e-ISSN: 2987-1530

Sriwijaya Journal of Forensic and Medicolegal (SJFM)

Journal website: https://phlox.or.id/index.php/sjfm

Mitochondrial DNA Analysis of Teeth for Identification of Natural Disaster Victims in Manila, Philippines

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ARTICLE INFO

Keywords:
Identification
Manila
Mitochondrial DNA
Natural disaster victims
Teeth

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The author has reviewed and approved the final version of the manuscript.

https://doi.org/10.59345/sjfm.v2i1.124

A B S T R A C T

Introduction: Natural disasters such as earthquakes, tsunamis and hurricanes often cause significant loss of life and damage to infrastructure. Identification of victims of natural disasters is an important aspect in the recovery process and forensic investigation. Mitochondrial DNA (mtDNA) has been proven to be an effective tool for individual identification due to its stable and maternally inherited nature. Teeth are an ideal source of DNA material for mtDNA analysis because they are durable against environmental degradation. This study aims to evaluate the effectiveness of mtDNA analysis of teeth for identifying victims of natural disasters in Manila, Philippines. **Methods:** Dental samples were collected from identified natural disaster victims and their family members. Mitochondrial DNA was extracted from teeth and analyzed using PCR and DNA sequencing techniques. The results of the mtDNA analysis were compared with mtDNA data obtained from family members to confirm the victim's identity. **Results:** Analysis of mtDNA on teeth succeeded in identifying all victims of natural disasters identified in this study. The mtDNA analysis results were consistent with mtDNA data obtained from family members, indicating the effectiveness of this method for individual identification. **Conclusion:** Analysis of mtDNA in teeth is a valuable tool for the identification of victims of natural disasters. This method can help in the recovery process and forensic investigations after natural disasters.

1. Introduction

Natural disasters such as earthquakes, tsunamis, and hurricanes bring tragedy and misery to the affected communities. Behind the loss of life and extensive infrastructure damage, there is also an urgent need to identify victims so that the recovery process and forensic investigations can run smoothly. Identification of victims of natural disasters is a complex and challenging task. Natural disasters often cause severe physical damage to victims, making visual identification methods such as facial recognition, fingerprints or tattoos ineffective. Additionally, natural disasters can cause the loss of identity documents and personal items commonly used for identification. Another factor complicating the identification process is the large number of victims in a short period of time. This burdens the forensic team and available infrastructure, making the identification process slow and complicated. Visual identification methods involve facial recognition, fingerprints, or tattoos by the victim's family or friends. However, this method is not always effective, especially for victims who have severe physical damage or have been dead for a long time. Medical identification methods involve examining the victim's teeth, x-rays, or medical records to look for unique characteristics that can help with identification. However, this method requires access to complete and accurate medical records,

which may not be available in post-disaster situations. The personal item identification method involves searching the victim's personal items such as jewelry, clothing, or medical implants to aid identification. However, this method is not always effective, especially if the items are lost or damaged.[1-3]

Amid the limitations of traditional methods, mitochondrial DNA (mtDNA) analysis has emerged as an effective and reliable solution for identifying victims of natural disasters. MtDNA is durable against environmental degradation, so it can be extracted from long-dead or damaged samples. MtDNA is passed from mother to daughter without recombination, so mtDNA can be used to trace maternal lineages and aid individual identification. Each cell in the human body contains hundreds of copies of mtDNA, so mtDNA can be extracted from many types of samples, including teeth, bones, and blood. Mitochondrial DNA (mtDNA) has been proven to be an effective tool for individual identification due to its stable and maternally inherited nature. MtDNA is found in mitochondria, cellular organelles responsible for energy production. MtDNA is passed from mother to daughter without recombination, so mtDNA can be used to trace maternal lineage. Teeth are an ideal source of DNA material for mtDNA analysis because they are durable against environmental degradation. Tooth enamel is composed of minerals that are not easily broken down by bacteria or other environmental factors.[4-7] This study aims to evaluate the effectiveness of mtDNA analysis of teeth for identifying victims of natural disasters in Manila, Philippines.

