

Recovery and Identification of Burnt Remains in a Military Theatre of Operations:

The Warrior Six

Introduction

This chapter presents a case study involving the deaths of six British soldiers during Operation Herrick, the British military operation in Afghanistan which took place between 2002 and 2014. A total number of 441 British soldiers were killed during the Operation, with the majority of deaths being caused by Improvised Explosive Devices (Russell et al., 2016). Operation Herrick was divided into 19 deployments and the incident which resulted in the deaths of the soldiers, who subsequently became known as “the Warrior Six”, occurred in 2012 during Herrick 15.

The focus of this case study is on the methods used to recover the burnt and commingled remains of the soldiers from the Warrior armoured vehicle and preliminary examinations of them in the temporary mortuary at Camp Bastion, Afghanistan. It demonstrates how the skills of the forensic anthropologist / archaeologist can be utilised when remains are extensively fragmented and burnt, and it emphasises the importance of utilising expert advice within the scene. The study also illustrates how the expert can be successfully integrated within a team of investigators to produce the best possible outcome in terms of recovery and repatriation of the deceased.

In consultation with the Royal Military Police (RMP), a decision was made to retain the anonymity of the casualties in this case study. Their names can be found in the public domain, but details of the levels of disruption and damage to the bodies of each soldier have not been published. As such, they will be referred to throughout as Soldiers A, B, C, D, E, and F. Similarly, the chapter will not contain any pictures of the large body parts, although fragments of burnt bone are shown. These have been included to illustrate the effects of burning (particularly calcination), the high levels of fragmentation and the methodological challenges which the working environment and the condition of the remains posed. All figures and images, with the exception of Figure 3 were taken or provided by the RMP. Figure 3 was produced by the Author in the field, using a template provided by the RMP.

Improvised Explosive Devices (IEDs) and Blast Injuries

An IED may be defined as “any device that uses modified conventional, or unconventional munitions to exert their effect” (Edwards and Clasper, 2016: 98). IEDs can take multiple forms and they are designed to cause maximum devastation (*ibid*). During an explosion damage to the human body may occur as a result of either blast or fragmentation mechanisms, and in the clinical literature injuries are divided into four categories; primary, secondary, tertiary, and quaternary blast injuries (Dussault *et al.*, 2014; Delannoy *et al.*, 2019). Physical manifestations range from blast lung, bowel and tympanic membrane (Primary injuries only), through to complete disruption of the body, amputations, penetration and crush injuries (Eskridge *et al.* 2012). The traumatic injuries caused by blast are complex and multifactorial. In addition to the size and nature of the device itself, injuries are greatly influenced by the external environment, e.g. the proximity of the victim to the device, whether the blast occurred in an enclosed or outdoor space, and presence of any intervening barriers (Edwards and Clasper, 2016). Research in Israel during the 1990s demonstrated that explosions in confined spaces were associated with both a higher incidence of primary blast injuries and a higher mortality rate than those which took place in the open air (Leibovici *et al.*, 1996). Certain parts of the body are more susceptible to injury than others and, in a military context, body armour plays a crucial role in mitigating severity of injuries often determining whether or not a casualty will survive (Breeze *et al.*, 2016; McGuire *et al.*, 2019; Eskridge *et al.*, 2012).

During operations in Afghanistan and Iraq, Anti-vehicular (AV) mines and IEDs became the most common cause of death amongst Coalition troops and local security forces (Ramasamy et al., 2009).

The Effects of Heat on Bone

The effects of heat on bone are well documented. They occur as a result of dehydration and oxidation of the organic component of the bone, and eventual re-crystallisation of the mineral component at very high or sustained temperatures (Ellingham et al 2018; Thompson 2015, DeHaan 2015; DeHaan and Nurbakhsh 2001; Holden et al, 1995). Predictable colour changes ranging from orange-brown through to black, light grey and white, reflect the amount of organic material left in the bone (Krap et al., 2019; Devlin and Herrman, 2015; Symes et al., 2015; Shipman et al., 1984). Burning will also cause delamination and patination (flaking and “checking”), curved cracking, thumbnail fractures, and step fractures, in bones which still contain some collagen (Goncalves et al., 2014; Symes et al., 2015). As the elasticity of bone is lost due to the combustion process it becomes much more fragile and susceptible to mechanical damage from a range of factors such as collapse of building structures, unfavourable weather conditions and even just movement of the body itself (Waterhouse, 2013; Mayne, 1997). This can result in high levels of fragmentation which affect both the recovery and the identification of burnt remains.

