Evaluation the effect of x-ray on the salivary pH in case of gingivitis

Running Titles: salivary pH, x-ray, gingivitis.

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Abstract

To evaluate the effect of the x-ray on the pH of the saliva in gingivitis in compare with control group. In this study 25 patients aged between 18-35 years suffering from gingivitis, were selected, came for periodontal treatment & 10 volunteers with normal gingiva used as control group. Unstimulated Saliva collected from all patients before & after exposed to the x-ray, the salivary pH measured in both groups pre & post exposed to the x-ray. The readings showed in control group decrease in salivary pH post exposure to x-ray, analyzed by ANOVA test. There was significant difference(p- value < 0.05) in pH value pre & post exposure to the x-ray, while the readings showed in gingivitis increase in salivary pH post exposure to x-ray, analyzed by ANOVA test . There was significant difference (p- value < 0.05) in pH value pre & post exposure to the x-ray .

$$CO_2 + H_2O \Leftrightarrow HCO^{-3} + H^+$$

When the salivary water exposure to the x-ray, it will analyze the following reaction:

$$2H_2O \xrightarrow{X-ray} 2OH^- + 2H^+$$

Therefore, this explains the decrease in the pH of saliva in the control group. But the calcium, phosphate & protein are high in the saliva of gingivitis patients, so the exposed of these patients to the x-ray lead to hydrolysis of salivary water to two hydroxide ions & 2 hydrogen ions.
The calcium hydroxide is strong base while the carbonic acid is a weak acid, so this explains why the salivary pH increased in case of gingivitis may be reach to the 9 degree due to this strong base. pH of the saliva decreased in case of the control group while increased in case of the gingivitis.

الخلاصة:-

لمعرفة تأثير الأشعة السينية على pH اللعاب في حالة التهاب اللثة ومقارنتها مع مجموعة السيطرة، في هذه الدراسة تم اختيار 25 مريض لعمر بين (18-35) سنة يعانون من التهاب اللثة ، وقد تم اختيارهم أثناء المراجعة لطبيب الأسنان لمعالجة التهاب اللثة المصابين به وعشر متطوعين من غير المصابين بالتهاب اللثة كمجموعة سيطرة.
يتم جمع اللعاب غير المحفز من كل المرضى قبل وبعد التعرض للأشعة السينية،وقد تم قياس pH اللعاب لكلا المجموعتين قبل وبعد التعرض للأشعة السينية. لقد بينت القراءات في مجموعة السيطرة نقصان في قيمة pH اللعاب بعد التعرض للأشعة السينية، تم تحليلها باستخدام اختبار ANOVA. وقد وجد اختلافا معنويا (p-value <0.05) لقيمة pH اللعاب قبل وبعد التعرض للأشعة السينية، بينما في حالة التهاب اللثة بينت القراءات زيادة في pH اللعاب بعد التعرض للأشعة السينية ، وكانت الاختلافات معنوية ((p-value <0.05 لقيمة pH قبل وبعد التعرض للأشعة السينية.

$$CO_2 + H_2O \Leftrightarrow HCO^{-3} + H^+$$

عند تعرض ماء اللعاب للأشعة السينية سوف يتحلل كما موضح في المعادلة أدناه:

$$2H_2O \xrightarrow{X-ray} 2OH^- + 2H^+$$

وهذه المعادلة تبين سبب نقصان قيمة pH اللعاب عند مجموعة السيطرة. لكن نسبة الكالسيوم و الفوسفات والبروتين تكون عالية في اللعاب عند المرضى المصابين بالتهاب اللثة، لذلك تعرض هؤلاء المرضى للأشعة السينية يؤدي إلى تحلل مائي لماء اللعاب إلى (2- ايون هيدروكسيد) و(2-ايون هيدروجين).
يعتبر هيدروكسيد الكالسيوم قاعدة قوية بينما يعتبر حامض الكاربونيك حامض ضعيف، وهذا يبين سبب زيادة pH اللعاب في حالة التهاب اللثة والذي ربما يصل إلى 9 نتيجة القاعدة القوية. وقد تبين إن pH اللعاب ينقص عند مجموعة السيطرة بينما يزداد عند المصابين بالتهاب اللثة.

