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MORPHOLOGICAL ANALYSIS OF EXTRACTED HUMAN TEETH IN THREE DIFFERENT ACIDS AS AN AID IN FORENSIC IDENTIFICATION

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ABSTRACT

Background: The mode of crime has been changing now days, which is becoming unbelievingly cruel. The victims of acid crime usually pose identification problem when the body is completely mutilated. The present study was conducted to know how teeth can help in identification of a totally mutilated body. **Aim and objectives:** The aim of the study was to know the strength and type of acid most likely to be used in acid crime with the objective to observe the morphological changes on teeth and time taken by various acids to produce the same. **Materials and method:** Natural human teeth were taken and placed in 50 ml of 3 types of acids viz. hydrochloric acid (HCl), nitric acid (HNO_3), sulphuric acid (H_2SO_4) and were observed periodically to notice the morphological changes occurring in the tooth. **Results:** The study revealed that the tooth could be completely dissolved in nitric acid in approximately 16 hours after immersion whereas hydrochloric acid takes 270 hours to completely dissolve the teeth specimen. Immersion of teeth in sulphuric acid showed precipitation of tooth within 232-240 hours after immersion. The mean time taken for HNO_3 to dissolve the teeth specimen was 24.3000, in HCl was 189.3500 and it was

found to be maximum in H_2SO_4 group i.e. 266.7500. **Conclusion:** It was concluded that all three acids produced observable morphological changes in the tooth, among which nitric acid was found to be the fastest and most dangerous.

KEYWORDS: Acid crime, Forensic, Dissolution, Precipitation.

INTRODUCTION

Human identification is one of the most challenging subjects that man has been confronted with. The forensic discipline is concerned with the application of science and technology to the detection and investigation of crime and administration of justice, requiring the coordinated efforts of a multidisciplinary team.[1] Dental identification remains one of the most reliable and frequently applied methods of identification, predominantly by the comparisons of ante-mortem and post-mortem records.[2] The science of dealing with evidence from dental and oral structures – Forensic Odontology, is a specialty unto itself.[3] Forensic odontology has established itself as an important and often indispensable science in medicolegal matters and in particular in identification of the dead.[4]

Dental identifications have always played a key role in natural and manmade disaster situations and in particular the mass casualties normally associated with aviation disasters. The most important role of the forensic odontologist is the identification of deceased individuals. Dental identification has two main forms. Firstly, and most frequently performed examination is a comparative identification of antemortem dental records with the post mortem dental records in order to establish the identity of the victim. Secondly, in those cases where antemortem records are not available, and no clues to the possible identity exist, a postmortem (after death) dental profile is completed by the forensic odontologist suggesting characteristics of the individual likely to narrow the search for the antemortem materials. Dental identification of humans is required for different reasons and in different situations. The bodies of victims of violent crimes, fires, motor vehicle accidents, acid crime, can be mutilated to such an extent that identification by a family member is neither reliable nor desirable.

The practice of destroying the human body by immersing it in an acid or some other caustic substance in order to avoid any personal identification is drawing a great deal of forensic interest these days.[5]

Acids make the perfect weapon since

- ✓ They are easily hidden and carried
- ✓ Cheap to buy
- ✓ Easy to use

The forensic scientist needs to know whether it is possible to destroy the human body partially or totally by immersing it in an acid and, if so, how much is necessary for its complete destruction. Another important question is whether there are any means of identifying the deceased individual from the residual remains.

HCl, HNO_3 and H_2SO_4, literally melts the skin instantaneously upon contact. In less than a few minute the bone under the skin begins to expose. If there is enough acid, the bone itself can become soft mass of non distinguishable jelly. The identification of dental remains is of prime importance when the deceased person is skeletonized, decomposed, burned or dismembered.[6] Joanna *et al*. have used various kinds of acids at various concentrations to compare the different decalcification methods for teeth. Since natural teeth are most durable of all tissues they can persist even long after skeletal structures have been destroyed by physical agents. Further, it is now possible to extract DNA even after decades after death.[7] This possibility makes tooth a suitable and desirable tool in victim identification.

AIM AND OBJECTIVES

- To identify the acid used by criminals for destruction of a human body
- To deduce the approximate time taken for total destruction of body after immersion in an acid
- To observe the morphological changes in natural human teeth when they are kept immersed in an acid.

MATERIALS AND METHOD

Sixty extracted human natural teeth were used for study. All teeth were non carious and had been extracted for periodontal and orthodontic reasons. The teeth were kept in a dry environment at room temperature before the onset of the experiment.

