

**EFFECT OF CONCENTRATED AND DILUTE NITRIC ACID ON TOOTH  
MORPHOLOGY - A FORENSIC STUDY**

**Running title:** Effect of nitric acid on tooth morphology.

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## **ABSTRACT**

### **BACKGROUND**

Teeth are the hardest substance present in the human body. Hence, it acts as a hint in determining the age and sex in forensic cases. Acid erosion is otherwise known as dental erosion in the case of teeth. It is the irreversible change in tooth structure due to chemical dissolution of acid.

**AIM** To study the effect of concentrated and dilute nitric acid on tooth morphology.

**MATERIALS AND METHOD** Extracted non-carious teeth ( n = 6 ) were used in the study. The teeth were placed in 69% concentrated nitric acid and partially diluted nitric acid separately. The samples were taken out at various intervals like 5 hours and 24 hours. The morphological changes were observed and the teeth were placed back in the container.

**RESULT** Statistically significant decrease in buccal and palatal length, mesial, distal, buccal and palatal width was observed in the teeth placed in both concentrated and dilute nitric acid. The teeth turned yellow, became glossy and soft after 5 hours of immersion in the acid. By the end of 24 hours the teeth were completely dissolved.

### **CONCLUSION**

Extreme morphological changes were observed when the teeth were placed in concentrated and dilute nitric acid. The major application of the present study is in forensic odontology.

**KEYWORDS:** Novel method, Dental erosion, Forensic odontology, Nitric acid, Tooth morphology, Innovative technique.

## **INTRODUCTION**

Teeth is found to be the hardest substance in the human body and it persists even after the destruction of all other skeletal structures (1). These dental structures are useful indicators in determining a person's age (2). Acid erosion is also known as dental erosion which is a type of tooth wear due to acids (3). It is the pathological loss of hard dental tissues due to the influence of chemicals from acids (4).

Destroying the human body by immersing it in acid to avoid identification of criminals is a common crime these days. Forensic scientists play a major role in finding out whether complete dissolution of the human body in acid can take place and if it is possible to find the time taken (5). This is considered as a help to the forensic odontologists (6). Forensic odontology plays an important role in identification of persons in disasters, in crime investigations, identification of skeletonised and deceased individuals (7). This branch of study depends on the antemortem dental reports to compare it with the postmortem reports of the deceased person which aids in the identification of the individual (8).

Erosion of the tooth begins with the softening of the enamel surface which depends on the immersion time and different acids (9). The critical pH below which a tooth starts to erode is found to be 4.5 (10). Hence, it is necessary to assess the time taken by the acid to demineralise the enamel and expose the dentin. This study focuses on creating awareness on the effect of acid on teeth to increase people's consciousness on the intake of acidic beverages. It also aids the forensic odontology sciences in the personal identification of criminals and controls such crimes.

The acid used in the present study was nitric acid which is a strong oxidising agent and it reacts often with the readily oxidisable substances. This reaction is exothermic and explosive (11). Our team has extensive knowledge and research experience that has translate into high quality publications (12),(13),(14),(15),(16),(17),(18),(19),(20),(21),(22),(23),(24),(25),(26),(27),(28),(29),(30), (31)

The aim of this research is to study the effect of concentrated and dilute nitric acid on tooth morphology.

## **MATERIALS AND METHOD**

Extracted natural teeth ( n = 6 ) were used in this study. These teeth were collected from the department of oral and maxillofacial surgery. Non carious teeth that were extracted for periodontal reasons were used and in view of chemical alteration, the teeth affected with caries were excluded from the study. The teeth collected were kept in a dry environment at room temperature before the experimental procedure. The acids used in the study were 69% concentrated nitric acid and partially diluted nitric acid. The teeth were immersed separately in different containers containing concentrated and dilute nitric acid and distilled water. The teeth were retrieved at an interval of 5 hours

and 24 hours from the caustic environment, washed in distilled water, dried, photographed and dimensional assessment were done. Buccal and distal length, mesial, distal, buccal and palatal width were measured using a digital vernier caliper. The teeth were again placed in the acid. The readings were tabulated and comparison of the length and width was done between the different intervals and it is represented as a graph.