Introduction:-

X-ray is a beam of energy that has the power to penetrate substance and record the resultant image on radiographic film, X-ray is a high energy, ionizing electromagnetic radiation produced by the collision of a beam of electrons with a metal target in an x-ray tube. X-ray have properties of both wave and particle (particles or photons are bundles of energy without any mass or weight and traveling as wave). X-ray cause ionization of matter and can cause biologic change in living cells. Dental radiology is that area of dentistry, which is concerned with the study of radiation and its use; for the evaluation of teeth, their associated structures, and facial and cranial bones,(1). The cell damage caused by x-ray is mainly due to the formation of free radicals. As the x-ray photons strike the living cells, there ionization of water resulting in the formation of hydrogen and hydroxyl free radicals (radiolysis of water). The free radicals are unstable and highly reactive, the live time of a free radical is about 10^{-10} sec (Fig-1-) (1).

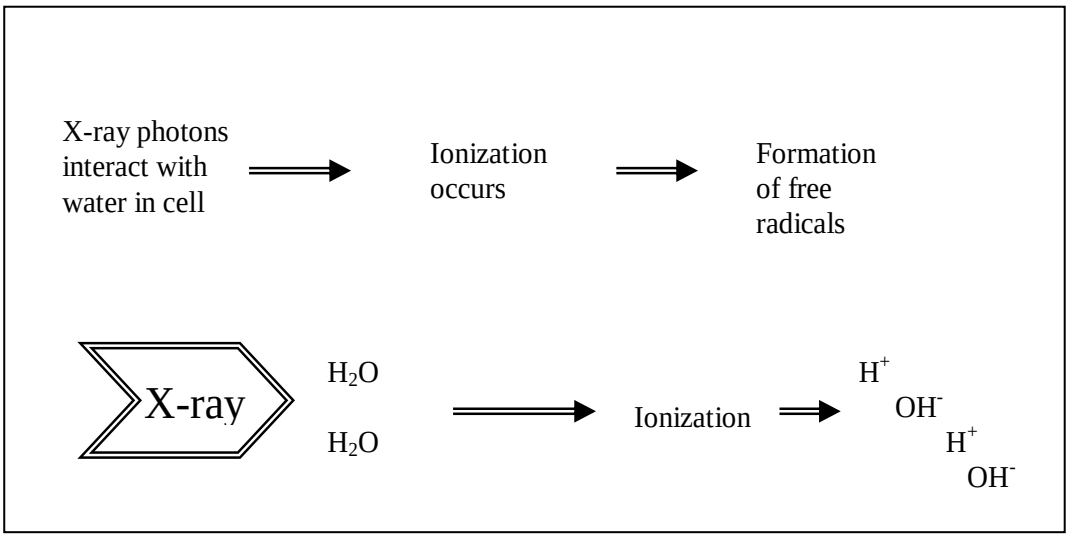

Fig (1) Radiolysis of water and formation of free radical

The major salivary glands are the parotid glands, submandibular glands and sublingual glands as shown in Fig (2). Minor salivary glands are situated on the tongue, palate, and buccal and labial mucosa. They are small mucosal glands with primarily a mucous secretion. The working part of the salivary gland tissue consists of the secretory end pieces (acini) and the branched ductal system (2). The parotid glands are "serous" glands, for their acinar cells contain only serous secreting cells, whose secretions are devoid of mucin compared to that of the submandibular and sublingual glands, which contain both serous- and mucin-secreting cells, (3&4). Whole saliva is an important fluid that contain a highly complex mixture of substance. It is secreted primarily by three paired major salivary glands and secondarily by hundreds of minor salivary glands located below the mucosal surfaces of the mouth. Salivary gland secretions contain locally produced proteins, as well as molecules from the systemic circulation (3).

