

# Morphologic and Radiographic Effects of Acids on the Teeth: An in-Vitro Forensic Study

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## Abstract

**Background:** Teeth are generally considered as the most durable structures that resist physical, chemical and biological insults than skeletal tissue. Human identification through dental remains is of prime importance when the remains are found in chemical accidents such as acid attacks or uneventful accident in chemical industries, where soft tissues cannot provide reliable information. Proper examination and analysis of dental remains can provide vital information in forensic context.

**Objective:** The present study aims to evaluate the morphology and radiographic features of teeth after exposure to highly acidic environment.

**Material and Method:** A sample of total 80 extracted permanent teeth was used. Teeth were exposed to different acidic conditions like - 35% hydrochloric acid (30ml), 69% nitric acid (30ml), 98% sulphuric acid (30ml), 85% phosphoric acid (30ml) at intervals of 30 min, 1 hr, 2 hr, 4 hr, 8 hr, 16 hr and 24 hr. Before and after exposure to acids, radiographic and stereomicroscopic images were taken.

**Results:** The effect of acids on teeth depends on various factors such as the type and concentration of the acid, and also the time period. The morphological and radiological changes normally includes - changes in dimensional stability, changes in texture and colour, changes in the appearance of fissures and cracks and also appearance of the fracture and fragmentation of the samples.

**Conclusion:** Teeth can serve as a tool in identification of the victim when in contact with acidic condition. Hydrochloric acid, nitric acid and sulfuric acid cause changes in the teeth and it is possible to deduce the approximate duration for which a body has been immersed in acid based on the changes observed. The characteristics of teeth may be of assistance in cases of human identification where soft tissue features are unavailable.

**Keywords:** Acids, stereomicroscope, dental identification, teeth, forensic odontology.

## Introduction

Forensic odontology has now evolved among the intriguing branches of forensic sciences over the past

few years. Forensic dentistry contributes well by way of reconstruction through dental structures. The forensic odontologist mainly deals with the identification based on recognition of unique features present in an individual's oral structures.<sup>1</sup>

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Teeth normally survives in most natural disasters and are a possible tool for personal identification of an otherwise unrecognizable body.<sup>2</sup> Teeth can survive in extreme climatic condition because enamel is the hardest substance in the body being 96% mineralized, compared to bone which is approximately 70% mineralized.<sup>3</sup> The posterior teeth are well protected by soft tissues like the

tongue, facial musculature, and adipose tissue. Due to its hard structural integrity it survives prolonged immersion, decomposition, desiccation, extensive trauma, and direct heat in excess of 1000°F.

In chemical accidents, the hard tissues including the skeletal structures are destroyed completely and soft tissues cannot provide reliable information, hence thereby rendering a challenge for identification of the individual.<sup>4</sup> Moreover, there is an apparent lack of data on radiographic alterations along with morphologic changes in teeth at various acids which necessitates study in this area.

The purpose of the study was to identify the acid that may be used by criminals for destruction of hard tissue – teeth and to find out the approximate time taken for total destruction of tooth after immersion in an acid. The objective was to observe the stereomicroscopic and radiographic changes.

**Material and Method**

Eighty extracted human natural teeth were obtained for an in-vitro experimental study.

All teeth were non-carious and had been extracted for orthodontic treatment or periodontal reason. Before exposing to various acids, teeth used for the study were rinsed thoroughly in tap water and cleaned with a

toothbrush in order to remove any soft tissue and later were disinfected by using 10% formalin. Deposits of calculus were removed using a manual scaler.

Thirty-five percent hydrochloric acid (conc. HCl), 69% nitric acid (conc. HNO<sub>3</sub>), 98% sulfuric acid (conc. H<sub>2</sub>SO<sub>4</sub>) and 85% Phosphoric Acid (conc. H<sub>3</sub>PO<sub>4</sub>) are used in this study.

Twenty samples were immersed in 30 ml of each acid solution and were observed for 24 hours. Teeth were retrieved at intervals of 30 min, 1 hr, 2 hr, 4 hr, 8 hr, 16 hr and 24 hours from the acidic environment, washed in distilled water, dried, photographed, and later radiographed. Each of specimen’s morphology was observed under a stereomicroscope at 15X magnifications (Zeiss Stemi DV4 Stereo Zoom Microscope) at time intervals of 30 min, 1 hr, 2 hr, 4 hr, 8 hr, 16 hr and 24 hours. The macroscopic and radiographic changes were well noted.