**Figure 1**



**Figure 2**



**Figure 3**

Figure 1 depicts the initial morphology of the tooth before immersing in concentrated nitric acid

Figure 2 depicts the morphological changes of the tooth such as discoloration, soft texture and glossy appearance after 5 hours of immersion in concentrated nitric acid.

Figure 3 depicts the complete dissolution of the tooth immersed in concentrated nitric acid by the end of 24 hours.



**Figure 4**



**Figure 5**



**Figure 6**

Figure 4 represents the initial morphology of the tooth before immersing in dilute nitric acid.

Figure 5 represents the morphological changes of the tooth after 5 hours of immersion in dilute nitric acid.

Figure 6 represents the complete dissolution of the tooth immersed in dilute nitric acid by the end of 24 hours.

**RESULT**

The teeth were retrieved after 5 hours and observed after 24 hours. The following changes were noticed.

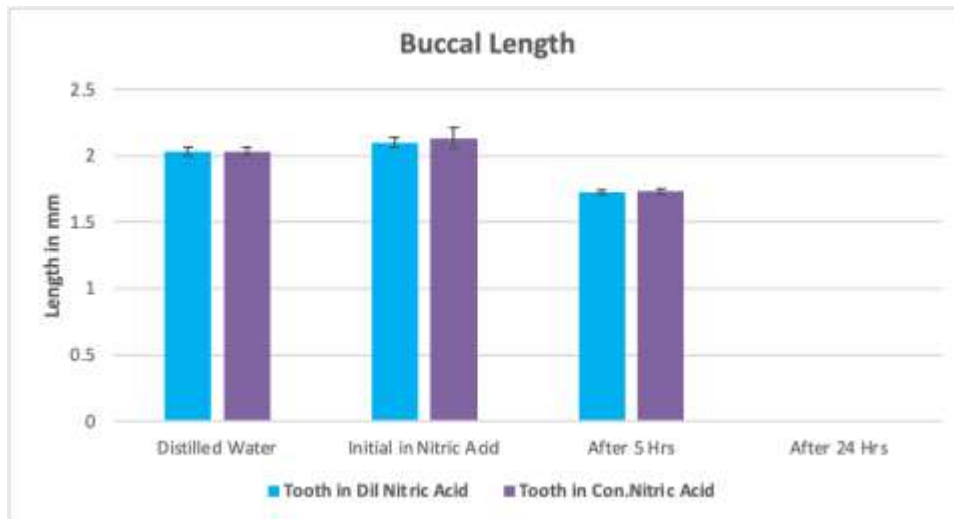
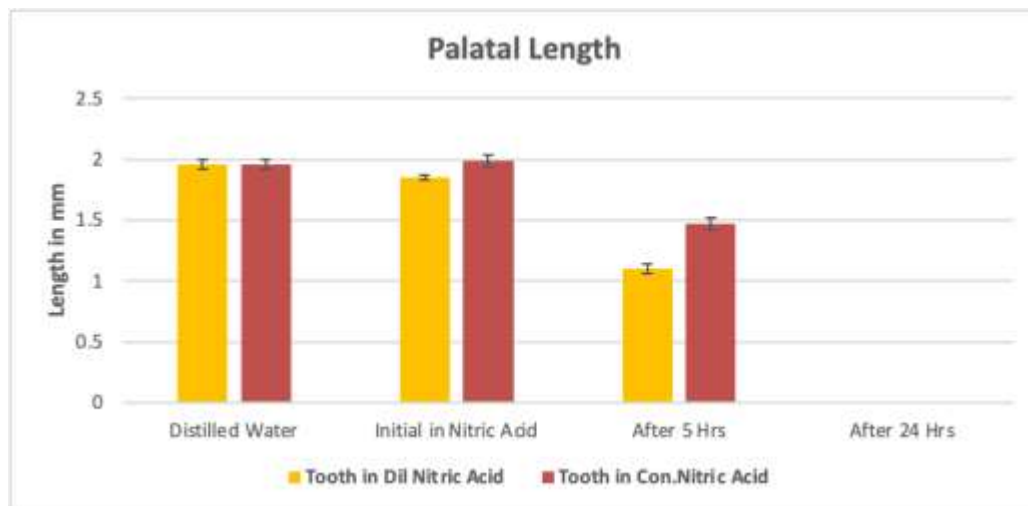


Figure 7 depicts the bar graph showing the relation between the time interval of tooth immersion and buccal length. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the buccal length. Blue colour represents the tooth in dilute nitric acid and purple colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the buccal length was observed in the teeth immersed in both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.

