess socio demographic data, dry weight. 2- Xerostomia Inventory (XI) to quantify the perceived xerostomia 3- Dialysis Thirst Inventory (DTI) to identify the occurrence of thirst. 4- Interdialytic Weight Gain (IWG) to measure the body weight during dialysis session. 5- Salivary Flow Rates Scale: Designed for measurement of saliva rates. **Results:** the result of the study was most prevalent age (<50) years in study and control group (60.0% & 53.3% respectively), there is a decrease in xerostomia, thirst and interdialytic weight gain from 4.6±0.6,4.3±0.6 and 4.4±1.2 to1.8±0.8, 1.9±0.7 and 1.8±0.7 (respectively) through sixth sessions. Also there is an increase in salivary flow rate (ml) from 0.4±0.1 to 0.8±0.2 in study group. While in control group there is an increase in xerostomia, thirst and interdialytic weight gain from 3.3±0.7, 2.3±1.1and 1.8±0.5 to 4.0±0.9, 4.4±0.8 and 3.0±1.5 (respectively) through sixth sessions. Also there is a decrease in salivary flow rate (ml) from 0.5±0.2 to 0.4±0.2 through sixth sessions. **Conclusion:** We conclude that the use of chewing gum alleviate thirst, xerostomia, significantly decreases interdialytic weight gain and increase salivary flow rate in HD patients**. Recommendation:** The study was highly recommended the use of chewing gum by patient undergoing hemodialysis for its significant in decreasing thirst, xerostomia, interdialytic weight gain and increase salivary flow rate in HD patients.

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1. Introduction

End-stage renal disease (ESRD) is one of the main health problems in Egypt. Currently, hemodialysis represents the main mode for treatment of chronic kidney disease stage 5 (CKD5), previously called ESRD or chronic renal failure. In Egypt, the estimated annual incidence of ESRD is around 74 per million and the total prevalence of patients on dialysis is 264 per million. Hemodialysis centers in Egypt exist in governmental, military, and university hospitals as well in the private sector. [(1)]

Hemodialysis is a method for extracorporal removing waste products such as creatinine and urea, as well as free water from the blood when the kidneys are in renal failure. Hemodialysis is one of three renal replacement therapies (the other two being renal transplant; peritoneal dialysis). An alternate method for extracorporal separation of blood components such as plasma or cells is apheresis.[(2)]) For many Hemodialysis patients, however, it is difficult to adhere to fluid restriction [(3)].

Several studies have demonstrated higher rates of oral pathology in dialysis patients with one or more oral symptoms such as xerostomia, taste disturbances, uremic odor, tongue coating, mucosal inflammation, mucosal petechia/ecchymosis, oral ulceration, or enamel hypoplasia. Xerostomia is the subjective feeling of a dry mouth, which is relatively common in patients on chronic hemodialysis. It can be caused by reduced salivary flow secondary to atrophy and fibrosis of the salivary glands, use of certain medications, restriction of fluid intake and old age. In patients undergoing hemodialysis, xerostomia is associated with the following problems; difficulties in swallowing, tasting and speaking; increased risk of oral disease, including lesions of the mucosa, gingiva and tongue; bacterial and fungal infections, such as candidiasis, dental caries and periodontal disease;

interdialytic weight gain resulting from increased fluid intake and a reduction in quality of life.[4]

Hyposalivation, on the other hand is the objective measured reduction in salivary flow rate (unstimulated salivary flow rate < 0.15 ml/ min).The signs and symptoms of hyposalivation are reduced lubrication, difficulties with speaking, swallowing and eating as well as an increased urge for water intake to moisture the oral cavity. Due to reduced protection, patients with oral dryness are prone to microbial colonization of the oral mucosa, which can result in an increased susceptibility for fungal infections and oral inflammations. [5]

Thirst is the craving for fluids, resulting in the basic instinct to drink. Its an essential mechanism involved in fluid balance. It arises from a lack of fluids and/or an increase in concentration of osmolites, such as salt. If the water volume in the body falls below a certain threshold or osmolite concentration becomes too high, the brain signals thirst. Continuous dehydration can cause many problems, but is most often associated with renal problems and neurological problems such as seizures.[6]

Severe thirst distress is frequent in haemodialysis (HD) patients, and some studies have noted a positive relationship between thirst and an increased interdialytic weight gain (IDWG). Interdialytic weight gain (IWG) is an indicator of compliance to the fluid – restricted diet, and is influenced by social and psychological factors, but foremost by physical factors like excessive thirst. In chronic hemodialysis, a patient's fluid status is reflected by their interdialytic weight gain (IDWG). In the United States, 10–20% of CHD patients routinely experience high IDWG, often defined as ≥ 5.7% of a patient's estimated dry weight.[7,8,9]