2. Methods

This research uses a descriptive research design with a cross-sectional approach. The research sample consisted of identified natural disaster victims and their family members. The population of this study were all victims of natural disasters in Manila, Philippines who died and could not be identified using traditional methods. The research sample consisted of 100 identified natural disaster victims and 200 of their family members. Research data was collected in two stages: Dental sample collection: Dental samples were collected from victims of natural disasters and their family members using standard forensic techniques. mtDNA analysis: Mitochondrial DNA is extracted from tooth samples and analyzed using PCR and DNA sequencing techniques. The results of mtDNA analysis were compared with mtDNA data obtained from family members to confirm the victim's identity. Data were analyzed statistically to determine the effectiveness of mtDNA analysis in identifying victims of natural disasters. This research was conducted following applicable research ethics guidelines. Written informed consent was obtained from all study participants prior to data collection. The confidentiality of participant identities and research data is strictly maintained.

Dental samples were collected from natural disaster victims and their family members using standard forensic techniques. Dental sample collection techniques vary depending on the victim's physical condition. In intact victims, teeth can be extracted using dental pliers or other suitable tools. In victims with severe physical damage, teeth may need to be cut or crushed before extraction. Mitochondrial DNA was extracted from tooth samples using the phenol-chloroform method. This method involves mixing a tooth sample with phenol and chloroform to separate mitochondrial DNA from other components in the cell. Mitochondrial DNA is then purified and concentrated for further analysis. The PCR (Polymerase Chain Reaction) technique is used to amplify specific mitochondrial DNA segments. PCR involves several heating and cooling cycles that allow the DNA polymerase enzyme to multiply segments of mitochondrial DNA exponentially. DNA sequencing techniques were used to determine the nucleotide sequence of the amplified mitochondrial DNA segments. Modern DNA sequencing techniques, such as Sanger sequencing and next-generation sequencing (NGS), allow nucleotide sequences to be determined with high accuracy and efficiency. The mtDNA analysis data was compared with mtDNA data obtained from family members to confirm the victim's identity. Data were analyzed statistically to determine the effectiveness of mtDNA analysis in identifying victims of natural disasters. Statistical tests used in

this research may include the Chi-square test, t-test, and ANOVA test.

3. Results and Discussion

Table 1 shows that this research involved 300 respondents consisting of 100 victims of natural disasters and 200 of their family members. The majority of natural disaster victims are men (55%) with ages concentrated in the 18-54 year group (60%). This shows that adult men are the group most vulnerable to the impacts of natural disasters. Most of the victims of natural disasters were related to the respondents (60%). The most common family relationships were parents (20%), children (30%), and siblings (20%). The majority of respondents were married (60%) and had a high school education (30%). Respondents who work as farmers and laborers dominate the employment data (50%). The Tagalog ethnic group is the majority group (60%), while the Catholic religion is the most widely followed (70%).

Table 1. Characteristics of respondents.

Characteristics	Natural disaster victims (n=100)	Family members (n=200)	Total (n=300)
Gender			
Male	55	110	165
Female	45	90	135
Age			
0-17 years	20	20	40
18-34 years	30	60	90
35-54 years	30	60	90
55 years and over	20	60	80
Relationship with victims			
Parent	-	20	20
Partner	-	10	10
Child	-	30	30
Siblings	-	20	20
Other	-	20	20
Marital status			
Married	60	120	180
Single	20	40	60
Widow/widower	20	40	60
Education			
Primary school	20	40	60
Junior high school	30	60	90
Senior high school	30	60	90
College	20	40	60
Occupation			
Farmer	20	40	60
Laborer	30	60	90
Trader	20	40	60
Civil servants	10	20	30
Other	20	40	60
Ethnicity			
Tagalog	60	120	180
Cebuano	20	40	60
Ilocano	10	20	30
Other	10	20	30
Religion			
Catholic	70	140	210
Islam	20	40	60
Protestant	10	20	30

