Morphological analysis of acid effects on extracted teeth and teeth with restorative materials

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ABSTRACT

Aim: The aim of the present study was to evaluate the destruction capacity of various commonly used concentrated acids on natural teeth and teeth with restorative materials.

Methods: The present study was carried out in the Department of Oral & Maxillofacial Pathology, DJ College Of Dental Sciences and Research, Modinagar (U.P). One hundred and fifty (150) teeth extracted teeth used as samples for this study.

Results: It was found that the intact teeth when immersed in HCL acid showed fragmentation of the tooth at 2 hrs which was shown by 50 % of the samples and at 16 hrs there was complete dissolution of the tooth in 60% of the samples and by 24 hrs all the test samples showed complete dissolution. It was found that the intact teeth when immersed in Nitric acid showed crumbling of the tooth at 2 hrs which was shown by 100 % of the samples whereas at 8hrs there was reduced tooth structure in all the samples at 16 hrs 90% of the samples showed complete dissolution and at 24 hrs 100% of the samples showed complete dissolution. It was found that the intact teeth when immersed in Sulphuric acid showed fragmentation of the tooth at 48 hrs which was shown by only 25% of the samples and at 256 hrs there was complete dissolution of the tooth in all the test samples. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Conclusion: As our study deals with morphological change observed in teeth and restoratives materials which can help forensic investigator to deduce the time elapsed since immersion of body in an acid. Human dentition can serve as great evidence when a person is affected with H2SO4. But if the bodies are immersed in the HCl or HNO3 it will be difficult to make a positive diagnosis with teeth as a factor. The restorative materials recovered in such situations could be used as a prime factor when the teeth were completely dissolved or precipitated.

Keywords: destruction capacity, concentrated acids, natural teeth, restorative materials.

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Introduction

Teeth are considered to be essential organs in both living and nonliving population for anthropological, genetic, odontologic and forensic investigations. This is due to the hardness and high resistance of dental tissues to degradation and putrefaction which enable the teeth to survive for longer periods than other human tissues[1], making them more resistant to trauma, decomposition, water immersion, chemicals and fire, serving as an invaluable evidential source. To match these natural requirements, the foreign materials subsequently placed in the mouth by the dental practitioner such as fillings, dentures, crowns, bridges and implants must be equally resistant to the intense mechanical demands placed upon them and therefore their survivability.[2]

Teeth normally survives in most natural disasters and are a possible tool for personal identification of an otherwise unrecognizable body.[3] 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.[4] 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.

Despite leaps in modern technology, medical breakthroughs and the geographical changes that the last century has brought, crime still persists in all aspects of our lives. Violent and heinous activities that shatter the lives of victims, their friends and families occur every day. Often, little can be done to repair such damage. The apprehension and subsequent prosecution of the perpetrator(s) is essential to maintain law and order. Through the specialty of forensic odontology, dentistry plays a small but significant role in this process. By identifying the victims of crime and through dental records, dentists assist those involved in crime investigation.[5] HCl, HNO3 and H2SO4, literally melts the skin instantaneously upon contact. In less than a 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. 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. This possibility makes tooth a suitable and desirable tool in victim identification.[6]

The aim of the present study was to evaluate the destruction capacity of various commonly used concentrated acids on natural teeth and teeth with restorative materials.

Material and Methods

The present study was carried out in the Department of Oral & Maxillofacial Pathology, DJ College Of Dental Sciences and Research, Modinagar (U.P). One hundred and fifty (150) teeth extracted teeth used as samples for this study which were removed due to periodontitis and for orthodontic purposes (maxillary and mandibular anterior and premolars) at Department Of Oral & Maxillofacial Surgery in D.J. College Of Dental Sciences And Research Modinagar (U.P). All the teeth were divided into three broad groups with 50 teeth each.

