THE USE OF DNA PROFILING IN THE IDENTIFICATION OF VICTIMS OF AN AIRCRASH

Dr C N Maguire Forensic Science Service

Dr V E Tate Kenyon Emergency Services

On the 28th of September 1992, the Pakistan International Airways flight PK268 crashed into the mountains as it approached Katmandu Airport. 164 passengers and crew were killed. The bodies of the victims were badly damaged by the force of the impact and a subsequent fire.

Kenyon Emergency Services, a UK company specialising in the management of disaster scenes, was contracted to organise the post-mortem examinations, and where possible identify the victims and re-patriate the bodies if the relatives so desired.

The body identifications were carried out by the analysis of documents, odontology the identification of clothing and other personal effects by relatives and by the use of DNA profiling.

In December 1992 we received post-mortem tissue samples taken from 85 of the bodies or body parts at the FSS laboratory in Wetherby. With our assistance Kenyon Emergency Services made arrangements to collect blood samples from direct relatives of the aircrash victims. Between the 18th of December 1992 and the 18th of January 1993 approximately 100 blood samples arrived at the laboratory. Almost all of the relatives who supplied blood samples were European; very few blood samples were received from the relatives of the Pakistani or Nepalese victims.

DNA profiles were prepared from the tissue samples and the blood samples, using standard FSS methods. High molecular weight DNA was obtained from 61 of the tissue samples. The remainder of the tissue samples were in a poor condition and the DNA obtaned from these samples was very degraded. No DNA profiles were obtained from these degraded samples.

The DNA profiles obtained from the tissue samples were compared one to another and in several cases the DNA profiling results indicated that the tissue samples had been taken from a number of parts of the same body. These findings were corroborated by the pathological data.

A total of 57 different DNA profiles were obtained from the tissue samples. Thirty of the tissue samples gave sufficient high molecular weight DNA to enable four or five SLP tests to be carried out. We used the following DNA probes routinely in this investigation; MS43a, MS31, YNH24, pMLJ14 and TBQ7.

The DNA profiles obtained from the tissue samples were compared with the profiles obtained from the blood samples of the relatives. The profiles were inspected for familial relationships. A total of 13 bodies were identified. The DNA profiling tests also gave information to enable us to eliminate many of the families from the identification enquiry.

We used a Baysian type statistical analysis to calculate likelihood ratios for the familial relationships. The complexity of the analysis leading to the identifications ranged from a comparison of the DNA profiles from the tissue samples with the DNA profile of a monozygotic twin brother of one of the victims, to the identification of four members of an extended Spanish family. Examples of the statistical analysis and details of three case types are presented.

Case Study 1

One of the victims of the aircrash had an identical twin brother who supplied a blood sample for comparison. An exact match was found between the DNA profiles of the relatives blood sample and one body, (designated 72), using four SLP probes.

In this case the likelihood ratio is given by the expression:

$$LR = \frac{1}{2 f_a f_b}$$

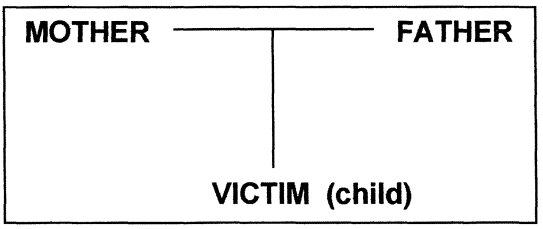
The likelihood ratio was calculated to be approximately 80,000,000.

We concluded that the body 72 was that of the identical twin of the relative submitting the blood sample.

Case Study 2

The majority of the identifications obtained fell into this case type. The victims parents supplied blood samples for comparison:

ie



Where appropriate matches were observed between a victim and a mother/father pair the likelihood ratio was calculated in the following way:

$$p(C \mid F) = \frac{1}{4}$$

ie The probability of obtaining the child's DNA profile if he/she is related to the family in question, and

$$p(C \mid \overline{F}) = \frac{1}{2 f_a f_b}$$

The probability of the profile if the victim is related to another family. Therefore the likelihood ratio is given by the expression:

$$LR = \frac{\frac{1}{4}}{\frac{1}{(2 f_a f_b)}} = \frac{1}{(8 f_a f_b)}$$

This calculation was employed in the following case.