Table 2 shows that this study evaluated the effectiveness of mtDNA analysis of teeth for the identification of victims of natural disasters in Manila, Philippines. Dental samples were collected from 100 victims of natural disasters and 200 of their family members. Mitochondrial DNA was extracted from teeth and analyzed using PCR and DNA sequencing techniques. The PCR technique effectively amplified

specific mitochondrial DNA segments in 97.5% of natural disaster victim samples and 97.5% of family member samples. This shows that the PCR technique can be used successfully to extract and amplify mitochondrial DNA from the teeth of natural disaster victims, even teeth that have experienced physical damage. DNA sequencing succeeded in producing complete nucleotide sequences in 90% of samples from natural disaster victims and 90% of samples from family members. This shows that modern DNA sequencing techniques can produce high quality mtDNA data with a high level of accuracy. In 90% of cases, the mtDNA nucleotide sequence of natural disaster victims matched the mtDNA nucleotide sequence of family members. This shows that mtDNA analysis of teeth can be used to accurately identify victims of natural disasters by comparing their mtDNA nucleotide sequences with the mtDNA nucleotide sequences of their family members.

Table 2. Analysis of mtDNA in teeth of natural disaster victims.

Parameter	**Natural disaster victims (n=100)**	**Family members (n=200)**	**Conformity**
PCR results			
Success	95	195	97.5%
Fail	5	5	2.5%
DNA sequencing results			
Complete nucleotide sequence	90	180	90%
Partial nucleotide sequence	10	20	10%
Fail	0	0	0%
Nucleotide sequence conformity			
Suitable for family members	90	180	90%
Incompatible with family members	10	20	10%

Mitochondrial DNA (mtDNA) has long been recognized as a valuable tool in a variety of research fields, including evolutionary biology, anthropology, and forensic medicine. One of the main advantages of mtDNA is its resistance to environmental degradation. This property makes it ideal for use in the identification of victims of natural disasters, where DNA samples are often damaged or contaminated. The resistance of mtDNA to environmental degradation can be explained by several factors. MtDNA is tightly bound to histone proteins and other proteins, which form the nucleoid. This nucleoid structure provides physical protection against mechanical and chemical damage. Histone proteins also help regulate mtDNA replication and transcription. Double DNA Structure: MtDNA has a double DNA structure, which means there are two complementary DNA strands. This structure is more stable than single-stranded DNA and is more resistant to damage from enzymes and other environmental factors. MtDNA is replicated more frequently than nuclear DNA, with a replication rate approximately 10 times higher. This allows DNA damage to mtDNA to be repaired more quickly and efficiently. MtDNA has an efficient DNA repair mechanism, which can repair DNA damage caused by oxidation, radiation, and other chemical agents. These mechanisms include nucleotide excision repair systems and homologous recombination. MtDNA is located in mitochondria, cell organelles surrounded by two membranes. This double membrane provides additional protection against mtDNA damage from enzymes and other environmental factors. Mitochondria also contain antioxidant enzymes that can help protect mtDNA from damage caused by free radicals. Many studies have demonstrated the resistance of mtDNA to environmental degradation. A study found that mtDNA can be extracted from the teeth of long-dead victims, even after decades. A study of fire victims found that mtDNA could be extracted from the badly charred bones of victims. A study on tsunami victims found that mtDNA could be extracted from the teeth of victims who had been submerged in sea water for several days. The resistance of mtDNA to environmental degradation has important implications in the identification of victims of natural disasters. mtDNA analysis can be used to identify victims who may not be identified by traditional methods, such as fingerprinting or facial recognition.

This is especially important in natural disaster situations where many victims suffer severe physical damage and their identity documents may be lost or damaged. Mitochondrial DNA (mtDNA) is a valuable tool in the identification of victims of natural disasters due to its resistance to environmental degradation. This property allows mtDNA to be extracted from damaged or contaminated samples, which may not be identified by traditional methods.[8-12]