1.   Hydrochloric acid group (35-38%); 50 extracted teeth (20 intact teeth+ 30 teeth restored with 3 different restorative materials like GIC, COMPOSITE & AMALGAM of 10 each)
2.   Nitric acid group (69-72%): 50 extracted teeth (20 intact teeth+ 30 teeth restored with 3 different restorative materials like GIC, COMPOSITE & AMALGAM of 10 each)
3.   Sulphuric acid group; 50 extracted teeth (20 intact teeth+ 30 teeth restored with different restorative materials of 10 each)

Inclusion Criteria:
•   Teeth extracted for orthodontic purposes (Therapeutic extractions)

- Impacted teeth free of any defects
- Teeth extracted for periodontal disease

Exclusion Criteria:
- Teeth with carious defect
- Teeth with any pulpal and periapical diseases
- Teeth with attrition, abrasion and erosion
- Fractured teeth
- Teeth with any developmental anomalies

Acids used for the study are:

Nitric Acid (HNO_3) 69-72 % LR 500 ml SDFCL company (sd fine chem. Ltd)

Hydrochloric acid (HCL) 35- 38% LR 500 ml SDFCL company (sd fine chem. Ltd)

Sulphuric Acid (H_2SO_4 98 % LR 500 ml SDFCL company (sd fine chem. Ltd)

Method:

Soft tissue surrounding the teeth was completely removed mechanically from the teeth which was followed by disinfecting the teeth in 0.5% sodium hypochlorite solution for one hour. Out of 150 extracted teeth, cavity preparation was done on 90 teeth and restored with different restorative materials namely amalgam, GIC and composite of 30 each. 10 teeth restored with each restorative material would be immersed separately in 3 different acids. The remaining 60 extracted teeth without any restorations were immersed separately in different containers containing 3 different acids of 20 teeth each. The teeth with and without restorations were immersed separately in different containers containing three different acids. At various intervals of 5 min,15min,30 min,1 hr, 2 hr, 3hrs , 8hr, 16 hrs, 24 hrs, 48 hrs, 72 hrs, 96hrs, 120 hrs 144 hrs, 164 hrs, 184 hrs , 204 hrs 256 hrs. for observing the morphological changes . The samples were taken out of the container and washed it under saline and examined for any morphological changes, then photographed and placed back in the containers. The specimens were kept under observation until completely dissolved or completely precipitated. The teeth were then be analyzed macroscopically by direct vision of the samples using the following parameters mentioned below:

For Teeth:

Color of the crown and root	visual parameters through pictures
Cracks & fissures in the tooth -	visual parameters through pictures

For Restoration

Color of the restoration	visual parameters through pictures
Cracks and detachment of the restoration	visual parameters through pictures

Fig 1: Dissolution of teeth in HCL acid after 16 hrs duration

Fig 2:

Teeth in HCL after 8 hours

Fig 3:Teeth immersed in HNO3 acid 5 min duration

Fig 4: Teeth after 15 min in HNO3

Fig 5:Teeth immersed in H2SO4 acid

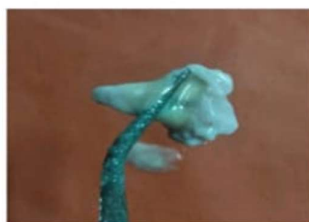**Fig 6:Teeth restored composite showing pink staining after 24 hours in H2SO4**

Fig 7: Teeth showing dislodged amalgam restoration after 72 hours in H2SO4

Fig 8: White precipitate at 256 hours in H2SO4

Results

Table 1: Morphological changes in intact teeth at different time intervals (HCL).