Equal quantity of 3 acids was used in this study procedure.

- ∗ Aqueous solution of hydrochloric acid (HCl): 50 ml (29.2 ml of 37% HCl + 20.8ml of water)

* Aqueous solution of nitric acid (HNO_3): 50 ml (32.50 ml of 65% HNO_3 + 17.25 ml of water)
* Aqueous solution of sulphuric acid (H_2SO_4): 50 ml (48 ml of 96% H_2SO_4 + 2 ml of water)

The teeth samples were divided into 3 groups.

Group I: 37% HCl + 20 extracted teeth

Group II: 65% HNO_3 + 20 extracted teeth

Group III: 96% H_2SO_4 + 20 extracted teeth

The teeth were immersed separately in different containers containing 3 different acids. At various intervals the samples were taken out of the container and examined for morphological changes, photographed and placed back in the containers. The specimens were under observation until completely dissolved /precipitated.

OBSERVATIONS

Teeth immersed in 37% HCl showed: (Fig 1 & Graph 1)

~ Effervescence (within half an hour)
~ Transparency (1 ½ hr)
~ Dissolution of 1/3rd of crown (approx. 18 hrs)
~ Dissolution of 2/3rd of crown (approx. 36 hrs)
~ Sac like appearance of teeth (approx.72 hrs)
~ Near complete dissolution (approx. 270 hrs)

Teeth immersed in 65% HNO_3 showed: (Fig 2 & Graph 2)

~ Effervescence (within half an hour)
~ Yellow discoloration (approx.1 ½ hr)
~ Disintegration and vertical lines and circular lines (approx. 3 hrs)
~ Fragmentation (10-11 hrs)
~ Dissolution (16-20hrs)

Teeth immersed in 96% H_2SO_4 showed: (Fig 3 & Graph 3)

~ White precipitate (20-24 hrs)
~ Pitting / Granular precipitate (40-48 hrs)
~ 1/3rd precipitation (72 -74 hrs)

~ 2/3rd precipitation (160 -168 hrs)

~ Complete precipitation (232 -240 hrs)

RESULTS

The observed data was tabulated and subjected to statistical analysis.

Table 1: Mean time of dissolution in three different acids

Acid	No. of teeth	Mean time of dissolution	Standard Deviation	Minimum	Maximum
HCl	20	**189.3500**	± 63.21498	83.00	296.00
HNO_3	20	**24.3000**	± 9.24577	12.00	46.00
H_2SO_4	20	**266.7500**	± 45.49942	188.00	320.00

Analysis of Variance (ANOVA)

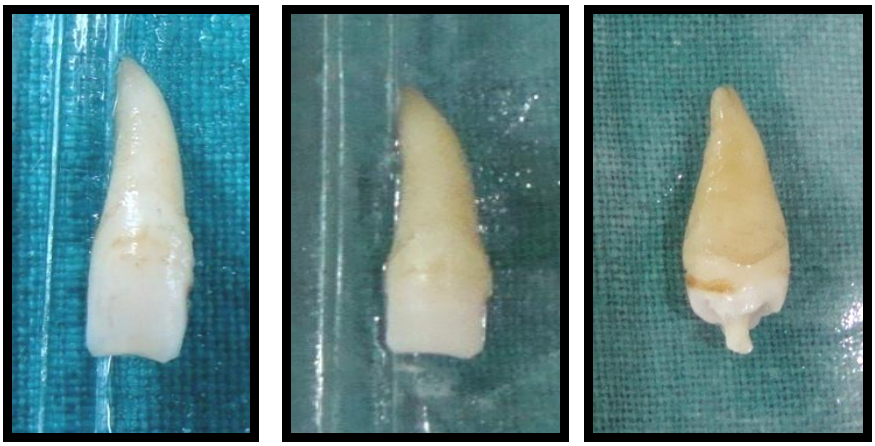
This test was used to compare intra group and inter group variances amongst study groups.