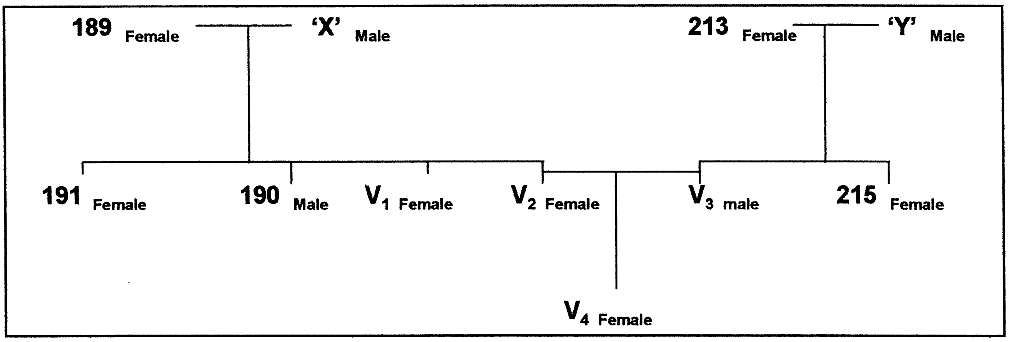
Blood samples were obtained from the mother (206) and father (205) of a female victim.

One body, designated 60, seemed to have a familial connection as for each probe used one band in the DNA profile from the tissue sample matched a band in the profile of the putative father, and the other tissue band matched a band in the profile of the putative mother.

In this particular case the likelihood ratio was calculated to be approximately 140,000 and we concluded that this victim was the child of the mother/father pair 205/206.

Case Study 3

This was the most complex of the analyses tackled. In this case the victims were four members of an extended family, the mother, father and child, and the mothers sister. Blood samples were received from other family members. Blood samples were not received from either of the 'grandfathers'. The extended family tree is shown below:



The problem was broken down into several stages:

STAGE 1 Generation of the profile of 'grandfather X'.

From information contained in the DNA profiles of family members 189, 190 and 191 the profile of 'grandfather X' could be almost completely be constructed. A comparison was then made between the results obtained from all of the tissue samples and the profile from 189 and the constructed profile of 'grandfather X'.

Only one body sample designated K101 fitted the criteria.

The likelihood ratio was calculated to be of the order of 200,000. This was taken to be extremely strong evidence that the body K101 was one of the two offspring of 189 and 'grandfather X'.

At this stage we were unable to determine whether this was the child's (V_4) mother or aunt.

STAGE 2

By inspection of the profiles of the family members 213 and 215 it was possible to construct at least part of the profile of the 'father Y'. Using this constructed profile and the profile of sample 213 we searched the profiles obtained from the body samples: only body 10 fitted the criteria

In this case the 'single parent' calculation is given by:

$$LR = \frac{1}{4 f_{parent}}$$

The likelihood ratio was calculated to be in the order of 100. **We concluded that body 10 was highly likely to be that of the victim designated V_3 male.**

STAGE 3

Using this information we searched the victims profiles for any bodies which could be related to body 10. Only one body, 99, fitted the criteria:

Again, using the 'single parent' calculation the likelihood ratio was calculated to be approximately 300.

We concluded that the body 99 was very highly likely to be that of the child V_4 female.

STAGE 4

Using the information from the bodies 99 (V_4), 10 (V_3) and K101 (V_1 or V_2), the profiles were inspected to determine whether victim K101 was the mother or aunt of the child V_4. If body K101 represented the mother of body 99 I would have expected to see 5 maternal bands present. However only 3 matching bands were seen and the results were consistent with the body K101 being that of the female V_1, ie the child's aunt.

STAGE 5

Finally, one body, (designated 79), which had given only a very limited DNA profile was found to be consistent with being a 'child' of parents 189 and 'X', and also a parent of the child V_4.

Conclusion

The results of the DNA profiling tests showed that this technique is extremely valuable in assisting in the identification of the victims of mass disasters, provided the appropriate relatives supply blood samples for comparison.

I would like to thank Rachel Atkinson, Mary-Anne Younie and Jonathan Whittaker for their assistance with the preparation of the DNA profiles and discussions concerning the interpretation of the profiles.