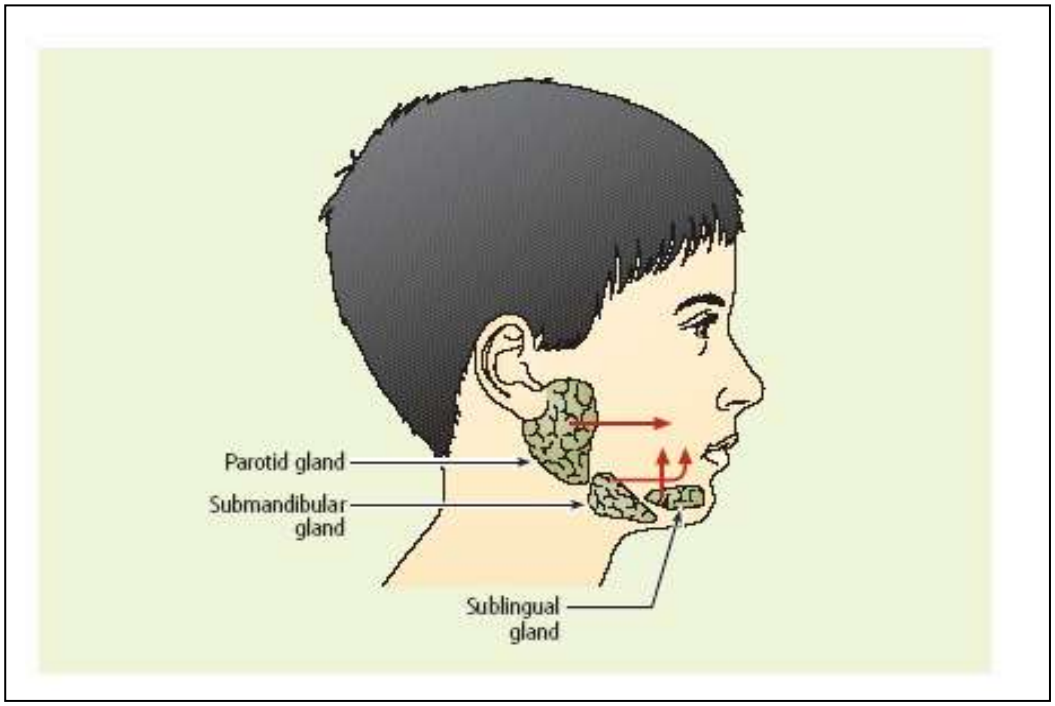

Figure (2) the major salivary glands. (5)

Saliva contains several effective buffering systems that can help maintain a normal pH when acidic foods and beverages are introduced. Thereby protecting oral tissues against acidic attack. When swallowed, these buffers protect the esophagus, helping neutralized the reflux acid of conditions such as heartburn and hernia. (6& 7)

Saliva in nature's miracle in the mouth: saliva plays a vital role in dental health as patients strive to maintain a healthy dentition throughout their lives (8).

Saliva is primary growth environment for the flora of the oral cavity (9). As the physio-chemical properties of the saliva are changed, this affect what microorganisms will grow in the mouth (10).

In terms of mineral loss, if the environment of the mouth is acidic, the mineral loss is likely to occur, however, if the environment has an alkaline pH, then the gain of mineral is equally possible, and in this context it is important to recognize that saliva is the major reservoir from which this mineral comes (11).

What happens when saliva stops protecting the teeth is exactly the opposite (12). In the mouth, which has a consistently low salivary pH at rest, it is not unusual to see recurrent caries, accelerated tooth wear, dent erosion, and candida albicans infection(13). Salivary testing provides base line information that help the clinician determine the ability of the saliva to protect the teeth from mineral loss. Follow-tests can then be used for monitoring (14 & 15).

Materials & methods:

1- patients selection:

in this study 25 patients aged between 18-35 years suffering from gingivitis**(** according to the gingival index of Loe & Sillness)(16), were selected , came for periodontal treatment & 10 apparently healthy volunteers with normal gingiva used as control group(17 &18).

2- saliva collection:

occur in two stage

- Before exposure to x-ray.

- After exposure to x-ray.

The same procedure followed in both stage before & after exposure to x-ray which involve the following: All the subjects were selected asked to rinse their mouth with distilled water thoroughly to remove any food debris & then after 10 minutes directed to collect their saliva (19).2ml of saliva was collected in resting conditions during the morning between 9AM & 12PM, at least 1 hour following food intake. Participants asked to collect saliva in their mouths & to spit it in to a wide mouthed test tube for 5 minutes (19). The saliva samples were immediately placed on ice & the stored in the temperature -4C° until used (20 &21).

3- exposure to x-ray:
after saliva collection all the participants exposed to the x-ray at the lower right premolar area (exposure time 0.500 sec) & by using the D type film, from the same x-ray appliance which characterized by the following:

Technical data of the x-ray tube & tube head:

- x-ray tube Toshiba DG 073B
- high voltage circuit single phase- self- rectifying
- size of focal spot 0.7 in compliance with IEC 336/1993
- nominal anode voltage 70 KV
- nominal anode current 8mA
- nominal anode power 420 w
- exposure time 0.08-3.2 sec in 17 steps
- anode material Tungsten
- anode inclination 20˚
- anode heat load 7 KJ
- intensity of radiation in the air 38 MGY/ mAs ± 20% at 1meter away from focal spot
- total infiltration 2mm at 70kv
- leakage radiation less than 0.25 MGY/h
- linearity 10%
- reproducibility 0.05
- radiological accuracy ± 10%

4- pH measuring :
By using the pH meter (inolob WTW 720 Germany) appliance for measuring the salivary pH. At first the electrode cleaned by distal water followed by inserted it in to the distal water for standardizing the reading, the reading the salivary pH by inserting the electrode in the defrozzed saliva (defrozzing occur by lifting the saliva at room temperature) (21). The electrode must be inserted in the distal water before & after any measuring.