In terms of the impact on forensic casework and human identification, the most significant effects of burning are degradation and destruction of DNA which occurs during carbonisation and calcination, the point at which the bone turns from black to grey (Imaizumi et al 2014; 2015). Similar results have been found in teeth and it has been demonstrated that burnt samples which were brown, black or grey in colour provided low or undetectable DNA quantification results (Federchok et al., 2019). This means that standard primary methods of identification can often not be applied to extensively burnt remains (Mamede et al., 2018)

Background to the Case

At approximately 18.30 hrs (local time) on the 7th March 2012, a Warrior armoured vehicle carrying six British soldiers was hit by an IED whilst on patrol in Helmand Province, Afghanistan (see Figure 1).



Figure 1: Location of incident within Helmand Province

The turret was blasted off in the explosion and the vehicle was thrown onto its side (see Image 1), it set on fire and all six soldiers onboard were killed. The soldiers inside had been carrying a large amount of ammunition therefore the fire inside the vehicle was instant and intense. The bodies of Soldiers A, B and C, were ejected from the main part of the vehicle at the time of the incident and those of Soldiers D, E and F remained within the vehicle.



image 1: The Warrior vehicle blasted onto its side at the site of the explosion.

RMP Special Investigation Branch (SIB) officers attended the scene and found Soldier A partially buried beneath the turret, Soldier B still inside the inverted turret, and Soldier C lying adjacent to the vehicle with the appearance of having fallen out of the aperture left by the turret. They made a rapid recovery of those bodies and body parts into body bags, and then loaded the vehicle and turret with the remains still inside onto a recovery truck for transportation back to Camp Bastion. The bodies of Soldiers A, B and C, which were the least disrupted, were transferred to the mortuary at the Role 3 Camp Bastion Hospital. The Warrior vehicle and the turret were secured in an area known as 'K Compound' and the insides of both were preserved untouched pending advice from the SIB forensic team in the UK.

On the same evening that the incident took place the RMP contacted Cellmark Forensic Services (CFS), to request assistance with the identification of the deceased. Subsequent strategy meetings were held between senior officers, the UK RMP forensic team, the forensic anthropologist and DNA scientists employed by CFS, and the Home Office Forensic Pathologist, regarding the best way to proceed. Having also reviewed some images from the scene, it was agreed that as the bodies of three of the soldiers and the commingled fragments of potentially all six soldiers were still inside the warrior vehicle and the turret, it would be advantageous for a forensic anthropologist to deploy to Afghanistan. The rationale for this was that an anthropologist could:

- assist with formulating a recovery strategy for the remains that would maximise the chances of identification of all six soldiers.
- excavate the vehicle and the turret using archaeological techniques in accordance with the strategy devised.

- undertake preliminary re-assignment of burnt fragments to larger body parts, where it could be seen that this would not be possible by DNA analysis in the UK.
- make a preliminary record of any individuating features or closely associated personal effects that might assist in the identification of the deceased.
- package the burnt fragile fragments of bone in a way that would minimise the possibility of damage during transit.

As part of planning and preparation for deployment there was close liaison with the Service Police team in Afghanistan who were leading the investigation. Members of the team had recently completed a training course delivered by the deploying forensic anthropologist, which had provided them with instruction on the recovery and identification of fragmented and commingled human remains. As such they were able to provide expert assistance and support throughout the excavation of the vehicle and examination of the remains. The forensic anthropologist deployed to Afghanistan (the author) is also a forensic archaeologist with extensive experience of excavating and identifying burnt, commingled remains and working in hostile environments.