	No Change	Pink Coloured Stain	Effervescence	Transparency	Crumbling	Reduced Tooth Structure and Flabby appearance	Complete Dissolution
5 MIN	100%	-	-	-	-	-	-
15 MIN	-	100%	-	-	-	-	-
30 MIN	-	-	100%	-	-	-	-
60 MIN	-	-	-	100%	-	-	-
2 HRS	-	-	-	-	50%	-	-
4 HRS	-	-	-	-	70%	-	-
8 HRS	-	-	-	-	-	90%	
16 HRS	-	-	-	-	-	-	60%
24 HRS	-	-	-	-	-	-	100%
48 HRS	-	-	-	-	-	-	100%
72 hrs	-	-	-	-	-	-	100%
96 hrs	-	-	-	-	-	-	100%
102hrs	-	-	-	-	-	-	-
120hrs	-	-	-	-	-	-	-
144hrs	-	-	-	-	-	-	-
164hrs	-	-	-	-	-	--	-
184hrs	-	-	-	-	-	-	-
204hrs	-	-	-	-	-	-	-
256hrs	-	-	-	-	-	--	-

It was found that the intact teeth when immersed in HCL acid showed fragmentation of the tooth at 2 hrs which was shown by 50 % of the samples and at 16 hrs there was complete

dissolution of the tooth in 60% of the samples and by 24 hrs all the test samples showed complete dissolution. The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 2: Morphological changes in intact teeth at different time intervals (HNO3)

	No Change	Coloured Stain	Effervescence	Transparency	Crumbling	Reduced Tooth Structure	Complete Dissolution
5 MIN	100%	-	-	-	-	-	-
15 MIN	-	100%	-	-	-	-	-
30 MIN	-	-	100%	-	-	-	-
60 MIN	-	-	-	100%	-	-	-
2 HRS	-	-	-	-	100%	-	-
4 HRS	-	-	-	-	100%	-	-
8 HRS	-	-	-	-	-	100%	-
16 HRS	-	-	-	-	-	-	90%
24 HRS	-	-	-	-	-	-	100%
48 HRS	-	-	-	-	-	-	100%
72 HRS	-	-	-	-	-	-	100%
96 HRS	-	-	-	-	-	-	100%
120 HRS	-	-	-	-	-	-	100%
144hrs	-	-	-	-	-	-	-
164hrs	-	-	-	-	-	-	-
184hrs	-	-	-	-	-	-	-
204hrs	-	-	-	-	-	-	-
256hrs	-	-	-	-	--	-	-

It was found that the intact teeth when immersed in Nitric acid showed crumbling of the tooth at 2 hrs which was shown by 100 % of the samples whereas at 8hrs there was reduced tooth structure in all the samples at 16 hrs 90% of the samples showed complete dissolution and at 24 hrs 100% of the samples showed complete dissolution. The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 3: Morphological changes in intact teeth at different time intervals (sulphuric acid)

	NO CHANGE	COLORED STAIN	EFFERVISCENCE	white precipitate	Fragmentation	COMPLETE DISSOLUTION
5 MIN	100	-	-	-	-	-
15 MIN	100	-	-	-	-	-
30 MIN	-	-	100%	-	-	-

60 MIN	-	-	100%	-	-	-
2 HRS	-	-	100%	-	-	-
4 HRS	-	-	100%	-	-	-
8 HRS	-	-	-	100%	-	-
16 HRS	-	-	-	100%	-	-
24 HRS	-	-	-	100%	-	-
48 HRS	-	-	-	-	25%	-
72 HRS	-	-	-	-	25%	-
96 HRS	-	-	-	-	50%	-
120 HRS	-	-	-	-	50%	-
144 hrs	-	-	-	-	50%	-
164 hrs	-	-	-	-	60%	-
184 hrs	-	-	-	-	60%	-
204 hrs	-	-	-	-	75%	-
256 hrs	-	-	-	-	-	100%

It was found that the intact teeth when immersed in Sulphuric acid showed fragmentation of the tooth at 48 hrs which was shown by only 25% of the samples and at 256 hrs there was complete dissolution of the tooth in all the test samples. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$

Table 4: Morphological changes in GIC restored teeth at different time intervals (HCL)