Results:

Control group :

The readings showed decrease in salivary pH post exposure to x-ray & these analyzed by ANOVA test , there was no significant difference(p- value > 0.05) in pH value pre & post exposure to the x-ray as shown in table (1) & figure (3):

Table (1) Statistic analysis of control group

Control group	Descriptive statistic					p- value
	Min	Max	Mean	SD	SE	
Pre exposure	6.90	8.97	7.832	0.682	0.215	0.126*
Post exposure	6.40	8.30	7.422	0.622	0.197	

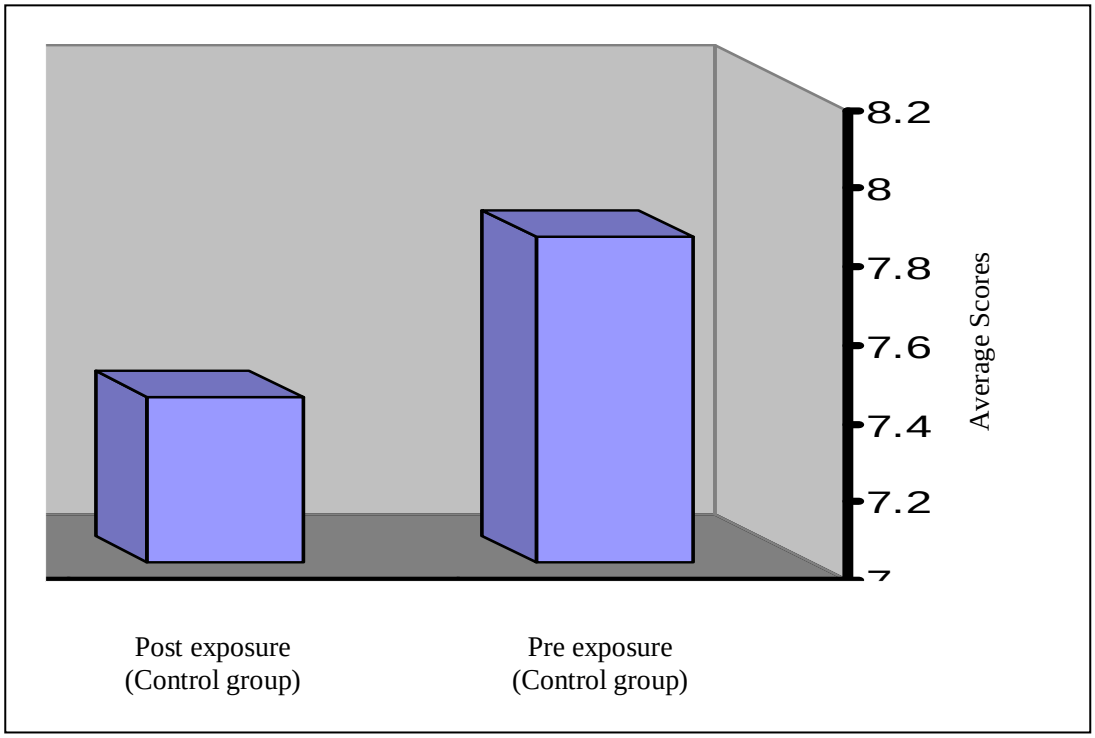

Figure (3) Average pre & post exposure pH scores of control group.