Assessment of the Vehicle and Recovered Remains

On arrival at Camp Bastion the forensic anthropologist was provided with a comprehensive briefing by the RMP Senior Investigating Officer (SIO) and Deputy SIO (DSIO). This included information on the circumstances of the attack, the condition of the vehicle and the casualties, and details of the recovery of the vehicle and the human remains from the scene. Immediately following the briefing, a preliminary inspection of the exterior of the vehicle was made. Figure 4 is a picture of an undamaged Warrior vehicle showing where troops would normally be located. In this instance, Soldiers A and B had been sitting in the Gunners and Commanders elevated seats, Soldier D had been sitting in the drivers compartment and Soldiers C, E and F had been sitting in the area labelled “Troop Seating”. Image 2 shows the exterior of the Warrior vehicle struck by the IED.

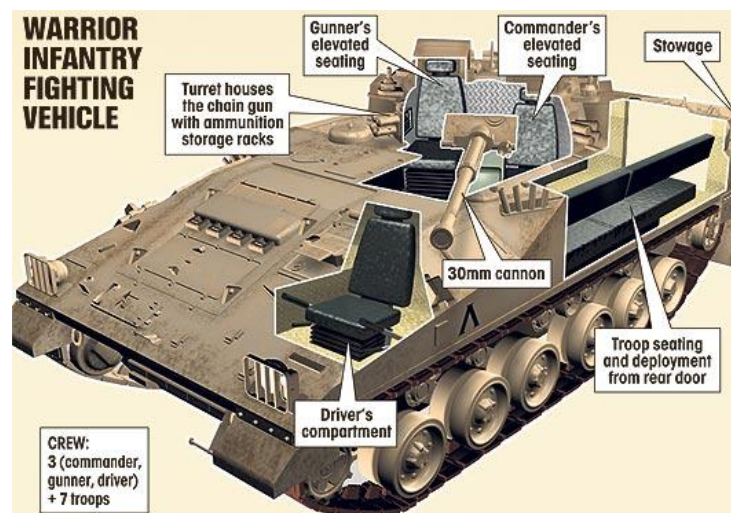


Figure 2: Design of a Warrior Fighting Vehicle Showing Position of Troops



image 2. Exterior of Warrior vehicle struck by IED.

The interior of the Warrior vehicle could be viewed by standing on its roof and looking through the aperture left by the ejection of the turret in the blast (see Image 3). From this position it was possible to see that the interior of the vehicle was completely burnt out, filled with debris and burnt human remains. The majority of the disassociated bone fragments appeared to be completely calcined. As such, it was immediately apparent that it would not be possible to identify and re-associate these fragments with the main body parts of the soldiers by DNA analysis, and that other methods would have to be employed.



Image 3: Inside the vehicle, viewed through aperture left by ejection of the turret

During the preliminary assessment it was possible to see only two large body parts clearly. One (Soldier D) was in the driver's compartment and the other (Soldier E) was lying in the central region of the back of the vehicle. A possible third soldier (Soldier F) was partially visible, covered in rubble and lodged

underneath one of the rear seats. An inspection of the inside of the detached turret revealed that there were multiple fragments of burnt bone inside it which would also require excavation.

In addition to the fragments and body parts inside the Warrior vehicle there were three body bags which contained burnt bone, soft tissue and earth recovered from the scene. The contents of Bag Z had been collected from directly underneath the turret and beneath the bodies of Soldiers A and B, so a preliminary assumption was made that the fragments within it belonged to them. Also recovered from the same location was a collection of 18 bones which had been exhibited separately. As these had fallen out of the turret when it was lifted, they were subsequently re-bagged as one collection, labelled Z2, and noted as also probably belonging to soldiers A and B. The other two body bags had not been assigned a letter, so they were labelled Bags X and Y by the anthropologist. These bags contained bone fragments that had spilled out of the vehicle through the aperture left by the turret. They had been closely associated with Soldier C but could also have originated from the commingled remains of Soldiers E and F in Zones 4, 5 and 6 (See Figure 3).

Prior to finalising the excavation strategy, the three incomplete bodies of Soldiers A, B and C were examined in the Role 3 Hospital, so that a record of all body parts missing could be made. This information was also used to assist with the calculation of duplicated skeletal elements and re-assignment of fragments at the end of the excavations and examinations in Camp Bastion.