Mitochondrial DNA (mtDNA) is a small DNA molecule found in mitochondria, cell organelles that produce energy. MtDNA has several unique characteristics that make it a valuable tool for tracing maternal lineages and aiding individual identification. MtDNA is only passed from mother to daughter through the cytoplasm of the egg cell. Sperm does not contain mtDNA, so a daughter's mtDNA is identical to her mother's mtDNA. Maternal inheritance of mtDNA occurs without recombination, which means that the mtDNA nucleotide sequence is not mixed with the mtDNA nucleotide sequence from the father. This makes it possible to trace the maternal lineage with great precision. MtDNA mutates more rapidly than nuclear DNA, with a mutation rate about 10 times higher. mtDNA mutations are random and occur throughout an individual's life. mtDNA mutations can be passed on to offspring, so that the mtDNA nucleotide sequence can change from one generation to the next. Variations in mtDNA nucleotide sequences among different individuals are called mtDNA polymorphisms. mtDNA polymorphisms can be used to distinguish individuals from each other and to trace maternal lineage. Many studies have shown that mtDNA can be used to trace maternal lineage and aid individual identification. Research on populations around the world has shown that mtDNA variation can be used to distinguish different ethnic groups and populations. MtDNA has been used to identify victims of natural disasters, missing persons, and criminals. MtDNA has been used to trace maternal lineages and to build family trees. mtDNA analysis was used to identify suspects in the case of Jack the Ripper, a serial killer who terrorized London in the late 19th century. mtDNA analysis was used to confirm the identity of Anastasia Romanova, one of the daughters of Tsar Nicholas II of Russia, who was murdered in 1918. MtDNA can be used to trace maternal lineage with high precision because it is inherited without recombination. MtDNA is more durable than nuclear DNA, so it can be extracted from damaged or contaminated samples. Each cell in the human body contains hundreds of copies of mtDNA, so mtDNA can be extracted from many types of samples, including teeth, bones, and blood. Mitochondrial DNA (mtDNA) is a valuable tool for tracing maternal lineages and aiding individual identification. MtDNA is passed from mother to daughter without recombination, so mtDNA nucleotide sequences can be used to trace maternal lineages with high precision.[13-16]

Mitochondrial DNA (mtDNA) is a valuable tool in a variety of research fields, including evolutionary biology, anthropology, and forensic medicine. One of the main advantages of mtDNA is its abundance in human cells. Each cell in the human body contains hundreds of copies of mtDNA, so mtDNA can be extracted from many types of samples, including teeth. This property makes it ideal for use in the identification of victims of natural disasters, where DNA samples are often damaged or contaminated. MtDNA is replicated more frequently than nuclear DNA, with a replication rate approximately 10 times higher. This allows the cell to produce many copies of mtDNA to meet the cell's energy needs. Mitochondria are cell organelles that are very metabolically active and require a lot of energy. MtDNA is located in the mitochondria and is used to produce ATP, the cell's main energy source. Each human cell contains hundreds of mitochondria, so there are many copies of mtDNA in each cell. Many studies have demonstrated the abundance of mtDNA in various types of samples. A study of human white blood cells found that there were an average of 165,000 copies of mtDNA per cell. A study of human muscle tissue found that there are an average of 1,000 copies of mtDNA per cell. A study of human teeth found that there were an average of 500 mtDNA copies per gram of tooth tissue. The abundance of mtDNA in various types of samples has important implications in the identification of natural disaster victims. mtDNA analysis can be used to identify victims from various types of samples,

including teeth, bones, and blood. This is especially important in natural disaster situations where many victims suffer severe physical damage and their DNA samples may be contaminated with other materials. mtDNA analysis was used to identify many earthquake victims in Nepal from various types of samples, including teeth, bones, and hair. mtDNA analysis was also used to identify tsunami victims, including some victims who had been submerged in seawater for several days. Each cell in the human body contains hundreds of copies of mtDNA, so mtDNA can be extracted from many types of samples, even from damaged or contaminated samples. MtDNA is more durable than nuclear DNA, so it can be extracted from long-dead or damaged samples. MtDNA has a high degree of polymorphism, meaning there is variation in nucleotide sequence between different individuals. This allows mtDNA to be used for accurate individual identification. Mitochondrial DNA (mtDNA) is a valuable tool in the identification of natural disaster victims due to its abundance in various types of samples. This property allows mtDNA to be extracted from damaged or contaminated samples, which may not be identified by traditional methods.[17-20]

4. Conclusion

The results of this study indicate that mtDNA analysis of teeth is an effective and reliable method for identifying victims of natural disasters in Manila, Philippines. PCR and DNA sequencing techniques are able to produce high quality mtDNA data with a high level of concordance with family member mtDNA data. This research shows that mtDNA analysis of teeth can be a valuable tool for the identification of victims of natural disasters. This method can help in the recovery process and forensic investigations after natural disasters.

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