Gingivitis group:

The readings showed increase in salivary pH post exposure to x-ray & these analyzed by ANOVA test , there was significant difference(p- value < 0.05) in pH value pre & post exposure to the x-ray as shown in table (2) & figure (4):

Table (2) Statistic analysis of gingivitis group

gingivitis group	Descriptive statistic					p- value
	Min	Max	Mean	SD	SE	
Pre exposure	6.34	8.79	7.7252	0.5803	0.121	0.03**
Post exposure	6.88	8.81	8.104	0.5478	0.1142	

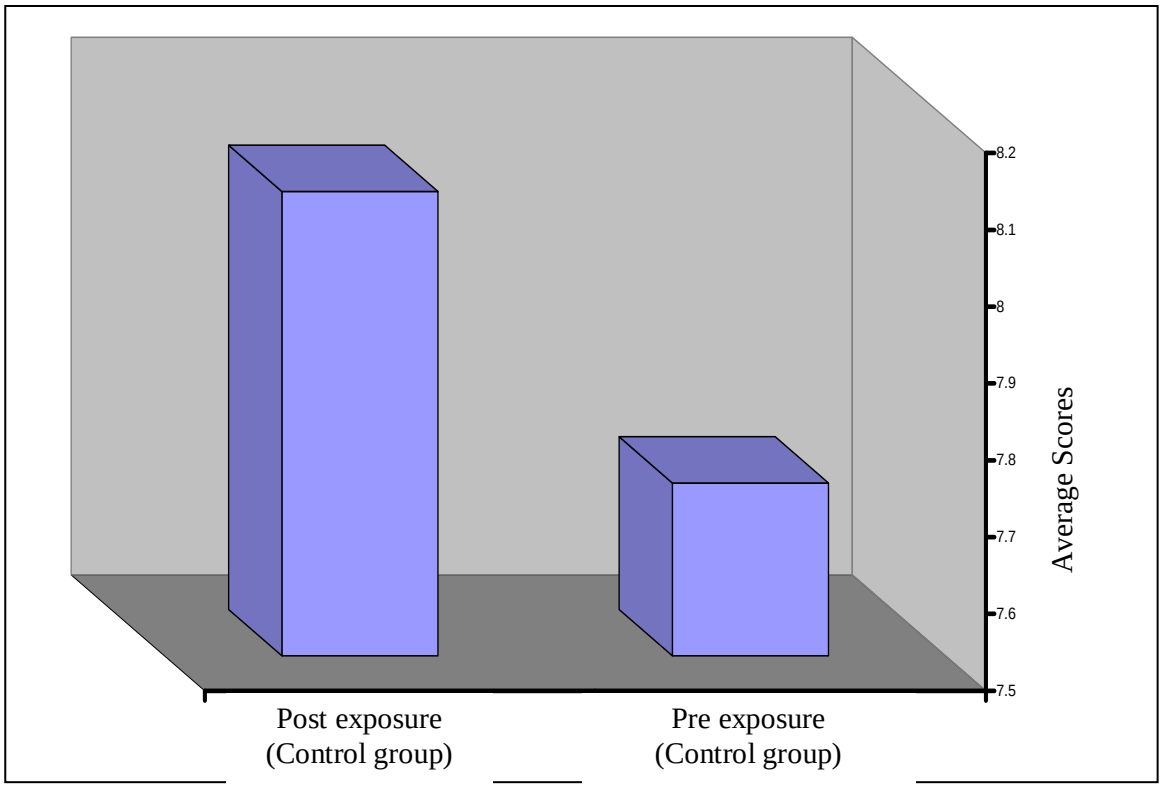

Figure (4) Average pre & post exposure pH scores of gingivitis group.

There was no significant difference in pH value between the control & gingivitis groups in pre exposure state, this shows in table (3) & there was high significant difference in pH value between the control & gingivitis groups in post exposure state, these shows in table (4) & figure (5)

Table (3) Statistic analysis of pre exposure state

Pre exposure state	Descriptive statistic					p- value
	Min	Max	Mean	SD	SE	
Control group	6.9	8.97	7.832	0.6821	0.215	0.635***
gingivitis group	6.34	8.79	7.7252	0.5803	0.121	

Table (4) Statistic analysis of post exposure state

Post exposure state	Descriptive statistic					p- value
	Min	Max	Mean	SD	SE	
Control group	6.4	8.3	7.422	0.6229	0.197	0.003****
gingivitis group	6.88	8.81	8.104	0.5478	0.114	