Figure 8 depicts the bar graph showing the relation between the time interval of tooth immersion and palatal length. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the palatal length. Yellow colour represents the tooth in dilute nitric acid and brown colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the palatal length was observed in the teeth immersed in both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.



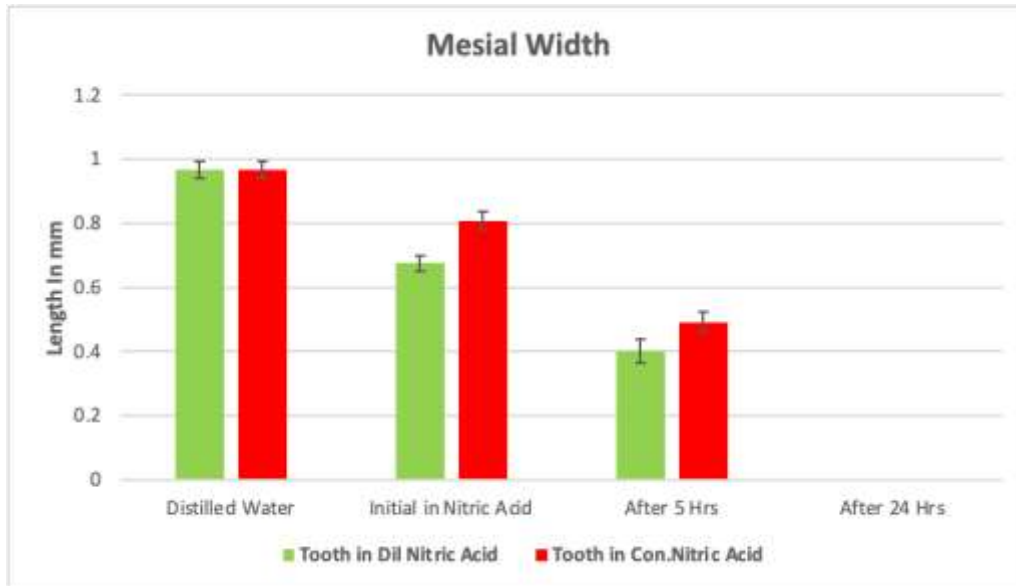


Figure 9 depicts the bar graph showing the relation between the time interval of tooth immersion and mesial width. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the mesial width. Green colour represents the tooth in dilute nitric acid and red colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the mesial width was observed in the teeth immersed in both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.

