ABSTRACT

Background: The mode of crime has been changing now days, which is becoming unbelievably 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 (HNO₃), sulphuric acid (H₂SO₄) 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 HNO₃ to dissolve the teeth specimen was 24.3000, in HCl was 189.3500 and it was
found to be maximum in \(\text{H}_2\text{SO}_4\) 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, HNO₃ and H₂SO₄, 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 (HNO₃): 50 ml (32.50 ml of 65% HNO₃ + 17.25 ml of water)
* Aqueous solution of sulphuric acid (H₂SO₄): 50 ml (48 ml of 96% H₂SO₄ + 2 ml of water)

The teeth samples were divided into 3 groups.

**Group I:** 37% HCl + 20 extracted teeth
**Group II:** 65% HNO₃ + 20 extracted teeth
**Group III:** 96% H₂SO₄ + 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% HNO₃ 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% H₂SO₄ 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

<table>
<thead>
<tr>
<th>Acid</th>
<th>No. of teeth</th>
<th>Mean time of dissolution</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl</td>
<td>20</td>
<td>189.3500 ± 63.21498</td>
<td>83.00</td>
<td>296.00</td>
<td></td>
</tr>
<tr>
<td>HNO₃</td>
<td>20</td>
<td>24.3000 ± 9.24577</td>
<td>12.00</td>
<td>46.00</td>
<td></td>
</tr>
<tr>
<td>H₂SO₄</td>
<td>20</td>
<td>266.7500 ± 45.49942</td>
<td>188.00</td>
<td>320.00</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Group</th>
<th>Sum of Squares</th>
<th>Degree of freedom (df)</th>
<th>Mean Square</th>
<th>Sig. (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter Group</td>
<td>613428.433</td>
<td>2</td>
<td>306714.217</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intra Group</td>
<td>116884.500</td>
<td>57</td>
<td>2050.605</td>
<td>Non Significant</td>
</tr>
</tbody>
</table>

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 HNO₃ group (24.3000) and maximum in H₂SO₄ 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]
Fig 1: Morphological changes in tooth in HCl at various intervals

36 hours

270 hours

Fig 2: Morphological changes in tooth in HNO$_3$ at various intervals

1 hour

4 hours

10 hours

12 hours

16 hours
Fig 3: Morphological changes in tooth in $\text{H}_2\text{SO}_4$ at various intervals

Graph 1: Morphological changes observed in teeth immersed in HCl
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.

\[
\text{Ca}^{+2} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2 \uparrow
\]

(completely soluble salt)

- Reaction of teeth with 65% HNO$_3$-
  This showed dissolution and yellow discoloration due to formation of calcium nitrate (Ca(NO$_3$)$_2$).

\[
\text{CaSO}_4 + 2\text{HNO}_3 \rightarrow \text{Ca(NO}_3)_2 + \text{H}_2\text{SO}_4
\]

- Reaction of teeth with 96% H$_2$SO$_4$-
  No dissolution was seen instead a white precipitate was formed due to formation calcium sulphate (CaSO$_4$) which is an insoluble salt.$^5$

\[
\text{Ca}^{+2} + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 \downarrow
\]

(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$_2$SO$_4$ are more easily available commercially than HNO$_3$. HCl is cheaper than HNO$_3$ & H$_2$SO$_4$. 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$_2$SO$_4$.

**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. 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.

REFERENCES