Major systemic changes occur during hemodialysis (HD), which could affect the flow rate and biochemical composition of saliva. Saliva is essential to the function and protection of the oral cavity and contiguous gastrointestinal epithelium. Underlying physiological conditions, approximately 500-1000 ml of saliva is secreted every 24 hours. To date, there have been studies evaluating the salivary, periodontal, and dental status of mostly hemodialysis patients. Saliva possesses important protective abilities in the oral cavity such as debridement/lavage, mechanical cleansing, and maintenance of mucosal and tooth integrity. Saliva also has neutral pH (SpH) in the oral cavity. Any disturbance in this ecological balance due to reduction in salivary flow rate (SFR) will cause signs and symptoms such as xerostomia and atrophic appearance of the oral mucosa. [10]

The whole saliva is derived predominantly from three paired major gland, i.e. the parotid, submandibular and sublingual glands (together accounting for about 90% of the fluid production) as well as from the minor salivary glands in the oral mucosa. Under stimulated conditions, parotid glands contribute approximately 25% of whole saliva, the submandibular / sublingual glands about 67% and minor salivary glands about 8%. At high – stimulated flow rates, parotid saliva may constitute up to 49% of whole saliva. [11]

Salivary flow rates is regulated by autonomic nervous system, with the parasympathetic response primarily responsible for stimulating flow and the sympathetic system involved in salivary protein production. Flow rate and salivary composition are dependent upon the type and length of stimulus and the gland from which the saliva is secreted. [12]

Chewing is the first step in the process of digestion. During chewing, saliva is secreted to moisten and lubricate the food. While saliva and chewing has been shown to be interrelated. During mastication, mechanoreceptors in the gingival tissues will be stimulated which may result in salivary flow. Chewing is well known to stimulate saliva secretion. However, once saliva secretion is impaired, concomitant chewing difficulty exaggerates the situation. Saliva secretion was stimulated by tongue exercise.[11, 13]

Mastication has been proven to enhance the systemic circulation, with circulatory responses seeming to be largely regulated by autonomic nervous activity via a more complex regulatory system than those of other activities. However, few studies have examined the relationships between changes in autonomic nervous activity and the systemic circulation that are induced by masticatory movement. Changes in the autonomic nervous activity of the heart are mainly involved in the enhancement of systemic circulation with gum chewing. This explains some characteristics of autonomic nervous regulation in masticatory movement.[14]

Several investigators suggested the clinical use of sugar-free chewing gums for the relief of patients with xerostomia/hyposalivation.[15] Several HD patients reported to postpone water intake probably due to the distracting effect of gum chewing.[12]

In a pilot study with seven non-compliant HD patients, the use of chewing gum reduced the number of dialysis sessions for patients with high IWG. Gum chewing has been known to be a part of adjunctive medical therapy for xerostomia. No adherence to fluid restriction in hemodialysis (HD) patients brought about by unrestricted thirst and

xerostomia leads to excessive interdialytic weight gain (IWG).[16,17] This suggests that chewing gum or stimulants could potentially be used to decrease xerostomia and, thus, the urge to drink in HD patients. This may increase compliance to the fluid – restricted diet and could, subsequently, result in a decrease IWG.[18]

Nursing intervention for patient with chronic renal failure and undergoing hemodialysis are including frequent oral hygiene to avoid tissue irritation and sometime ulcer formation caused by urea and other acid waste products excreted through the skin and mucous membranes and providing the client with hard candy and chewing gum to stimulate saliva flow and decrease thirst.[19, 20]

Significance of the Study:

Most hemodialysis patients have to maintain a fluid restricted diet since they have no residual urine output and are allowed to drink at maximum 500 ml per day. In addition,dialysis treatment has a direct effect on the amount of saliva.Furthermore, both feeling of oral dryness (xerostomia) and thirst are associated with the amount of fluid consumed between dialysis sessions (Interdialytic Weight Gain).Maintaining this fluid restricted diet can be very difficult resulting in a high interdialytivc weight gain also patients suffer from xerostomia and thirst find it difficult to speak, chew, or swallow, and run an increased risk of dental caries or oral infection.

Saliva stimuli might diminish the urge to drink in hemodialysis patients, enhancing compliance to the fluid – restricted diet and leading to fewer systemic complications. Chewing gum should be easily available to assist in maintaining the fluid restricted diet beside it is safe, inexpensive and easily applicable intervention without side effects. In additions it is of major importance to prevent oral infections. Thus, they contribute to better HD patient's outcome and improve their Quality of life.

Aim of the Work:

The aim of this study was to examine the effect of using sugar-free chewing gum on xerostomia, thirst and interdialytic weight gain (IWG) in patients on hemodialysis.