**Results**

The teeth samples that were subjected in 30 ml of 35% hydrochloric acid (conc. HCL) showed following morphological and radiographic changes. (Table -1) (Figure-1)









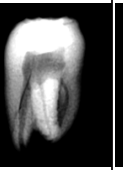


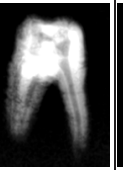
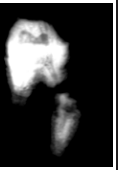
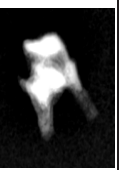
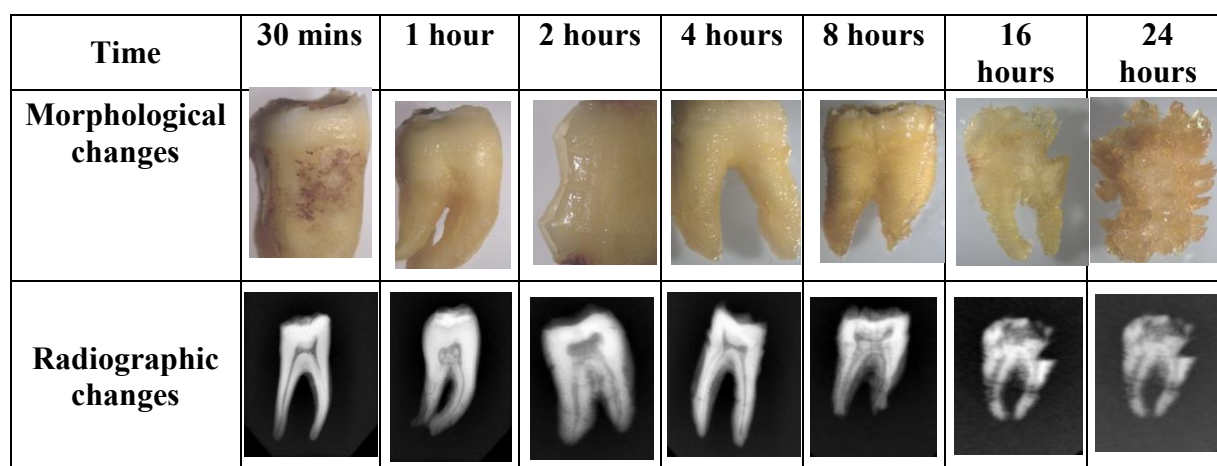
Time	30 mins	1 hour	2 hours	4 hours	8 hours	16 hours	24 hours
<b>Morphological changes</b>							
<b>Radiographic changes</b>							

Figure-1: Sequential morphological and radiographic changes observed after immersion in 30 ml - 35% hydrochloric acid (conc. HCL)

**Table-1: Changes observed in teeth placed in 30 ml - 35% hydrochloric acid (conc. HCL)**

Time	Morphological changes	Radiographic changes
30 mins - 1 hour	Only deterioration of enamel surface was seen.	Deterioration of enamel surface and the curvature appeared smooth.
2 - 4 hours	Disintegration of the crown with gel like formation on dentin	Presence of small fractured lines in root portion.
8 - 24 hours	Crown loses its morphology and deterioration is well appreciated in enamel and dentin	Teeth to be showed as start dissolving.

The teeth samples that were subjected in 30 ml of 69% Nitric acid (Conc. HNO<sub>3</sub>) showed following morphological and radiographic changes (Table-2) (Figure-2).



**Figure-2: Sequential morphological and radiographic changes observed after immersion in 30 ml - 69% Nitric acid (Conc. HNO<sub>3</sub>)**

**Table-2: Changes observed in teeth placed in 30 ml - 69% Nitric Acid (conc. HNO<sub>3</sub>)**

Time	Morphological changes	Radiographic changes
30 min	Loss of enamel surface and surface structure become smooth and yellow color residue deposited over the tooth.	Showed no fracture lines in teeth, deterioration of enamel surface was noticed, surface outline of the teeth is smooth.
1 hour	Further dissipation of enamel is observed and yellow colored residues are seen over the tooth. At this temperature, surface texture becomes sticky in nature	Deterioration of enamel surface, many fracture lines are seen in root portion.
2 - 8 hours	Teeth shows gel like consistency and sticky over the entire crown portion than compared to the root.	Teeth showed loss of thickness of the root portion and the complete deterioration of the crown.
16 - 24 hours	The 3-dimensional structure of teeth gets converted into 2-dimensional structure, and later, the total morphology of teeth gets lost.	Teeth lost their complete morphology.