Table 2: intra group & inter group variances among study groups

Group	Sum of Squares	Degree of freedom (df)	Mean Square	Sig. (p)
Inter Group	613428.433	2	306714.217	**<0.001**
Intra Group	116884.500	57	2050.605	**Non Significant**

INFERENCE

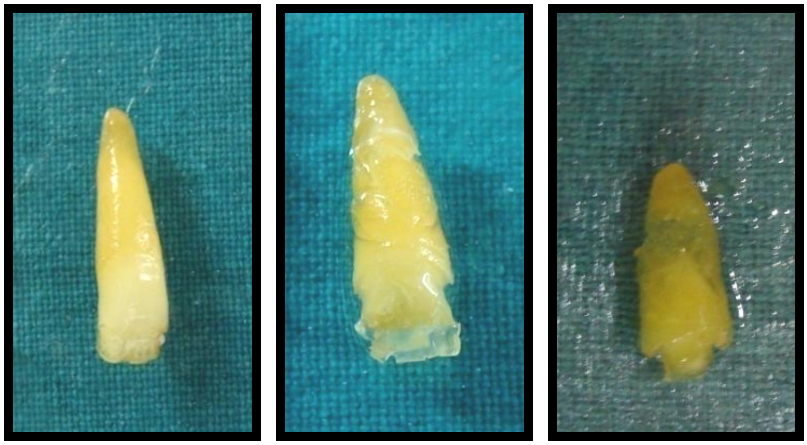
A statistically significant intergroup difference was observed regarding mean time of dissolution/ precipitation` of teeth in different groups. The mean time of dissolution of teeth was minimum in HNO_3 group (**24.3000**) and maximum in H_2SO_4 group (**266.7500**). The obtained "p value" was found to be significant ($p<0.001$). This was found to be in accordance with a study conducted by.[8]