Research Hypotheses:

It was hypothesized that the patients who will use a sugar – free chewing gum (study group) will have decrease in xerostomia, thirst and interdialytic weight gain (IWG) and increase in their salivary flow rates compared to (control group) subjects who will not use this chewing gum.

2. Subjects and Methods:

The research design used is a quasi-experimental design, with a study group using sugar – free chewing gum and a control group not using it.

Research Setting:

The research was conducted at the hemodialysis units at Ain –Shams University Specialized Hospital.

Subjects:

Sixty patients were consecutively recruited into this study. The inclusion criteria were being diagnosed as ESRD (End Stage Renal Disease) patients undergoing hemodailysis for at least 3 months, dialyzed three times a week for 4 hours, daily urine output < 200 ml, stable clinical conditions including stable dry weight and hematocrit and only adult (≥ 18 years), educated patients were included in the sample with mentally and physically being able to participate and complete the study.

Exclusion criteria included presence of diabetes mellitus, ischemic heart disease, autoimmune disease, those with malignancy in the oral cavity, and those who had microscopic evidence of oral infection in the oral cavity. In addition, patients who are smokers, alcohol drinkers, who had periodontal diseases,hemodynamic instability preventing sufficient ultrafiltration, dementia or terminal diseases logistic impossibility of investigation, anxiety or depression (which cause xerostomia possibly as a result of the dysfunction of both brain and salivary glands), use of chemotherapy or radiotherapy or both or use of xerogenic medications (including anticholinergic, antidepressants, antipsychotics, antihistamines, antiparkinsonian agents and diuretics) and unwillingness to participate in the study.

After application of the inclusion and exclusion criteria, the consecutive 60 patients were randomly allocated to two equal groups, 30 subjects each. The study group Patients were to use the sugar – free chewing gum, while the control group patients did not use it.

Tools of Data Collection:

The following tools were used to collect data related to this study:

1- Data Collection Sheet:

Designed by the researchers to collect data regarding age, sex, dry weight and duration of hemodialysis. This data was filled once from the patient.

2- Xerostomia Inventory (XI):

-Designed for quantify the perceived xerostomia before and after each session. It was adopted from.[21] The xerostomia inventory is a validated questionnaire with 11 items, each with a 5 point Likert – type scale (never =1 to very often = 5). The scores are summed and provide a patient score as follows : 11=No dry mouth, 22=Almost no dry mouth, 33=Occasionally, 44= Often dry mouth, and 55= Extremely dry mouth

-When the patients reported ‘’NO’’ and ‘’Almost NO’’ were judged as ‘’ absent xerostomia ‘’. In all

other patients who reported ''occasionally'' until ''extremely'', it was judged as ''present xerostomia''.

3- Dialysis Thirst Inventory (DTI):

Designed for quantify the occurrence of thirst before and after the dialysis session. It was adopted from [22]. Dialysis Thirst Inventory is a validated questionnaire with 5 items, each with a 5 point Likert – type scale (never =1 to very often = 5). The responses to the five items were summed, which results in a score as follows : 5= Never thirsty, 10= Almost never thirsty, 15 = Occasionally, 20 = Fairly often thirsty and 25 = very often thirsty.

The patients reported '' never'' and almost never'' were judged as '' absent thirst ''. In all other patients, ''occasionally '' until '' Very often '', it was judged as '' present thirst ''.

4- Interdialytic Weight Gain (IWG):

The body weight was determined using an electronic chair monitor. A sheet was designed by researchers to record patients weight before and after each session. According to the literatures [23] that interdialytic weight gain was defined as the amount of fluid (Kg) removed during the session (weight pre-dialysis minus weight post – dialysis). IWG was calculated and expressed as the mean IWG during a period of 2 weeks.

5- Salivary Flow Rates Scale:

Designed for measurement of saliva rates.It was adopted from [24, 25, 26] Based on salivary flow rates classified as follows:

*No hyposalivation = > 0.15 ml / min., * hypo salivation = < 0.15 ml / min.

The researchers assessed the amount of saliva before and after each dialysis session. Saliva volumes were determined gravimetrically (assuming 1 gm = 1 ml).

Pilot Study:

A pilot trial was carried out on five hemodialysis patients with the same inclusion and exclusion criteria. A verbal consent was obtained from each patient. Based on the pilot trial findings, necessary revisions were made in the data collection forms, and a schedule was developed for using sugar-free chewing gum. These five patients were not included in the main study sample.

Study Maneuver:

The research team approach eligible potential patients, and explained to them the purpose of the study. The patient was then asked if he / she are interested in participating. Patients were informed about their rights according to medical research ethics. Then, written informed consent was obtained from patients who agreed to participate.

Patients were assigned to either the study group or the control group using block randomization. Thus, blocks of ten patients were recruited, and five were randomly assigned to each of the two groups. This process was continued until the total 60 patients were recruited.