The teeth samples that were subjected in 30 ml of 98% Sulphuric Acid (conc. H<sub>2</sub>SO<sub>4</sub>) showed following morphological and radiographic changes (Table-3) (Figure-3).

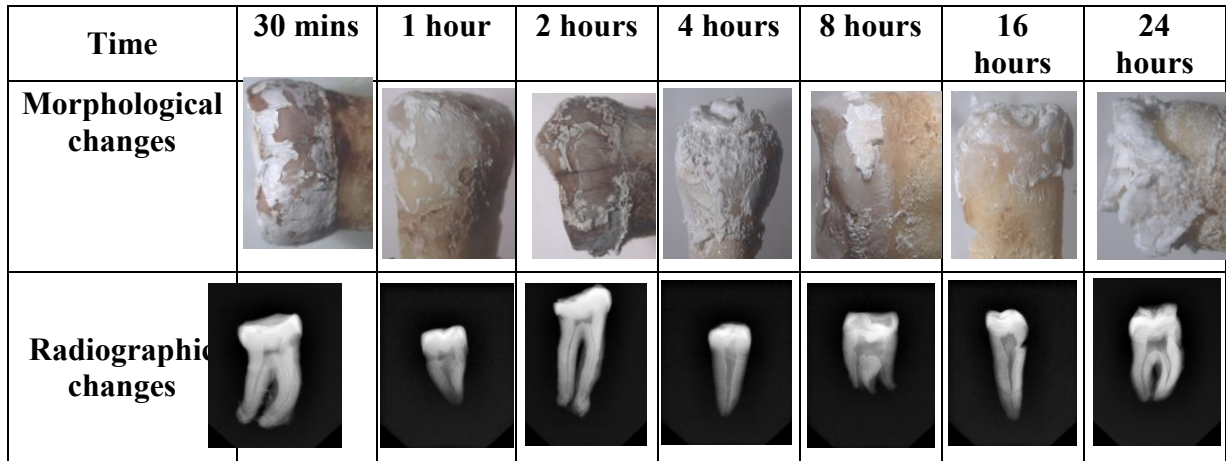


Figure-3: Sequential morphological and radiographic changes observed after immersion in 30 ml - 98% Sulphuric Acid (conc. H<sub>2</sub>SO<sub>4</sub>)

Table-3: Changes observed in teeth placed in 30 ml - 98% Sulphuric Acid (conc. H<sub>2</sub>SO<sub>4</sub>)

Time	Morphological changes	Radiographic changes
1-3 hours	Chalky white appearance seen on the crown portion and slight over the root portion, loss of glossy surface of the crown.	No morphologic were observed.
4-8 hours	White chalky precipitates seen on crown and root portion, dryness of teeth with loss of glossiness of surface.	Flaking of enamel was observed and fracture line seen in root portion.
16-24 hours	Chalky white appearance and dissipation of the morphology of the crown portion and irregular lines seen over the surface of the root.	Deterioration of enamel surface and multiple fractures line are seen in root portion.

The teeth samples that were subjected in 30 ml of 85% Phosphoric Acid (conc. H<sub>3</sub>PO<sub>4</sub>) showed following morphological and radiographic changes (Table-4) (Figure-4).

