Impact Objectives

- Use a digital tooth image analysis technique to identify victims of natural disasters
- Develop software to support this work and build a database based on tooth information obtained

A new approach to victim identification

***Dr Hideyuki Takano**, **Professor Kenji Terada** and **Dr Yukihiro Momota** are collaborating on a project to create an effective system of victim identification designed to help with disaster relief*

Dr Hideyuki Takano

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Can you talk a little about your research background in dental forensics?

HT: Tokushima Prefecture, where we live, is one of the highest earthquake risk areas in the Nankai Trough. I participate in personal identification training with the assumption that there will be a reoccurrence of the great earthquakes seen in the past. The high population densities of the region mean we have to assume a high number of casualties. With current methods, we cannot quickly confirm the identity of large numbers of victims, so a new approach is necessary. My studies on the development of a personal identification method using digital tooth image analysis technique will help overcome the challenges with the current approach. This is because the method can innovatively accelerate the collection and organisation of pre- and post-mortem data, making it possible to confirm identity and return the victim to their family.

AI Diagnostics for X-Ray of Medihome Inc.

You have done some research into the Great East Japan Earthquake and the need for dentists in that disaster response. Can you talk a little about the role of dentists in disaster relief?

HT: The role of dentists in disaster relief changes as the disaster progresses. The immediate initial role for a dentist would be in assistance with triage, assistance for emergency life-saving procedures, treatment of oral facial trauma, and so on. Later, the role switches to assisting with personal identification. After this the role returns to one of dental and oral care.

What are some of the benefits and advantages of the digital tooth image analysis technique?

HT: The advantage of machine processing is the ability to process large amounts of data at high speed. This is especially difficult in harsh conditions that prevail in the event of a large-scale disaster as it is impossible for people in shock to continue this work. Using digital tooth image analysis technology, we will make this possible.

You are planning to construct a database based on tooth information obtained from the application software you will be developing. Can you talk a little about what this will encompass and how you plan to undertake this task?

HT: The identification is performed by matching pre-mortem and post-mortem data, which requires standardised data. After the Great East Japan Earthquake, the need for standardised data was recognised and an oral examination information standard code was prepared by the Ministry of Health, Labor and Welfare. The input of pre-mortem data also takes a very long time and is done using the developed application software. In this way, the database of pre-mortem dental records built during peace is compared with post-mortem records acquired at the time of disaster.

Are there any results from your work that you are particularly pleased with and why?

HT: We are pleased that we have made the basic application software for identification by dental findings. But it is not enough. In the case of a major disaster there are still things that need to be improved to make it really useful.

How important are collaborations with any academic institutions or technology providers to your studies?

HT: I was introduced to Professor Terada by the collaboration coordinator of the University of Tokushima. We were also able to cooperate with Medihome Inc., which has diagnostic Artificial Intelligence technology for dental panoramic x-ray. By collaborating with multiple organisations and providers, I think that you can develop a highly complete project that makes use of each area of expertise.

Artificial Intelligence supports victim identification

*Researchers at the **University of Tokushima** are training Artificial Intelligence to identify dental records to support victim identification after major natural disasters*

Planning for natural disasters is a challenging process. Extensive planning is essential to support the prevention and effective response, as well as dealing with the aftermath. All three areas deserve careful planning and together work to minimise casualties, damage and trauma.

Japan sits in a high-risk zone for earthquakes and related disasters such as tsunami. Therefore, many steps need to be taken in order to mitigate the effects of strong earthquakes. Many buildings are built to withstand the effects, early warning systems exist nationwide and communities are trained in how to respond. However, more work still needs to be done on the post-disaster preparations. Japan is now densely populated and, unfortunately, this means the number of victims from a new earthquake has the potential to be high. One practical complication of this is how to quickly and accurately identify victims in this situation.

There are many ways to potentially identify a casualty of disaster. The preferred method still remains identification through some physical aspect or through belongings found with the person. However, in many cases, the victim will have suffered significant trauma and be without any distinguishing belongings. In these cases, DNA testing and fingerprint analysis are available, however, dental records are often a go-to in these scenarios. All three of these methods require an extensive database of records from which to compare, but only one already possesses significant information. Most people are not DNA tested nor have they had their fingerprints taken for official record. However, most people have been to the dentist and had their dental records taken. These vary in detail, but most have at least a verbal account of the inside of their mouth.