Data collection took about two and a half months, from July to September 2011. The work was done 3 days per week, 5 hours per day

The measures were used along 2 weeks before and after each dialysis session (3 sessions/ week) among patients in the study and control groups taking into consideration that sugar- free chewing gum was used only in the study group.

The patients were asked to come to the dialysis unit 1 hour earlier than their mid – week schedules and they received the assessment.

Before the beginning and at the end of each dialysis session, the main parameters xerostomia, thirst, interdialytic weight gain and salivary flow rates were determined.

The chewing gum used in this study was white, a low- tack and menthol – containing but sugar – free chewing gum. To get optimal patient compliance, two flavors of the same type of chewing gum (strawberry: mild, peppermint: strong) were selected and given to the patients. The patients in the study group were instructed to chew one or two pieces of gum gently, for > 10 min, 6 times a day and as desired throughout the day when the mouth felt dry or when they were thirst. The initial increase in flow rate is probably induced by gustatory stimulus by the chewing gum within 39 seconds, the intensity of the taste showed a peak value and saliva become secreted. When the patient used chewing gum, the average chewing times for each piece of gum was 30 minutes, which is comparable with the [27]

Special Procedures:

*** Interdialytic Weight Gain (IWG):**

All patients were routinely asked to remove their shoes, and on a clean gown before using an electronic chair monitor. IWG was calculated as the patient weight at the beginning (pre-weight) minus the weight after (post – weight) each dialysis session. The urologist set the ultra- filtration rate according to the weight gain and corrected the post- dialysis body weight to the target dry weight in each dialysis session. The post – dialysis body weight of the patients were thus comparable with their target dry weight throughout the study.

***Saliva Collection:**

Unstimulated whole saliva (UWS) was collected immediately before a dialysis session (before = baseline) and chewing - stimulated whole saliva (CH- SWS) was collected directly after completion of the dialysis session.

The patients were seated comfortably in an upright position, with back support up to midscapular level

but without headrest. All patients were instructed to refrain from eating, drinking and tooth brushing for one hour prior to the two saliva collection periods. In each patient, the samples were collected during one dialysis session.

For unstimulated *whole saliva* (UWS) according to the spitting method [28, 29] before collection, the patients rinsed their mouth with tap water. The collection started with the instruction to void the mouth of saliva by swallowing. Saliva was allowed to accumulate on the floor of the mouth and the patients were instructed to spit into pre- weigh test tubes every 30 seconds. The saliva collection period was 5 minutes.

For *chewing – stimulated saliva* (CH-SWS) using sugar – free chewing gum was also spitted out into pre-weighed test tubes every 30 seconds for 5 minutes. During the saliva collection period, the patients chewed at their natural pace.

Ethical Consideration:

The ethical research consideration in this study was included the following:

-The research approval was obtained before research implementation from director of hemodialysis unit, the objectives and the aim of the study were cleared to the patients.

-Acceptance of participation on the study was obtained from the subjects

-The research maintains on anonymity and confidentiality of the subjects and they have the right to withdraw from the study any time without penalty.

Statistical analysis

Data entry was done using Epi-Info 6.4 computer software package, while statistical analysis was done using SPSS 11 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations for Quantitative variables. Quantitative continuous data were compared using Student t-test in case of comparisons between two groups. When normal distribution of the data could not be assumed, the non-parametric Mann-Whitney test was used instead of Student t-test. Qualitative variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. Statistical significance was considered at p-value <0.05. When normal distribution of the data could not be assumed, the non-parametric Kruskal-Wallis test was used instead.

3. Results

Table (1) shows that the age of the studied sample was divided into two categories, was most prevalent their age (<50) years in study and control group (60.0% & 53.3% respectively), while followed by category (50+) years. The gender distribution was almost equal between males and females with slightly higher preponderance of males in both groups. Regarding to duration of hemodialysis about 40% of study group and 33.3% of control group were received hemodialysis for more than 4 years. As regard to the dry weight, the mean for study and control group was (74.94±5.13), (72.92±3.7) respectively. With no statistical significant differences were revealed among the two groups in any of these characteristics.

Table (2) identified that there is a statistically significant difference among patients in the study group throughout the six sessions in relation to xerostomia, thirst, salivary flow rate (ml) and interdialytic weight gain (kg). In which there is a decrease in xerostomia, thirst and interdialytic weight gain from 4.6±0.6,4.3±0.6 and 4.4±1.2 to1.8±0.8, 1.9±0.7 and 1.8±0.7 (respectively) through sixth sessions. Also there is an increase in salivary flow rate (ml) from 0.4±0.1 to at 0.8±0.2 through sixth session.