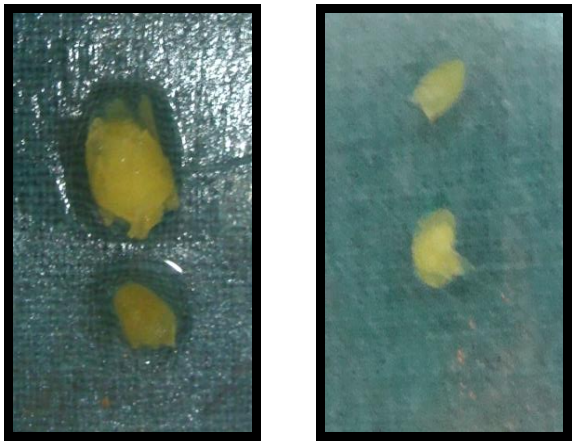
0.5 hours **1 hour** **18 hours**

36 hours **270 hours**

Fig 1: Morphological changes in tooth in HCl at various intervals

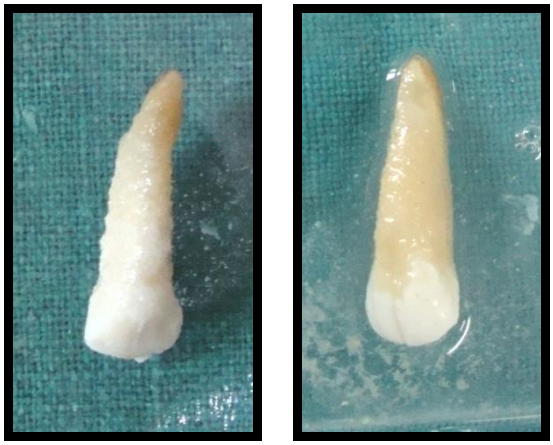


1 hour **4 hours** **10 hours**

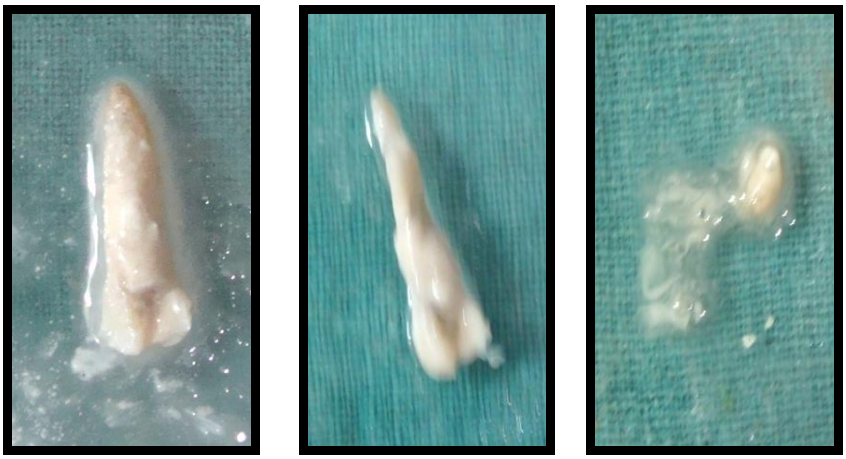


12 hours **16 hours**

Fig 2: Morphological changes in tooth in HNO_3 at various intervals



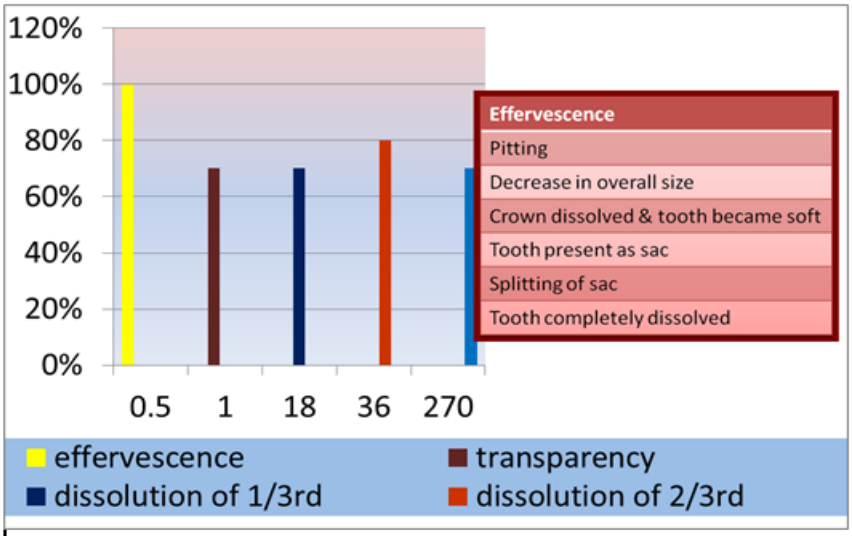
24 hours 48 hours



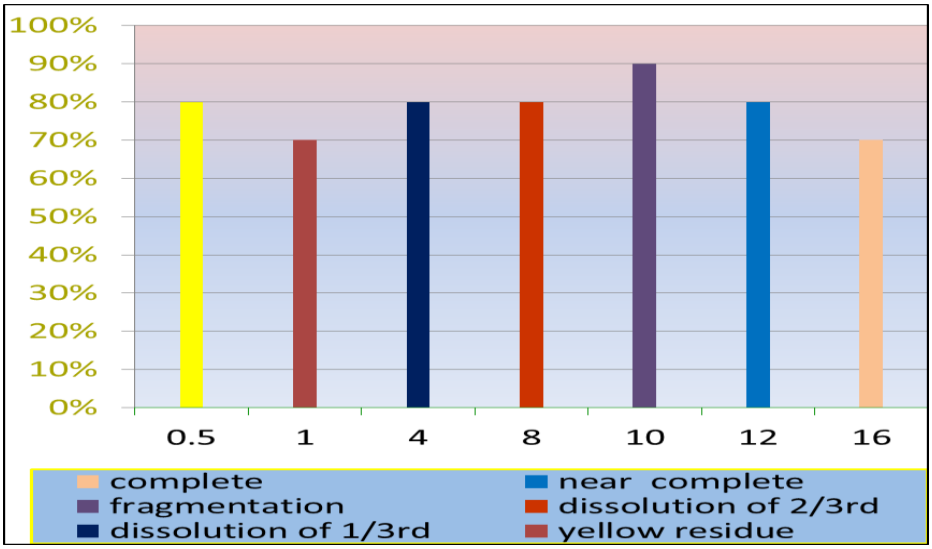
72 hours 168 hours 240 hours

Fig 3: Morphological changes in tooth in H_2SO_4 at various intervals

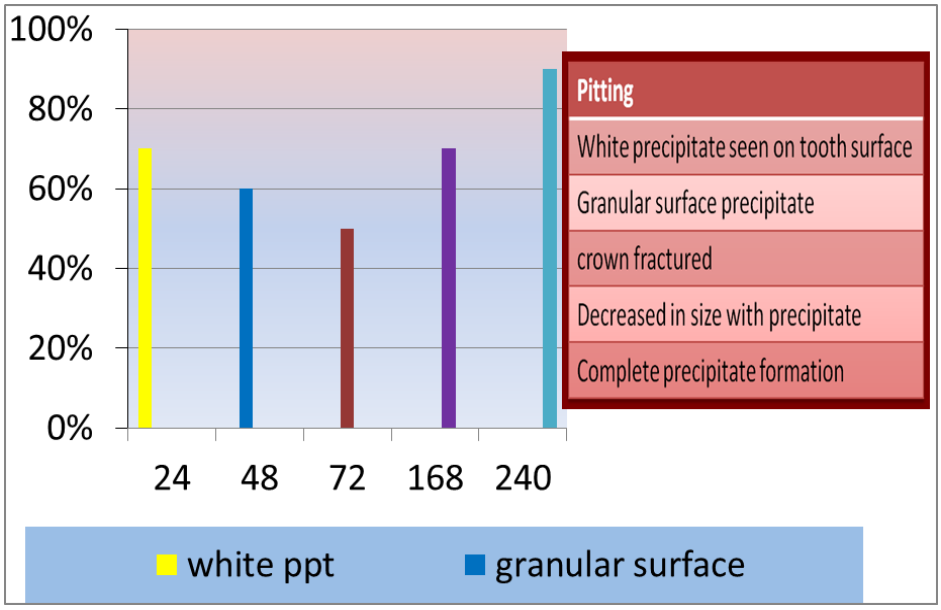
GRAPHS



Graph 1: Morphological changes observed in teeth immersed in HCl



Graph 2: Morphological changes observed in teeth immersed in HNO_3



Graph 3: Morphological changes observed in teeth immersed in H_2SO_4

DISCUSSION

Literature reveals that there are very few studies that have actually focused on the issue of destruction of human body by chemical means. This serves the issue of positive identification after acid dissolution. The use of teeth in this study is justified by the evidence that natural teeth are most durable of all tissues. We used non- carious teeth because caries can modify behavior of teeth when they are placed in an acid; there may be acceleration of destruction process because of cavitation secondary to caries.

❖ Reaction of teeth with 37% HCl-

This showed complete dissolution because of formation of calcium chloride ($CaCl_2$) which is a completely soluble salt.

$$Ca^{+2} + 2HCl \rightarrow CaCl_2 + H_2\uparrow$$

(completely soluble salt)

❖ Reaction of teeth with 65% HNO_3-

This showed dissolution and yellow discoloration due to formation of calcium nitrate $(CaNO_3)_2$.

$$CaSO_4 + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2SO_4$$

❖ Reaction of teeth with 96% H_2SO_4-

No dissolution was seen instead a white precipitate was formed due to formation calcium sulphate ($CaSO_4$) which is an insoluble salt.[5]

$$Ca^{+2} + H_2SO_4 \rightarrow CaSO_4\downarrow$$

(insoluble salt)

The information derived in this study on the morphological changes observed in teeth after particular periods of immersion in acid solution can be utilized for

- identification of acid used
- to deduce approximate duration of immersion in acid

Concentration of acids used in the present study was the ones that are most commonly available commercially.