Dental records are, indeed, used extensively in casualty identification. However, the process is long and requires the manual sifting of these records by dentists and helpers. In the context of a major disaster, this process is no doubt slowed by the psychological trauma experienced by the identifiers. In addition, verbal dental records can match multiple people and mix-ups can occur. Dental forensic expert Dr Hideyuki Takano, based at the University of Tokushima in Japan, is working towards digitising the dental record. From Takano's perspective, innovation in the processing of dental records is critical and digitising the way this is done is the best solution, but does come with a number of challenges. 'An important factor in the digitising process is the improvement of accuracy, speed and certainty,' he points out.

INNOVATION WITH AI

The project involves a number of key steps. The first stage addresses the need to improve the accuracy. 'We are establishing and accumulating more pre-dental care data,' explains Takano. 'This requires the creation of a dental chart from visible intraoral image, which is essentially developing an application to create dental charts through image recognition.' This is where Takano has looked to the benefits of Artificial Intelligence (AI) to be able to identify a person from dental records. He is working in collaboration with the Medihome Inc. who have developed a diagnostic AI for dentistry. 'By combining our expertise and skills together, we are making the victim identification process faster, more accurate and less stressful for those involved through dental forensics and AI,' explains Takano.

The innovation of this project lies in the novelty of the idea and the adaption of AI to undertake the identification of dental records. Takano reached out to Medihome Inc. who had already developed software for the diagnosis of dental problems. Together they have designed a way to repurpose this diagnostic AI into one capable of identification based on dental panoramic x-ray. 'Technically, this involves training the AI with vast amounts of dental information from different people,' highlights Takano. 'Essentially, dental data, including diagnostic X-rays, are entered into a standard format interpretable by the system. The system reads this and stores both the specific data and general recognition patterns. The more dental records the system sees, the more accurate future identification will be.' ▶

MATCHING DATA

The second step involves improving the speed of identification. This requires a 'matching method' to be established where the pre-dental data records can be as quickly as possibly matched to the remains. The team is building a system that is capable of comparing dental charts from birth and death. 'To deliver this we are looking for something that is compatible with the "Dental Finder" software, the current *de facto* standard for identity verification,' clarifies Takano. Finally, the last step looks at improving both the identification and certainty of the information, which requires enhancing of the ability to share dental care data quickly. 'From the experience in the Great East Japan Earthquake, it became necessary to standardise the medical treatment information along with the dental clinics' receipt computers and electronic medical records,' explains Takano. The team is now working on integrating their research with Japan's national 'Utilization and standardization of dental information' programme, which was set up in 2017.

The project also comprises a number of trials. This includes trialling the creation of dental charts using image analysis. 'Dental charts are not only completed by findings in the oral cavity, but information such as roots and apical lesions are also very important,' outlines Takano. He says that his collaboration with Medihome Inc. is an important step in progressing this stage of the research. 'Our partnership with Medihome Corporation means we have been able to develop diagnostic AI based on dental panoramic x-ray and have now begun research to create a complete dental chart.'

Developed image analysis application

FUTURE R&D

Takano is keen now to progress their work towards future research and development through demonstration experiments and commercialisation of the research. 'To deliver this we plan to complete intraoral visible image and R&D of AI X-ray dental diagnosis,' he confirms. One of the challenges he is facing is that the current national Japanese system that provides a reference for medical data has security protection which limits the access some institutions and organisations have. Meaning when a large-scale disaster happens, many emergency organisations and temporary medical clinics do not have access to the data. 'This means that new business plans are needed, including systems and security, administration, and regulations maintenance so that they can be used in times of disasters,' says Takano. For this reason, he is keen to use this system as a demonstration experiment.

Technically, the process to deliver the project goals is not too challenging, however Takano points out that it has been difficult to obtain funding for their work and he says that more government funding is needed. 'The problem lies in obtaining research funding. This research result is not connected to financial, so it is difficult for companies to invest in funds. We still need public research funding.' Ultimately this study will help streamline an important part of the disaster response process, relieving both emergency workers and families of the trauma behind casualty identification. Once the trials have been completed and any system difficulties addressed, Takano is hopeful that the programme can then be standardised and then commercialised. 'Ultimately, I envisage this technology will be introduced at dental clinics throughout the country with the cooperation of the administration and the Japan Dental Association.'

Project Insights

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COLLABORATORS

- Professor Kenji Terada is Director of Department of Information Science and Intelligent Systems at University of Tokushima
- Dr Yukihiro Momota is Senior Lecture of Oral medicine at University of Tokushima
- Medihome Inc. has a team of experts in AI (www.medihome.jp)

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BIO

Dr Hideyuki Takano is Vice Director of Oral Health Management Center, Tokushima University Hospital. He is responsible for oral management of hospitalised patients. In the event of a disaster he provides identification of the victim.

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