Table (3) showed statistically significant differences among patients in the control group throughout the six sessions in relation to xerostomia, thirst, salivary flow rate (ml) and interdialytic weight gain (kg). In which there is an increase in xerostomia, thirst and interdialytic weight gain from 3.3±0.7, 2.3±1.1and 1.8±0.5 to 4.0±0.9, 4.4±0.8 and 3.0±1.5 (respectively) through sixth sessions. Also there is a decrease in salivary flow rate (ml) from 0.5±0.2 to 0.4±0.2 through sixth sessions.

Figure (1) showed that there is an apparent decrease in xerostomia among patients in study group than in control group throughout the six sessions.

Figure (2) explained that there is an apparent decrease in the thirst among patients in study group than in control group throughout the six sessions.

Figure (3) showed that there is progressive increase in the salivary flow rate among patients in study group than in control group throughout the six sessions.

Figure (4) represented that there is progressive decrease in the mean weight gain among patients in study group than in control group throughout the six sessions.

Table (4) indicate that there is a statistical significant difference between study and control group regarding interdialytic weight gain from third to six session that indicate a progressive decrease in interdialytic weight gain among patients in the study group in comparison with control group in each session.

Table 1. Socio-demographic characteristics of patients in the study and control groups

	Group				X^2 Test	*p*-value
	Study (n=30)		Control (n=30)			
	No.	%	No.	%		
Age (years):						
<50	**18**	**60.0**	**16**	**53.3**		
50+	**12**	**40.0**	**14**	**46.7**	**0.54**	**0.46**
Sex;						
Male	**16**	**53.3**	**17**	**56.7**		
Female	**14**	**46.7**	**13**	**43.3**	**0.13**	**0.71**
Duration of hemodialysis:						
3≤6 months	**4**	**13.3**	**3**	**10.0**		
6-<24 months	**5**	**16.7**	**8**	**26.7**	**2.03**	**0.57**
2-<4 years	**9**	**30.0**	**9**	**30.0**		
4+ years	**12**	**40.0**	**10**	**33.3**		
Dry weight (kg) Mean ± SD	**74.94± 5.13**		**72.92 ± 3.7**		**2.435**	**0.552**

(*) Statistically significant at p<0.05

Table 2. Comparison of the scores of xerostomia, thirst, and salivary flow among patients in the study group throughout the six sessions

	Session (mean ±SD)						Kruskal Wallis test (p-value)
	1	2	3	4	5	6	
Xerostomia (max=5)	**4.6±0.6**	**3.7±0.6**	**2.5±0.5**	**2.3±0.5**	**2.2±0.6**	**1.8±0.8**	**120.14 (<0.001*)**
DTI (max=5)	**4.3±0.6**	**3.6±0.7**	**2.5±0.5**	**2.1±0.6**	**2.1±0.6**	**1.9±0.7**	**116.23 (<0.001*)**
Salivary flow rate (ml)	**0.4±0.1**	**0.5±0.1**	**0.7±0.2**	**0.7±0.2**	**0.8±0.2**	**0.8±0.2**	**79.81 (<0.001*)**
Interdialytic weight gain (kg)	**4.4±1.2**	**4.2±1.3**	**3.8±1.0**	**3.0±1.0**	**2.6±0.8**	**1.8±0.7**	**80.78 (<0.001*)**

(*) Statistically significant at p<0.05

Table 3. Comparison of the scores of xerostomia, thirst, and salivary flow among patients in the control group throughout the six sessions

	Session (mean±SD)						Kruskal Wallis test (p-value)
	1	2	3	4	5	6	
Xerostomia (max=5)	**3.3±0.7**	**3.8±1.1**	**3.9±1.0**	**3.8±1.1**	**4.1±1.0**	**4.0±0.9**	**12.21 (0.03*)**
DTI (max=5)	**2.3±1.1**	**3.4±1.1**	**3.8±1.8**	**3.7±1.0**	**4.0±0.9**	**4.4±0.8**	**52.64 (<0.001*)**
Salivary flow rate (ml)	**0.5±0.2**	**0.4±0.2**	**0.4±0.1**	**0.4±0.2**	**0.3±0.2**	**0.4±0.2**	**25.44 (<0.001*)**
Interdialytic weight gain (kg)	**1.8±0.5**	**2.2±0.8**	**2.2±1.0**	**2.7±0.9**	**2.6±1.2**	**3.0±1.5**	**22.99 (<0.001*)**