Excavation Strategy and Methodology

The excavation strategy was formulated with the aim of reconciling as many of the burnt fragments as possible, to specific named individuals. Four criteria were used to provisionally reassign the fragments to the six main body parts of varying sizes, labelled Soldier A, B, C, D, E or F:

1. The occurrence of a 'mechanical fit', whereby the two broken ends of a bone could be fitted together, and a fragment could be physically re-joined to a main body part.
2. The identification of isolated bones or parts of bones, which were already present in the articulated remains of five out of the six soldiers. For example, if Soldiers A, B, C, D and E were in possession of all their thoracic vertebrae, any additional disarticulated thoracic vertebrae must belong to Soldier F, whether they were in direct association with him or not.
3. The occurrence of fragments in areas of the vehicle where it was believed commingling could not have taken place.
4. The position of the fragments and any direct association with a main body-part, e.g. fragments of cranium that could be co-joined, located at the top of the neck of a body.

The first three criteria were taken as conclusive evidence that a fragment belonged to a main body part. The fourth provided strong support but could only be confirmed by DNA analysis where this was possible. All preliminary assignments of fragments to bodies in Afghanistan, was subject to approval by the Coroner following the postmortem examinations in the UK.

As part of the excavation strategy a considerable number of potential hazards and risks, including large pieces of jagged metal, substances that might cause irritation to the skin and eyes, and the presence of unexploded ammunition within the vehicle, had to be considered. This was done in close consultation with senior members of the military police team and Ammunition Technology Officers (ATO).

A systematic approach for the excavations was of paramount importance in order to maximise recovery of the remains and ensure that the location of the fragments could be recorded accurately. To facilitate this the vehicle was divided into eight zones which corresponded to existing divisions such as partitions, shelving and seating. The placing of the zones also took into account the damage caused by the blast

and the location of the main body parts. Figure 3 is a drawing which illustrates the zones and the incomplete bodies / body parts within the vehicle, produced prior to excavations commencing. The descriptions below Image 3 provide further detail of the Zones.

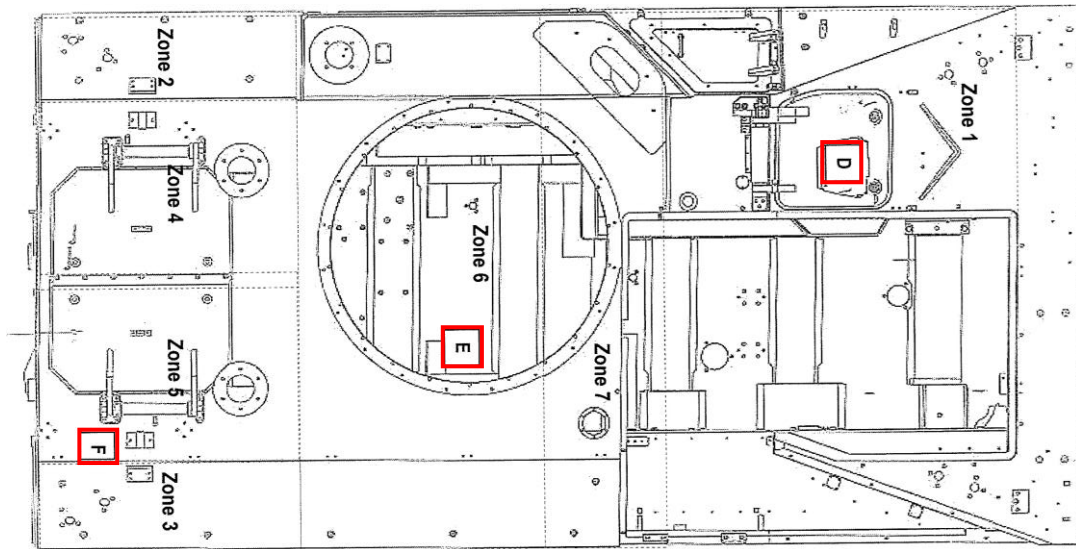


Figure 3: Plan drawing of the Warrior vehicle showing zones and location of main body parts for Soldiers D, E and F

Zone 1: The driver's cabin which formed a separate unit at the front of the Warrior vehicle. There was a small tunnel behind the driver's seat which would normally allow access from the driver's cabin to the rear of the vehicle. This was largely blocked by the driver's seat and usual access into the cabin would be through a door in the roof above the seat. The effects of the blast had caused the entrance of the tunnel to become blocked which meant that the cabin was effectively a sealed unit through which no fragments could pass in or out.