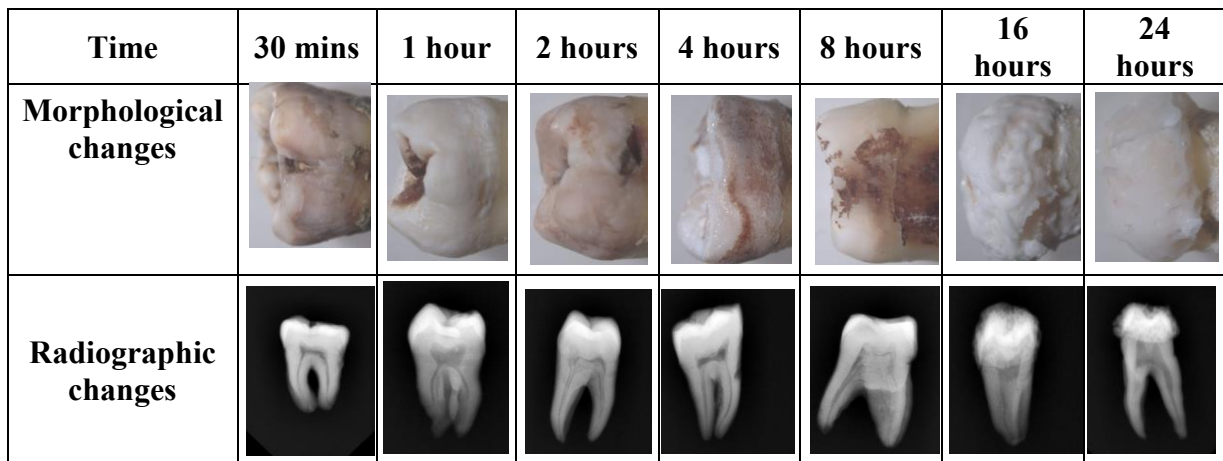


Figure-4: Sequential morphological and radiographic changes observed after immersion in 30 ml - 85% Phosphoric Acid (conc. H<sub>3</sub>PO<sub>4</sub>)

**Table-4: Changes observed in teeth placed in 30 ml - 85% Phosphoric Acid (conc. H<sub>3</sub>PO<sub>4</sub>)**

Time	Morphological changes	Radiographic changes
30 mins - 2 hours	Teeth loss its glossiness and enamel becomes dry and chalky deterioration of enamel.	No morphologic changes were observed.
4-8 hours	slight brownish discoloration of teeth is seen with removal of enamel surface	Crown covered by some radioopaque cloudiness no morphologic changes were observed in crown and root portion.
16-24 hours	Crown portion showed melting of enamel surface by which crown portion look slightly large as compared to pre-exposure teeth and the root surface look dry and shiny.	More radioopaque cloudiness over the crown portion slight deterioration of enamel surface, morphology of the teeth is intact.

### Discussion

This study justified that the natural teeth are the most durable of all the living tissues as they persist by chemical agents.

Teeth can be used as a source of evidence in cases of human identification, especially those cases where the soft tissues are unavailable as a possible identification tool. 5, 6

In this study, the morphologic and radiographic changes were observed to the teeth exposed to varied acidic medium. From this experimental study, we could conclude that teeth do not react in the same way in all acids.

In case of 35% HCl and 69% HNO<sub>3</sub> the teeth were completely dissolved but in HNO<sub>3</sub> medium, the color change in the form of the yellow colored deposit was mainly because of the nitrate formed in the chemical reaction and in H<sub>2</sub>SO<sub>4</sub> and H<sub>3</sub>PO<sub>4</sub> there was no dissolution; instead, a white precipitate was formed because of the formation of a non-soluble salt. Thus, there are clear differences in the destructive capacities of the different acids.

Recognizable morphological and radiographical appearances of teeth persisted for 8 hr. in HCl but Raj et al (2013) <sup>4</sup>. in their study reported that mild to deep cracks developed in tooth in 15 to 30 mins, and the tooth started dissolving in 1 hour, the tooth was completely dissolved in 8 hours, for Nitric acid is same as 8 hr. in HCl where as Jadhav et al (2009) <sup>7</sup> observed in their study that yellow colour appears in 15 min, disintegration of apical 3rd in 4 hours, splitting of teeth in 8 hours, and completely dissolved in 15 hours. Cope and Dupras note

in their study that the teeth immersed in hydrochloric acid took on a “jelly-like appearance” which describes the outer layer translucency observed in this study <sup>8</sup> - and for Sulphuric and phosphoric acid morphological and radiographical appearances of teeth persisted even after 24 hr Mazza et al (2005) <sup>9</sup> found in their study that no changes seen till 5 hours.

Thus by seeing the morphological and radiographical feature we can determine the type of acid used and for which duration it can also determine, slight elevation of dimension were observed in Sulphuric and phosphoric acid during 16-24 hr. Thus there are clear differences in the destructive capacities of different acids used in the study.

### Conclusion

The durability of these teeth may be utilized as a successful identification tool in forensic science. According to this study, the morphological and radiographical changes observed in teeth after particular time interval of immersion in an acid solution can be utilized for identification of the acid used and to deduce the approximate duration of immersion in the acid. However, the final decision on which acid has been used should be based on biochemical tests. It should also be noted that the effect of acids on teeth not only depends on the type of the acid or the concentration of acid or the time period but it also depends upon the size of the teeth or the position of the teeth.

**Conflict of Interest** – None Declared

**Source of Funding** – None

**Ethical Clearance** – Not required (As this article has used only extracted teeth and does not contain any



studies with human participants or animals)

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