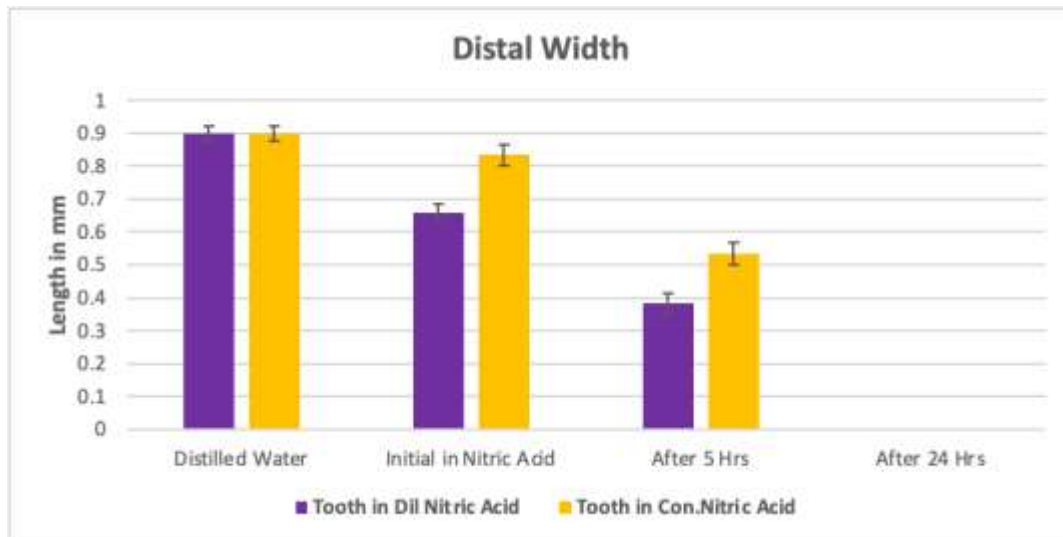


Figure 10 depicts the bar graph showing the relation between the time interval of tooth immersion and distal width. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the distal width. Purple colour represents the tooth in dilute nitric acid and yellow colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the distal width was observed in the teeth immersed in

both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.

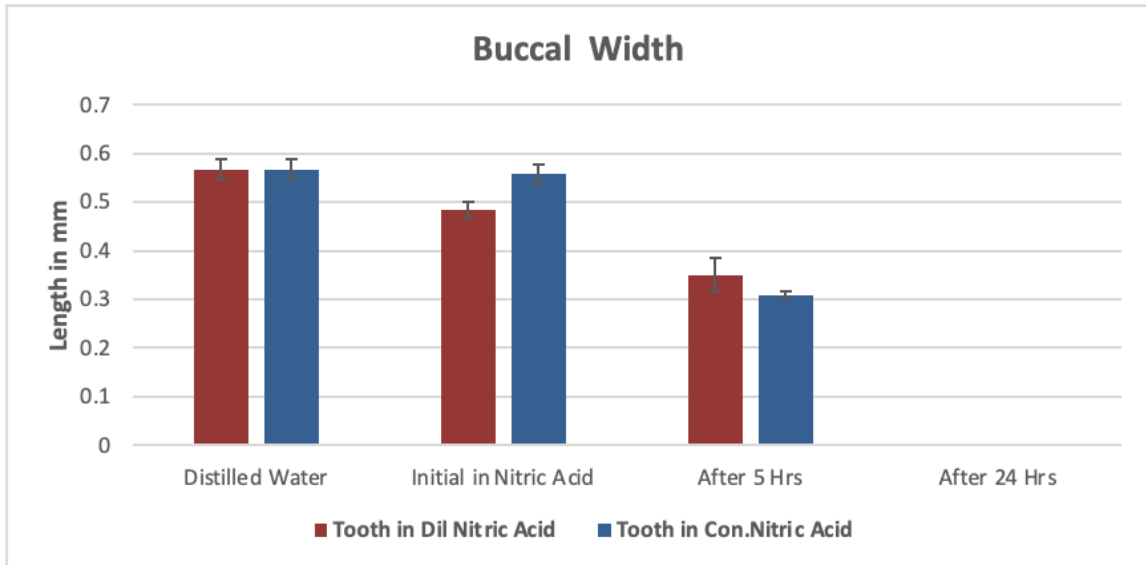


Figure 11 depicts the bar graph showing the relation between the time interval of tooth immersion and buccal width. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the buccal width. Brown colour represents the tooth in dilute nitric acid and blue colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the buccal width was observed in the teeth immersed in both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.