Zone 2: The area which extended along the top of the rear seats on the left-hand (driver) side of the vehicle. It included the side of the vehicle up to the level of the roof. The interior had been burnt away to expose recesses which formed metal shelves in the side of the vehicle.

Zone 3: The area above the rear seats on the right side of the vehicle, which extended up to the roof. It corresponded to Zone 2 on the opposite side, and it too was burnt out exposing metal shelves.

Zone 4: The floor at the rear of vehicle on the left side, beneath the seats and Zone 2. It extended as far as the end of the seats and inwards towards the middle of the vehicle where it met with Zone 5.

Zone 5: The floor at the rear of the vehicle underneath the seats on the right and Zone 3. It extended as far as the end of the seats and inwards towards the middle of the vehicle where it met with Zone 4.

Zone 6: The floor area in the centre of the vehicle beneath where the turret had been. It started at the ends of the seats on both sides where Zones 4 and 5 finished, and extended forwards for the full width of the vehicle as far as the edge of the breach in the floor caused by the explosion.

Zone 7: The interface between Zone 6 and Zone 1, this was a somewhat arbitrary area extending from the other side of the breached metal floor, across the full width of the vehicle, to the rear wall of the drivers cabin and Zone 1.

Zone 8: The interior of the turret which had been blasted off the roof of the Warrior vehicle.

The vehicle was examined and declared safe by an Ammunition Technology Officer who remained on standby throughout the excavations. The zones were excavated from the rear of the vehicle, progressing forwards to the front. Access to conduct the excavations was via the aperture in the roof, as it was not possible to open the rear doors because of damage caused to them by the blast and the large amounts of debris and seating which were blocking them. The sheer volume of small fragments of burnt bone, and the constraints of time and space, meant that utilisation of Interpol DVI documentation was not practical in this situation. Instead, the same rigorous and systematic process described below was applied in each Zone.

The large pieces of debris were removed from the top layer of rubble and preserved in a designated area within 'K Compound'. Following pre-excavation photography of the zone, the larger fragments of bone were recovered individually by hand and transferred to the temporary mortuary. The smaller fragments of bone which could not be separated from the dust and debris were removed by trowel and put into trays which were labelled according to zone. This material was then sieved by RMP and RAF police officers who had undertaken training in the recovery and identification of fragmented remains (a sieving station had been set-up adjacent to the vehicle). It was agreed that a 4mm mesh would achieve optimum recovery of identifiable fragments whilst still allowing the pace of the excavations to be maintained. All bone fragments recovered from the sieving were taken to the temporary mortuary for examination by the forensic anthropologist and the sieved material was retained. Image 4 shows the excavation in progress.



Image 4: Excavation of Zone 6 within the Warrior Vehicle

The body armour from each zone was collected, produced as a separate exhibit, and labelled according to zone to increase the chances of it being reconciled with the correct wearer. As previously discussed, studying the damage caused to body armour in conjunction with the remains of the deceased has been of vital importance in improving the chances of subsequent casualties surviving blast incidents. This

has been particularly true of the research conducted on body armour from military operations in Iraq and Afghanistan (Breeze et al., 2016). Personal effects such as ID tags and pocketknives were collected and exhibited separately if they were not being worn or carried by the deceased, and no personal effects were removed from any of the bodies in Afghanistan.

The large body parts of Soldiers D, E, and F were recovered from the vehicle as soon as this could be achieved without causing damage to the remains. Whilst the excavation was in progress nylon bags were placed over their neck and head regions to minimise damage to any dentition which could potentially be used to assist with their identification. It was a relatively straightforward procedure to carefully lift the main body parts of Soldiers E and F once the surrounding debris had been removed and the areas around them had been processed. The recovery of Soldier D, however, was far more challenging. The body was more complete and access into and out of the driver's cabin was problematic. Prior to commencing excavation of Zone 1, a number of options were considered regarding how best to lift the body, which was lying prone along the seat facing backwards, out. Removing the body through the trap door in the roof was discounted as it was felt that this would cause too much disruption to the fragile remains, particularly the cranium which had sustained perimortem fractures. Ultimately, the forensic anthropologist and DSIO were able to carefully lift Soldier D from the seat without causing any damage and he was passed through the tunnel to the rear of the chair, which had been cleared and lined with bubble wrap to protect the remains. The body was then placed on a stretcher in the rear of the vehicle, lifted out through the aperture left by the loss of the turret, and transferred to the temporary mortuary.