(*) Statistically significant at p<0.05

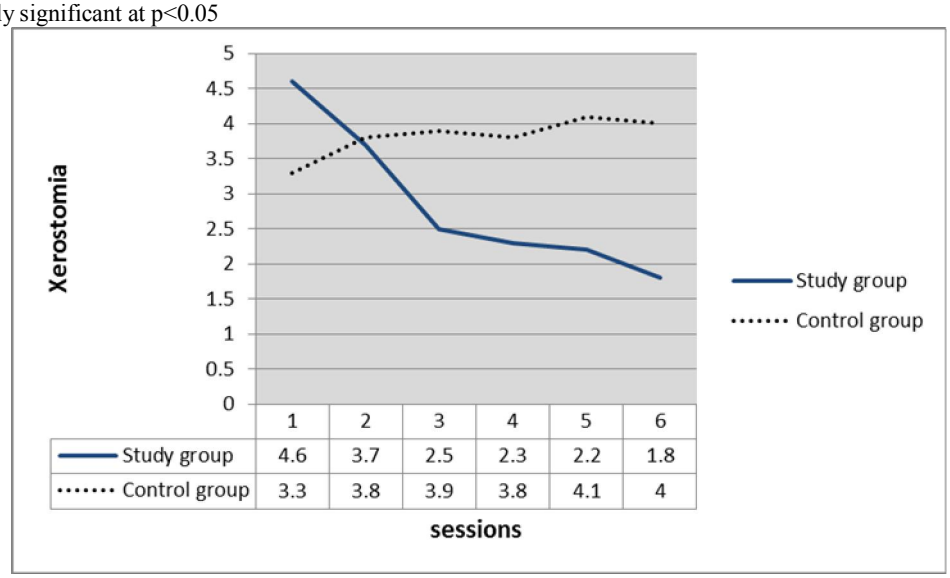
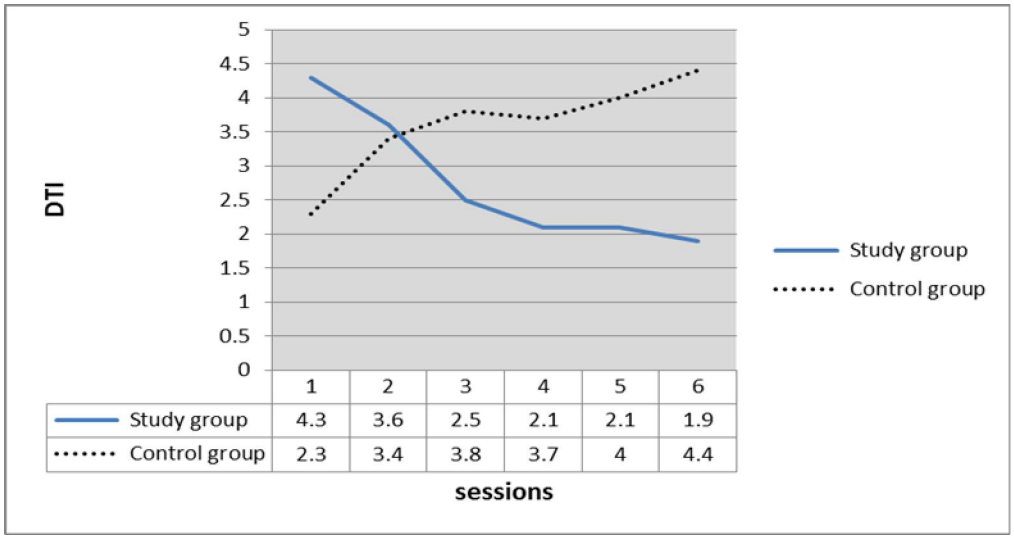
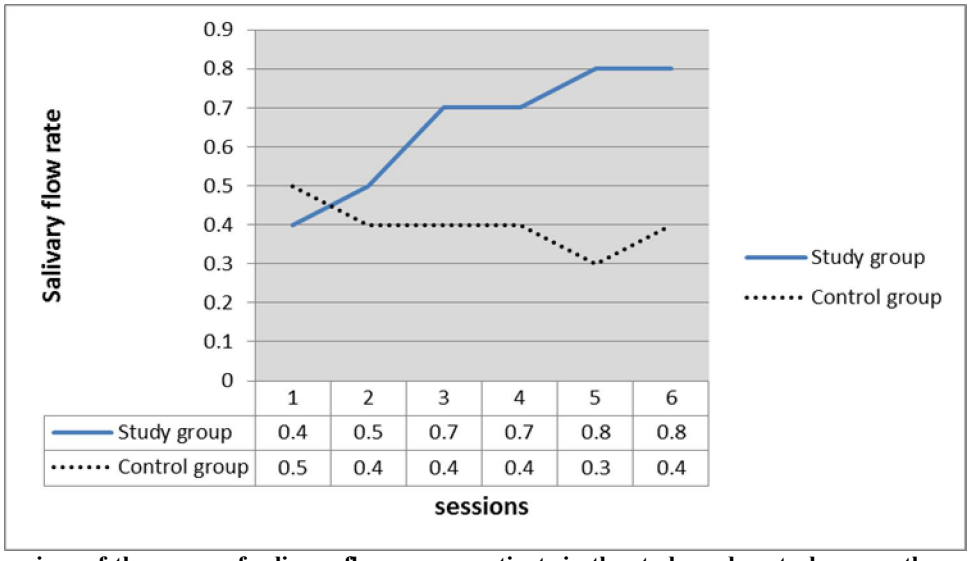