	No Change	Dislodged Restoration	Dislodged RestorationAnd Crystalline Tooth Structure
5 MIN	100%	-	-
15 MIN	100%	-	-
30 MIN	100%	-	-
60 MIN	100%	-	-
2 HRS	-	40%	-
4 HRS	-	80%	-
8 HRS	-	-	90%
16 HRS	-	-	100%
24 HRS	-	-	100%
48 HRS	-	-	100%
72 hrs	-	-	100%
96 hrs	-	-	100%
120hrs	-	-	-
144hrs	-	-	-
164hrs	-	-	-

184hrs	-	-	-
204 hrs	-	-	-
256 hrs	-	-	-

It was found that the GIC restored teeth when immersed in HCL acid , showed no change in the restoration till 1 hr whereas at 2 hrs acid there was dislodgement of restoration in 40 % of the samples.,.The complete dislodgment of restoration with crystalline tooth structure was seen in 100 percent of the samples at the time period of 16 hrs The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 5: Morphological changes in GIC restored teeth at different time intervals (Nitric acid)

	No Change	**Dislodged Restoration**	**DislodgedRestoration and crystalline and undifferentiated Tooth**
5 min	100%	-	-
15 min	100%	-	-
30 min	100%	-	-
60 min	50%	50%	-
2 hrs	-	100%	-
4 hrs	-	100%	-
8 hrs	-	-	100%
16 hrs	-	-	100%
24 hrs	-	-	100%
48 hrs	-	-	100%
72 hrs	-	-	100%
96 hrs	-	-	100%
120 hrs	-	-	100%
144hrs	-	-	-
164hrs	-	-	-
184hrs	-	-	-
204hrs	-	-	-
256hrs	-	-	-

It was found that the GIC restored teeth when immersed in Nitric acid , showed no change in the restoration till 30 min whereas at 1 hr there was dislodgement of restoration in 50 % of the samples. All the samples showed the complete dislodgement of restoration at the time period of 4 hrs The un differentiation of the tooth structure in all the samples with dislodgment of restoration was seen at 8 hrs The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 6: Morphological changes in GIC restored teeth at different time intervals (SULPHURIC ACID)

	No Change	Dislodged Restoration	Dislodged and crystalline and undifferentiated Tooth
5 MIN	100%	-	-
15 MIN	100%	-	-
30 MIN	100%	-	-
60 MIN	100%	-	-
2 HRS	100%	-	-
4 HRS	100%	-	-
8 HRS	100%	-	-
16 HRS	100%	-	-

24 HRS	100%	-	-
48 HRS	100%	-	-
72 hrs	100%	-	-
96 hrs	90%	10%	-
120 hrs	70%	30%	-
144 hrs	30%	30%	-
164 hrs	10%	90%	-
184 hrs	-	-	100%
204 hrs	-	-	100%
256 hrs	-	-	100%

It was found that the GIC restored teeth when immersed in Sulphuric acid, showed no change in the restoration till 72 hrs whereas at 96 hr there was dislodgement of restoration in 10 % of the samples. The undifferentiation of the tooth structure in all the samples with dislodgment of restoration was seen at 184 hrs. the difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Table 7: Morphological changes in composite restored teeth at different time intervals (HCL)

	NO CHANGE	DISODGE	Brown Staining
5 MIN	100%	-	-
15 MIN	100%	-	-
30 MIN	100%	-	-
60 MIN	100%	-	-
2 HRS	100%	-	-
4 HRS	60%	40%	-
8 HRS	40%	60%	-
16 HRS	10%	90%	-
24 HRS	-	100%	-
48 HRS	-	100%	-
72 hrs	-	100%	-
96 hrs	-	-	100%
102hrs	--	-	-
120hrs	-	-	-
144hrs	-	-	-
164hrs	-	-	-
184hrs	-	-	-
204hrs	-	-	-
256hrs	-	-	-

It was found that the Composite restored teeth when immersed in HCL acid, showed no change in the restoration till 2 hr whereas at 4 hrs acid there was dislodgement of restoration in 40 % of the samples., The complete dislodgment of restoration was seen in 100 percent of the samples at the time period of 24 hrs. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Table 8: Morphological changes in composite restored teeth at different time intervals (NITRIC ACID)