It took approximately four days to complete the excavations in the main vehicle and then work in the turret (Zone 8) commenced. The space within the inverted turret was extremely limited and visibility was poor. The seating was removed to create a larger working area, but only one person at a time could gain partial access. As in the main part of the vehicle, the larger fragments of bone were removed individually by hand and the debris containing smaller fragments was recovered by trowel and placed in trays for sieving. Much of the work had to be carried out in an inverted position and use of a head torch improved visibility. The turret was found to contain multiple commingled calcined foot bones and fragments of lower limb, some of which were quite large. The remains of a right foot were identified, partially fused to the metal floor of the turret on the left side where the right foot of the gunner would have been placed. To the immediate right of this foot was a burnt left foot, also partially fused to the floor, in the location where the commander of the vehicle would have been sitting. The right foot was provisionally assigned to Soldier B and the left foot was assigned to Soldier A. It was thought that the commingled fragments within Zone 8 were most likely attributable to Soldiers A and B, but the possibility that some fragments might also belong to Soldier C could not be excluded entirely.

Examination of the Remains in the Temporary Mortuary

A temporary mortuary was constructed by RMP officers within 'K Compound' immediately following the incident and prior to the arrival of the forensic anthropologist in Afghanistan. Mortuary facilities were available at the Role 3 Hospital but that was located a considerable distance away (Camp Bastion being 35 square kilometres in size) and, as an operational field hospital, it was focussed on treating large numbers of live casualties. The temporary mortuary was situated adjacent and to the rear of the tent which housed the Warrior vehicle and the sieving stations. Logistically this meant that it was easy for the forensic anthropologist and Service Police team to work between the two locations, and the distance for transferring the remains was minimal.



Image 5: Tent housing the Warrior vehicle with temporary mortuary to the rear, 'K Compound', Camp Bastion

Six examination tables had been set up and only minor changes were made by the forensic anthropologist to the organisation of the mortuary following the initial assessment of the vehicle and remains within it. Those changes consisted of relabelling the examination tables according to Zone rather than Body Number, on the basis that no assumptions could be made about the identity of the soldiers until all the examinations had been completed.

Full anthropological examination of the remains was difficult due to their burnt and fragmented condition and as the remains were so fragile, handling of all the body parts was kept to a minimum to prevent further damage prior to full post-mortem examination in the UK. All the fragments and associated items were photographed on arrival in the temporary mortuary by the designated RMP photographer who also acted as exhibits officer (see Image 6).



Image 6: RMP Photographer / Exhibits Officer within Temporary Mortuary

Excavations in the Warrior vehicle had to continue in conjunction with the fragments being received and examined in the mortuary, as there was considerable pressure to repatriate the remains as quickly as possible. To address this and enable progress to continue in both areas, a member of the Police Service team who had completed the specialist training in human remains was appointed as triage officer in the temporary mortuary. The triage officer was responsible for transferring the fragments from the photography station to the correct examination table and dividing them into skeletal elements. The forensic anthropologist periodically reviewed these preliminary identifications in advance of conducting the full examinations. Image 7 shows some of the smaller fragments being laid out on the examination tables together with body armour and other associated personal effects.