HCl & H_2SO_4 are more easily available commercially than HNO_3. HCl is cheaper than HNO_3 & H_2SO_4. Based on these observations and our experimental results, it is concluded that 37% HCl is most likely to be used in crimes of this nature. However, it is always advisable to carry out the usual biochemical tests to confirm the acid used.

Recognizable morphological appearances of teeth persisted for approximately 40-44 hrs in HCl, 12-14 hrs in HNO_3 &190- 200 hrs H_2SO_4.

Morphological characteristics help investigator in deciding whether the tooth:

- Single/Multirooted
- Deciduous/Permanent
- Restored/ Unrestored

The field of genetics is making advances at a tremendous speed. Technological and methodological innovations are advancing, along with our knowledge about the human genome. One application of this knowledge is to the field of forensics, which has undergone an enormous wave of technological improvements.[9] The genetic approach taken by a forensic investigator can be employed in situations when it becomes absolutely impossible to identify dental structures. In such circumstances, other investigations mitochondrial DNA analysis of the residual material can be considered.

Other investigations like chemical and histological analysis clearly depends on the state of the remains, the types of available reference samples, and the facility with which other identification methods can be applied.

CONCLUSION

Forensic dentistry plays a major role in the identification of those individuals who cannot be identified visually or by other means. The unique nature of our dental anatomy and the placement of custom restorations ensure accuracy when the techniques are correctly employed.

From this study it is concluded that human body can be destroyed with the help of an acid. In crimes of this nature, HCl is the most commonly used acid. Morphological changes in teeth can help the forensic investigator to deduce the time elapsed since immersion of body in an acid. By keeping in mind the likely choice of a criminal and by observing the morphological changes in teeth, it may be possible to deduce the type of acid used to destroy body. However, the final decision on which acid has been used should be based on biochemical analytical tests.

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