	No Change	**Dislodged Restoration**	**Dislodged and crystalline and undifferentiated Tooth**
5 MIN	100%	-	-
15 MIN	100%	-	-
30 MIN	100%	-	-
60 MIN	-	50%	50%
2 HRS	-	50%	50%
4 HRS	-	70%	30%
8 HRS	-	70%	30%
16 HRS	-	80%	20%
24 HRS	-	100%	-
48 HRS	-	100%	-
72 hrs	-	100%	-
96 hrs	-	100%	-
120 hrs	-	-	100%
144hrs	-	-	100%
164hrs	-	-	-
184hrs	-	-	-
204hrs	-	-	-
256hrs	-	-	-

It was found that the Composite restored teeth when immersed in Nitric acid , showed no change in the restoration till 30 min whereas at 1 hr there was dislodgement of restoration in 50 % of the samples.,. All the samples showed the complete dislodgement of restoration at the time period of 24 hrs. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Table 9: Morphological changes in composite restored teeth at different time intervals (SULPHURIC ACID)

	No Change	Yellow colour restoration	Brown Red Colour	Dark Pink Colour	Dislodged restoration	Precipitation
5 MIN	100%					
15 MIN	100%					
30 MIN	100%					
60 MIN	100%					
2 HRS	100%					
4 HRS	100%					
8 HRS		100%				
16 HRS			100%			
24 HRS				100%		
48 HRS					10%	
72 hrs					10%	
96 hrs					10%	
120 hrs					40%	
144 hrs					40%	
164 hrs					50%	

184 hrs					60%	
204 hrs						60%
256 hrs						100%

It was found that the composite restored teeth when immersed in Sulphuric acid, showed no change in the restoration till 4 hrs whereas at 48 hr there was dislodgement of restoration in 10 % of the samples. The precipitation of the tooth structure in all the samples with dislodgment of restoration was seen at 256 hrs The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 10: Morphological changes in amalgam restored teeth at different time intervals (HCL)

	No Change	Dislodged Restoration
5 MIN	100%	-
15 MIN	100%	-
30 MIN	100%	-
60 MIN	100%	-
2 HRS	70%	30%
4 HRS	60%	40%
8 HRS	40%	60%
16 HRS	10%	90%
24 HRS	-	100%
48 HRS	-	100%
72 hrs	-	100%
96 hrs	-	100%
120 hrs	-	-
144hrs	-	-
164hrs	-	-
184hrs	-	-
204hrs	-	-
256hrs	-	-

It was found that the amalgam restored teeth when immersed in HCL acid, showed no change in the restoration till 1 hr whereas at 2 hrs acid there was dislodgement of restoration in 30 % of the samples., The complete dislodgment of restoration was seen in 100 percent of the samples at the time period of 24 hrs The difference between the time intervals was statistically significant when analyzed using chi square test at p≤0.05.

Table 11: Morphological changes in amalgam restored teeth at different time intervals (NITRIC ACID)

	No Change	Dislodged Restoration	Dislodged restoration and Staining of Surface
5 min	100%		-
15 min	100%		-
30 min	100%		-
60 min	-	100%	-
2 hrs	-	100%	-
4 hrs	-	100%	-
8 hrs	-	100%	-
16 hrs	-	100%	-

24 hrs	-	100%	-
48 hrs	-	100%	-
72 hrs	-	100%	-
96 hrs	-	100%	-
120hrs	-	-	100%
144hrs	-	-	-
164hrs	-	-	-
184hrs	-	-	-
204hrs	-	-	-
256hrs	-	-	-

It was found that the amalgam restored teeth when immersed in Nitric acid , showed no change in the restoration till 30 min whereas at 1 hr there was dislodgement of restoration in 100 % of the samples.,. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Table 12: Morphological changes in amalgam restored teeth at different time intervals (SULPHURIC ACID)