Image 7: Examination of smaller fragments and personal effects in the temporary mortuary

Each fragment of bone greater than 4mm in size was examined individually and, where possible, identified according to skeletal element or tooth. Fragment identification was aided by reference to White and Folkens (2005) and dental casts (ESP Adult Teeth Model Set). Observations relating to fragment size, colour and extent of burning were also recorded. The biological sex and ancestry of all six soldiers was already known. Age estimation was based on Scheuer and Black (2000) and Buikstra and Ubelaker (1994). Where available, the appearance of the pubic symphyses (Brooks and Suchey 1990) and the sternal ends of the ribs (Iscan *et al.* 1985) were also assessed. Information relating to age at death was in fact of limited use, as all the soldiers except for one had been within the same age range of 19-21 years. It was not possible to estimate the statures of any of the deceased due to fragmentation and distortion of the long bones caused by the fire. Where there was good preservation of soft muscle tissue on the larger body parts, an assessment could be made of body build. Any dentition was preserved for the specialist attention of a forensic odontologist rather than cleaned and examined. Images 8 and 9 show a typical example of a larger fragment of bone and a tooth root (respectively) which were recovered individually.



Image 8: Calcined distal end of femur

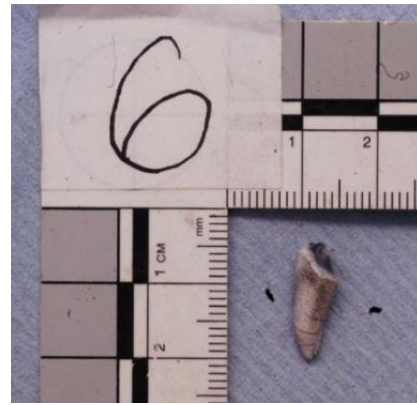


Image 9: Calcined Tooth Root

All body parts and fragments were reviewed for the presence of individuating features. Antemortem data, including information from medical notes, had been recorded prior to leaving the UK. These showed that five of the deceased had indicators such as scars, tattoos, and minor healed fractures, which might have assisted in their identification. Unfortunately, due to the severity of the burns and disruption to the remains these were no longer observable. The medical notes proved to be useful in the case of only one soldier who had suffered from a heart defect that had been surgically repaired during childhood. Evidence of this was seen on the CT scans performed on the incomplete bodies of Soldiers A, B and C, at the Role 3 Bastion hospital mortuary immediately following their recovery. It was possible for the forensic pathologist in the UK to view these images remotely and for a positive identification to be made on that basis.

Examinations in the Role 3 Hospital

Once all the body parts and fragments had been recovered from the vehicle and the turret, they were transferred from the temporary mortuary in 'K Compound' to the mortuary at the Role 3 hospital. As with Soldiers A, B and C, the incomplete bodies of Soldiers D, E and F were CT scanned on arrival. A full review of all the fragments and body parts was then made. This included an assessment of whether any of the larger fragments could be physically fitted to the main body parts, and any corresponding joint surfaces could be articulated. There follows a short summary of the remains of each soldier following this process.

Soldier A

The lower limbs of Soldier A were missing from mid-thigh level downwards, but the rest of the body was complete. Some body parts were extensively charred, and sections of bone were missing from the left elbow and the front of the ribs. Muscle tissue containing fragments of tibial plateau and shaft of tibia and fibula, had been placed within the same body bag as Soldier A at the scene. From the excavations in the turret, the incomplete left foot which had been fused to the metal floor was attributed to Soldier A. Also returned to him from the turret were fragments of the right and left distal tibia (including a large piece of the proximal joint surface), the right and left patella, and the distal ends of the right and left femur. These assignments were based on similarities in size and morphology, articulations, positions within the turret and observations from photographs taken at the scene. Fragments of distal shafts and ends of the right and left fibula were thought also to belong to Soldier A, but Soldier B could not be completely excluded, so those identifications were tentative.

Soldier B

The lower limbs of Soldier B were partially missing from just above the level of the knees. The right and left femur were articulated at the hips and covered by soft tissue, but both were fractured across the lower ends of the shafts just above the knees. It was not possible to see the upper parts of the knee joints, but the lower parts (the intact proximal ends of the tibia and fibula) were present on both sides, held in place by soft tissue. The right and left tibia were broken off at the upper third of the shaft and the middle and distal sections and feet were missing. The rest of the body was largely intact, but it was extensively burnt and there were some areas of damage to the skeleton. There was disruption to the left elbow, some of the bones from the right hand were missing and there was damage to the ribs on the right side. The incomplete right foot which had been fused to the metal floor in the turret was returned to Soldier B. It was also possible to achieve mechanical fits of the following fragments to the body; the proximal end of the right radius, three fragments of shaft of right femur, a piece of the outer table of the cranial vault. Articulations could be made between the partial right foot, a right talus, and the distal end of the right tibia, which had all been recovered from the turret.