Figure 1. Comparison of the scores of xerostomia among patients in the study and control groups throughout the six sessions



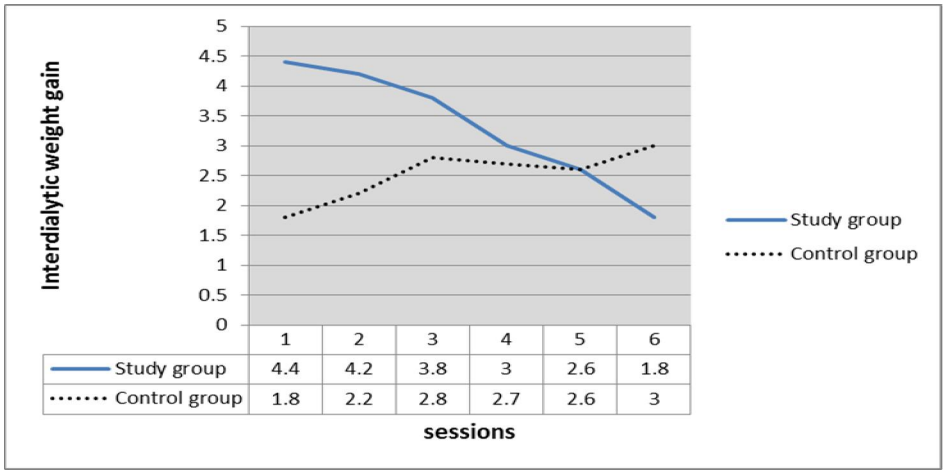
	1	2	3	4	5	6
Study group	4.3	3.6	2.5	2.1	2.1	1.9
Control group	2.3	3.4	3.8	3.7	4	4.4

Figure 2. Comparison of the scores of thirst (DTI) among patients in the study and control groups throughout the six sessions



	1	2	3	4	5	6
Study group	0.4	0.5	0.7	0.7	0.8	0.8
Control group	0.5	0.4	0.4	0.4	0.3	0.4

Figure 3. Comparison of the scores of salivary flow among patients in the study and control groups throughout the six sessions



	1	2	3	4	5	6
Study group	4.4	4.2	3.8	3	2.6	1.8
Control group	1.8	2.2	2.8	2.7	2.6	3

Figure 4. Comparison of the scores of weight gain among patients in the study and control groups throughout the six sessions

Table 4. Comparison of weight change among patients in the study and control groups in various sessions

Session	Interdialytic weight gain – kg (mean±SD)		
	Study (n=30)	Control (n=30)	Mann-Whitney Test (p-value)
1	4.4±1.2	1.8±0.5	0.02 (0.90)
2	4.2±1.3	2.2±0.8	2.44 (0.12)
3	3.8±1.0	2.2±1.0	10.24 (0.001*)
4	3.0±1.0	2.7±0.9	11.13 (<0.001*)
5	2.6±0.8	2.6±1.2	23.05 (<0.001*)
6	1.8±0.7	3.0±1.5	18.26 (<0.001*)

(*) Statistically significant at p<0.05

4. Discussion

The aim of this study was to examine the effect of using sugar-free chewing gum on xerostomia, thirst and interdialytic weight gain (IWG) in patients on hemodialysis. It was hypothesized that the patients who will use a sugar – free chewing gum (study group) will have decrease in xerostomia, thirst and interdialytic weight gain (IWG) and increase in their salivary flow rates compared to (control group) subjects who will not use this chewing gum.

The study result reveals that more than half of the subjects either in study or control group in relation to their age were less than 50 years .This result supported by the result of study carried out by (Alharbi & Enrione 2012) [30] who's mentioned that *subject demographics* of 269 participated in the study; 186 (69.1%) were younger than 55 years, while the remaining 83 (30.9%) were 55 years and older. Also the result is consistent with result of (Gouda *et al. 2011)* [31] who state that the overall mean age of the participants was 39 ± 14.3 years. The current result was contradicts with the result of (Rubin, 2011) [32] who mentioned that the fastest-growing group of patients starting dialysis in the USA is 75 and older. And the average age at which an American goes on dialysis is now older than 64 years.