	No Change	Dark pink colour	Dislodged Restoration
5 min	100%	-	-
15 min	100%	-	--
30 min	100%	-	-
60 min	100%	-	-
2 hrs	100%	--	-
4 hrs	100%	-	--
8 hrs	100%	-	-
16 hrs	100%	-	-
24 hrs	100%	-	-
48 hrs	100%	-	-
72 hrs	-	100%	-
96 hrs	-	100%	-
120 hrs	-	60%	40%
144 hrs	-	60%	40%
164 hrs	-	60%	40%
184 hrs	-	20%	80%
204 hrs	--	-	100%
256 hrs	-	-	100%

It was found that the amalgam restored teeth when immersed in Sulphuric acid, showed no change in the restoration   till 48 hrs whereas at 120 hr   there was dislodgement of restoration in 40 % of the samples. The dislodgement of restoration in all the samples was seen at 204 hrs. The difference between the time intervals was statistically significant when analyzed using chi square test at $p \leq 0.05$.

Discussion

Human identification is one of the most challenging subjects that man has been confronted with. Forensic odontology has established itself as an important and often indispensable science in medico-legal matters and in particular in identification of the dead.[6-8] The importance of dental identification is on the rise year after year. With the passage of time, the role of forensic odontology has increased, as very often teeth and dental restorations are the only means of

identification.[7]

Teeth were observed initially from 5 min and no distinguished changes were observed until 30 minutes. Light pink-colored stains were observed on the tooth on the root surface of the tooth at 15 min which were not so significant. Effervescence is observed at 30 minutes. After 1 hr, the teeth were translucent only at the incisal edge and this translucency progressively increased all around the teeth in the following hours of observation. The teeth dissolved at 108 hrs Jadhav et al[9] and Gupta et al[6], observed effervescence in the acid solution at 30 mins, which is similar to the present study. After 2 hr of immersion of the teeth restored with GIC, nearly half of the teeth (40%) showed dislodged restorations and 80% of restorations were dislodged by 4 hrs. There was complete dislodgement of the GIC from the teeth by 8 to 16 hrs, which was quite fast when compared to the time taken for the remaining 2 types of restorative materials to dislodge. The GIC, unlike the remaining restorations was collected as powder at the bottom of the container. At 8 hrs, approximately half the amount of powder content got dissolved and the solution was clear with no evidence of powder by 96 hrs The study conducted by Thanuja S et al[10], also showed similar findings, where 50% GIC restored teeth immersed in HCL showed dislodgement within 1 hr and complete dislodgement of GIC in 4 hrs.

The composite restorations started to dislodge from the teeth at 4 hrs with eventual dislodgement on hourly basis. 60% teeth showed dislodgement in 8 hrs. All the teeth were completely devoid of restorations by 24 hrs. There were no considerable morphological changes after 48 hrs. Brown color staining was noted after 96 hrs. The restorations were slightly brown initially and the color intensified eventually until the last day of observation (96 hrs) without any dissolution. The study conducted by Thanuja S et al[10] also showed similar finding where composite dislodgement started in 2 hr and complete dislodgment was seen in 24 hrs. Brown color changes was seen after 144 hrs. There were many changes observed in silver amalgam restorations when placed in HCl acid. After 2 hrs, the restorations started to dislodge from the teeth and only 70% of the teeth showed intact restorations in them. As the time progressed, at each time interval during the experiment, the restorations eventually dislodged and all the teeth were completely devoid of restorations by 24 hrs. The amalgam restorations whether intact or dislodged did not show any morphological changes throughout the observation period of and was in the same size and shape as it was during the commencement of the experiment. Similarly, 50 % dislodgement was seen in 1 hr and complete dislodgement of amalgam in HCL was seen in 15 hrs in the study conducted by Similar findings were seen in study conducted by Thanuja S et al.[10]