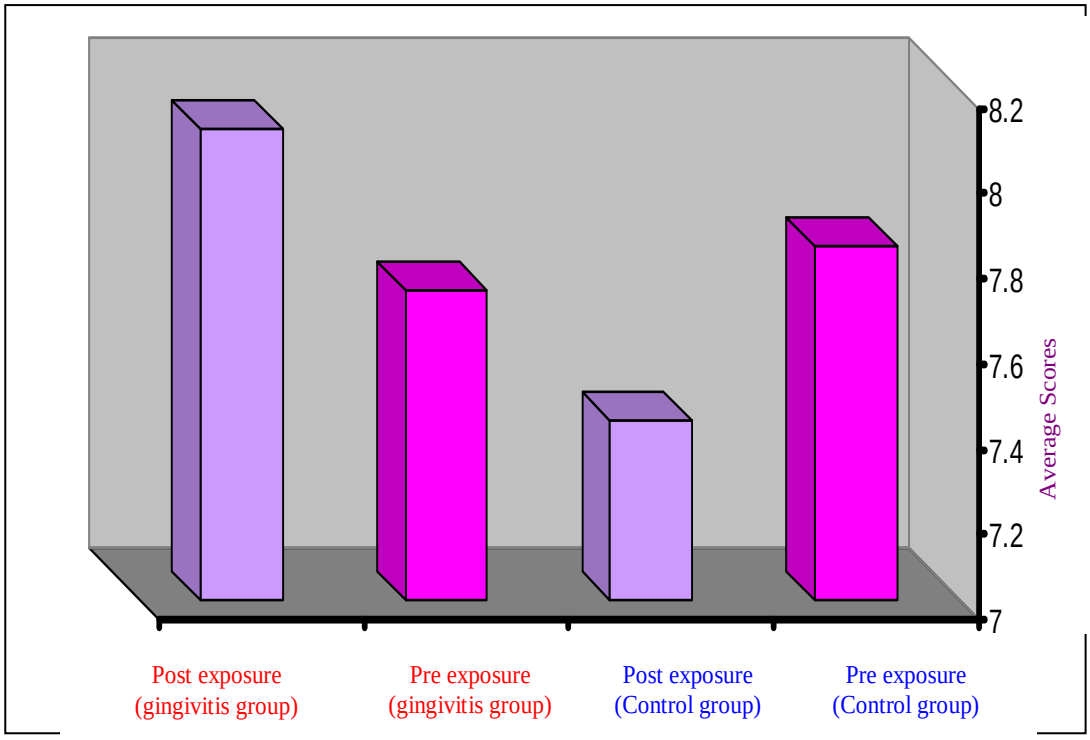

Figure (5) Average pre & post exposure pH scores of gingivitis &control groups.

Discussion:

The buffer capacity of both unstimulated &stimulated saliva involves three major buffer systems, which are the bicarbonate (HCO^{-3}), the phosphate & the protein buffer systems. The carbonic anhydrases participate in the maintenance of pH homeostasis in various tissues & biological fluid of the human body by catalyzing the reversal hydration of carbon dioxide (21):

$$CO_2 + H_2O \Leftrightarrow HCO^{-3} + H$$

When the salivary water exposure to the x-ray , it will undergo the following reaction:

$$H_2O \xrightarrow{X-ray} 2OH^- + 2H$$

Therefore, this explains the decrease in the pH of saliva in the control group.

We said say the gingivitis is the inflammation of the gum& the main causative agent for this inflammation is the accumulation of the plaque & the calculus which are rich in calcium & phosphate ions & this agreement with George et al (2009) who said the salivary proteins selectively adsorbed to solid & semisolid surfaces & consequently form a salivary film on the surfaces of the oral cavity & with Bastos et al (2001) who said protein ratio can be used as indicator for periodontal disease progression.

Therefore, the calcium , phosphate & protein are high in the saliva of gingivitis patients, so exposed these patients to the x-ray lead to hydrolysis of salivary water to two hydroxide ions & 2 hydrogen ions, the cataions calcium ions according to the following reaction:

$$Ca^{+2} + 2OH^- \rightarrow Ca(OH)_2$$

While the anaions would interacted with the bicarbonate (HCO^{-3}) ions according to the following reaction:

$$HCO^{-3} + H \leftrightarrow H_2CO_3$$

The calcium hydroxide is strong base while the carbonic acid is a weak acid, so this explains why the salivary pH increased in case of gingivitis may be reach to the 9 due to this strong base. The effects of salivary pH change is transit because the saliva formed and swallowed continuously so there is changing continuously in the salivary composition and also this affected by salivary flow rate when it decrease by different dieses affected the salivary glands or systemic dieses . Also affected by the time if decrease in sleeping and increase by affected of apatite.

*no significant difference
** Significant difference
***no significant difference
**** High significant difference (P- value <0.005)

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