According to the sex of subjects in both groups, the study document that more than half of them were male which congruent with (Bots *et al.* 2007) [33] who stated that In total 43 chronic dialysis patients participated in this study, 30 men (mean age 54.0 ± 15.7 years) and 13 women. But it is incongruence with Patel et al. 2012 & Smith et al.2011) [34, 35] who reported in his study that most participants were women.

The results of the current study showed that most of subjects of both groups have duration of hemodialysis more than 4 years. This is in accordance with (Prohovnik et al. 2007) [36] they mentioned that in large Japanese study of 508 patients undergoing hemodialysis for an average duration of 11 years.

Also it is supported by (Lee et al. 2012) [37] who stated that the mean duration of dialysis (HD: 55 months, PD: 36 months, p<0.001)

The study show that there is a statistically significant difference among patients in the study group throughout the six sessions in relation to xerostomia, thirst, salivary flow rate (ml) and interdialytic weight gain in study group. This is consistent with (Jenkins and Edgar, 2012) [38] in relation to salivary flow rate they mentioned the results of their study suggest that increased mastication, in the form of gum-chewing, can increase flow rates, especially in those with low salivary function. In addition to short-term beneficial effects of sugarless gum, it has long-term effects indicate the possibility of a beneficial effect of it. Also (Dawes & Kubieniec, 2004 and Jagodzińska et al. 2011) [39, 40] they stated that during prolonged chewing gum use, both salivary flow rates and pH remained significantly above the values for stimulated saliva .but the result is contradict in relation to xerostomia, thirst, and interdialytic weight gain in which it conclude that regular gum chewing is known to be well tolerated by most hemodialysis patients; however, it does not lead to the alleviation of xerostomia or excessive thirst and does not reduce IWG or improve hydration status.

The study revealed that there is a statistically significant difference among patients in the study group throughout the six sessions in relation to xerostomia, thirst, salivary flow rate (ml) and interdialytic weight gain in control group. This result is in agreement with (Dirschnabel 2011& Murtagh, 2010) [41,42] in relation to xerostomia and saliva flow rate they reported that xerostomia is a frustrating symptom for patients on hemodialysis, mechanisms that contribute to its development include low saliva flow, mouth breathing, diabetes mellitus and altered salivary composition. In patients on hemodialysis the prevalence ranges from 28.2% to 66.7%. An increased intake of fluids secondary to xerostomia in patients on hemodialysis will result in excessive IWG. In a group of 94 patients undergoing hemodialysis, researchers found a strong positive

correlation between thirst and xerostomia (as assessed by the Xerostomia Inventory) as well as between both of these symptoms and IWG [22].

It is apparent from study that there is a decrease in xerostomia among patients in study group than in control group throughout the six sessions which consistent with (Bossola et al. 2012) [43] whose find that the use of sugarless chewing gum significantly reduced the severity of xerostomia (Xerostomia Inventory scores decreased from 29.9 ± 9.5 to 28.1 ± 9.1). The researchers reported that the majority of study participants rated sugarless chewing gum as a beneficial therapy, but they did not report how this beneficial effect was assessed.

Also the study noticed that there is apparent decrease in the thirst among patients in study group than in control group throughout the six sessions, this result in agreement with (Bayraktar et al. 2009) [44] who stated that chewing gum appears to alleviate thirst, and consequently may attenuate the negative cognitive performance effects of thirst that is not appears in control group.

A progressive increase in the salivary flow rate among patients in study group than in control group throughout the six sessions was noticed in present study which supported by (Stephens et al. 2011)[45] whose mentioned that salivary flow rate values were significantly lower in dialysis patients than in healthy controls. Sugar-free chewing gums should prescribe to these patients to increase the flow rate.

The study shows that there is progressive decrease in the mean weight gain among patients in study group as compared with control group throughout the six sessions. This is contradicting with the study results of (Bots et al. 2005) [46] that are stated that compliance to the fluid-restricted diet (500 ml/day) was measured by IWG. Although gum chewing and spraying with saliva substitute significantly reduced thirst, the IWG in HD patients was not affected. This result was support the result of control group which not chewed gum.

Conclusion

We conclude that the use of chewing gum alleviate thirst, xerostomia, significantly decreases interdialytic weight gain and increase salivary flow rate in HD patients.

Recommendation

1. The study was highly recommended the use of chewing gum by patient undergoing hemodialysis for its significant in decreasing thirst, xerostomia, interdialytic weight gain and increase salivary flow rate in HD patients.
2. A clinical tool should be considered as assist HD patients in adhering to the fluid-restricted diet.
3. Production and the efficacy of saliva substitutes—including new products formulated as gels, mouth washes should be conducted in populations of patients on hemodialysis.
4. Restoration of salivary function through salivary gland regeneration, tissue engineering and gene therapy could be potential therapeutic options in patients undergoing hemodialysis.

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