The teeth that were restored with different restorative materials showed the same sequential changes as described above, irrespective of the type of restorations used to restore it. The only difference that was noted in case of teeth with restorations is that, there was delayed appearances of these morphological changes like vertical split, translucency etc. from the time that have been mentioned above. Similarly the study conducted by S. Singh et al[11], also showed effect of Nitric acid on teeth, where it was concluded that Nitric Acid is fastest decalcifying action on teeth causing Morphological changes. No morphological changes were observed until 8 hrs, later precipitation on the teeth was noticed. In the following hours of observation, the precipitation on the teeth increased relatively and there was deposition of this precipitate at the bottom of the container as well. As there was reduction in the size of the teeth. After 72 hrs of observation there was fragmentation of the teeth. Finally, the teeth were not recognizable and only precipitate was remaining at 256 hrs. Gupta et al[6] observed pitting/granular precipitate at 40-48 hrs, which was not noticed in any of the above-mentioned studies.

Conclusion

As our study deals with morphological change observed in teeth and restoratives materials which can help forensic investigator to deduce the time elapsed since immersion of body in an acid. Human dentition can serve as great evidence when a person is affected with H2SO4. But

if the bodies are immersed in the HCl or HNO3 it will be difficult to make a positive diagnosis with teeth as a factor. The restorative materials recovered in such situations could be used as a prime factor when the teeth were completely dissolved or precipitated. The present study could be of great help when it is no longer possible to identify tooth that have been dissolved in acid, the restorative materials if retrieved in such a situation could serve as a useful tool in forensic investigations. Additionally, to compare the residuals of dissolution with the ante mortem records would be an aid in dental human identification.

Refrences
1. Lund H, Mörnstad H. Gender determination by odontometrics in a Swedish population. The Journal of forensic odonto-stomatology. 1999 Dec 1;17(2):30-4.
2. Dinakaran J, Dineshkumar T, Nandhini G, Priyadharshini N, Rajkumar K. Gender determination using dentition. SRM Journal of Research in Dental Sciences. 2015 Jan 1;6(1):29-34.
3. Patidar KA, Parwani R, Wanjari S. Effects of high temperature on different restorations in forensic identification: Dental samples and mandible. Journal of forensic dental sciences. 2010 Jan;2(1):37.
4. Nanci, Antonio., and Ten Cate, A. R. Ten Cate's Oral Histology : Development, Structure, and Function. 8th Ed. / Antonio Nanci.. ed. St. Louis, Mo.: Elsevier, 2013.
5. Pretty IA, Sweet D. A look at forensic dentistry–Part 1: The role of teeth in the determination of human identity. British dental journal. 2001 Apr;190(7):359-66.
6. Gupta J, Gupta KK, Kabiraj A, Samadi FM, Karki RS, Yadav S. Morphological analysis of extracted human teeth in 3 different acids as an aid in forensic identification. World J Pharm Res. 2015;4:1982-92.
7. Saxena S, Sharma P, Gupta N. Experimental studies of forensic odontology to aid in the identification process. Journal of forensic dental sciences. 2010 Jul 1;2(2):69-76.
8. Whittaker DK. Research in forensic odontology. Annals of the Royal College of Surgeons of England. 1982 May;64(3):175.
9. Jadhav K, Gupta N, Mujib BA, Amberkar VS. Effect of acids on the teeth and its relevance in postmortem identification. Journal of Forensic Dental Sciences. 2009 Jul 1;1(2):93.
10. Seethapathy T, Shylaja S, Sekhar MS, Manthapuri S, Ramanand OV, Reddy SK, Paul JB, Funato A, Kubo K, Maeda H, Alam MK. Effect of acids on teeth and restorative materials: An aid in forensic odontology. Journal of Hard Tissue Biology. 2019;28(1):21-30.

Singh S, Sircar K. Evaluation of efficacy of various chemicals for decalcification of dental hard tissues-An in-vitro study.