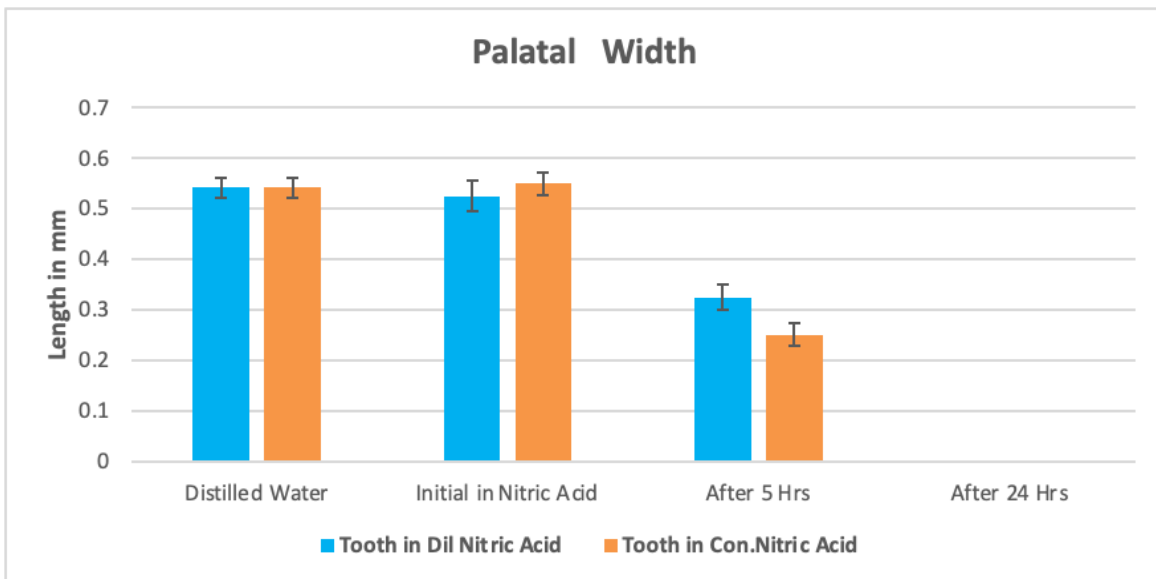


Figure 12 depicts the bar graph showing the relation between the time interval of tooth immersion and palatal width. X axis represents the different time intervals like initial, after 5 hours and after 24 hours and Y axis represents the palatal width. Blue colour represents the tooth in dilute nitric acid and yellow colour represents the tooth in concentrated nitric acid. A statistically significant decrease in the palatal width was observed in the teeth immersed in both concentrated and dilute nitric acid after 5 hours of immersion and the teeth were completely dissolved after 24 hours.

## **DISCUSSION**

The teeth immersed in dilute and concentrated nitric acid showed a lot of morphological changes like decolourisation, soft texture, glossy appearance and showed statistically significant decrease in length and width after 5 hours. By the end of 24 hours complete dissolution of the teeth were observed. In another experiment conducted by (1) the tooth immersed in concentrated nitric acid showed discoloration in its root in 15 minutes and cracks were formed in one hour and at the 8th hour the tooth was dissolved completely. This is because these acids cause dental erosion which causes enamel erosion and ultimately leads to tooth loss (32). Dissolution of enamel is significantly related to various parameters like viscosity, pH, buffer capacity, titratable acid, etc (33).

In an experiment conducted by (5) the tooth was immersed in 65% concentrated nitric acid. After 15 hours of interval the tooth was almost completely dissolved except for some remnants. Complete dissolution was observed by 20 hours. In another study conducted by (34) the posterior mandibular molar tooth of a rat immersed in 10% formal nitric acid was completely decalcified within 40 hrs 48 mins. From the previous findings of (35) it is observed that the speed of decalcification of teeth in 10% nitric acid was the fastest. In the previous study conducted by (36) with 2.5% nitric acid, the 30 second treatment of tooth was referred for etching after which the tooth started to erode and lose its natural morphology.

The limitation of the present study was small sample size and the handling of harmful acids. In future, a similar study can be conducted with larger samples, as the morphological changes that occur in the tooth immersed in acid can be used for sex determination, finding the age of the victim and ultimately identifying the individuals attacked with acid. Hence, this study may play a key role in forensic odontology.

## **CONCLUSION**

The effect of concentrated and dilute nitric acid on tooth morphology was observed. From this study, it is observed that the hardest part of the human body- the tooth can be destroyed using nitric acid. Hence, awareness about acids and its effect on teeth is necessary. It is important to follow safety measures while handling acids for either commercial or laboratory purposes. Further studies may be required to study the ultrastructure of teeth exposed to different acids, which may be helpful for forensic sciences.

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## **AUTHOR CONTRIBUTION**

Revathy.E - contributed in designing the study, execution of the project, statistical analysis, manuscript drafting.

V.Vishnu Priya - contributed in study design, guiding the research work, manuscript correction.

Abirami Arthanari, Gayathri.R, Kavitha.S, Reshma PK - study design, statistical analysis, manuscript proofreading and correction.

### CONFLICT OF INTEREST

The authors hereby declare that there is no conflict of interest in this study.

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