Soldier C

The body of soldier C comprised the base of the cranium, the neck, torso, incomplete arms and thighs, which were all joined and covered by soft tissue. The cranial base included the mastoid processes and petrous temporal bones, but the mandible and dentition were not visible. Only the proximal part of the upper arm was present on the right side, but more of the left arm appeared to have survived. It was not possible to record the latter accurately due to the position of the body and the requirement to minimise movement of the remains in their fragile state. The thighs were intact to the level of the lower shafts of the femora. An additional piece of burnt tissue and two calcined fragments of shaft of tibia, recovered from the scene, had been included within the body bag of Soldier C.

The location of Soldier C, both before and after death, meant that there was a high probability any disassociated remains from him were extensively commingled with those from Soldier E and, to a lesser extent, Soldier F. It was felt that the majority of the fragments belonging to Soldier C would be in Zones 6 and Bags X and Y, but the possibility of them being more widely dispersed could not be excluded due to the disturbance of the vehicle. A collection of disassociated cranial fragments were tentatively assigned to Soldier C based on the fact that other, repeated, pieces of crania found in the rear of the vehicle were in close association with Soldiers E and F.

Soldier D

The articulated head, neck, torso, upper arms and upper thighs of Soldier D had survived. The body was extensively burnt, there was no soft tissue surviving on the cranium, and the mandible was partially disarticulated. The left side of the face was badly fragmented and there was also a large defect in the cranial vault. There was some damage to the torso in the mid-thoracic region on the left side and there was slight damage to the sacrum. The distal half of the right and left humerus, and the entire right and left forearms and hands were missing. The right and left lower limbs were missing from the mid-shaft of the femur downwards.

At the time of recovery, the body had been in a prone position in the drivers chair with the tops of the upper arms pointing downwards either side of it. Fragments of right distal humerus, radius, ulna, metacarpals and phalanges had collected in the gap between the outer wall of the vehicle and the left side of the chair. Similarly, on the other side of the chair, fragments of left distal humerus, radius, ulna, metacarpals and phalanges, had collected in the gap between the right side of the seat and the wall partitioning the cabin from the engine. This strongly suggested that the forearms and hands had

become disassociated from the rest of the body whilst it was lying in the same prone position in the chair, and that the body (and the fragments) had not moved when the vehicle had been turned onto its side. In addition to the upper limb bone, fragments of right and left femur, tibia, fibula, the patellae, numerous tarsals and metatarsals (some of which were intact) and phalanges, were found in front of the driver's seat in the foot-well area.

As there was no evidence of commingling of body parts from different individuals in Zone 1 and the fragments recovered corresponded to the missing body parts from Soldier D, both in terms of skeletal element and position within the cabin, they were assigned to him with a high level of confidence. Multiple loose teeth recovered from Zone 1 were also attributed to Soldier D.

Soldier E

The body of Soldier E comprised an articulated incomplete skull, neck, torso, the proximal halves of the upper arms and the upper part of the right thigh. The body was severely burnt with deeply charred muscle tissue and the spine and neck were hyperextended. Parts of the mandible and maxilla including dentition had survived. There was some damage to the right and left shoulder girdle and to the ribs, the right side of the pelvis appeared to be intact, but the left *os coxa* was entirely missing. The arms had broken off in the region of the upper third of the humerus on both sides.

The location of Soldier E meant that there was a high probability any disassociated remains from him were extensively commingled with those from either Soldier F or Soldier C. It was felt that many of the fragments in Zone 6 (the central part of the rear of the vehicle) could have originated from Soldier E, but there was also a chance that they could have been in Zones 4, 5, 7, or Bags X and Y. It was possible to physically fit a small number of the recovered fragments from those zones to the body of Soldier E. These included most of the left clavicle and three fragments of the left humeral shaft. A number of cranial fragments, which were closely associated with the top of his neck and basi-cranium, could also be re-joined with each other.

Soldier F

Soldier F was the most severely burnt and disrupted of the six soldiers. His main body part consisted of only an incomplete head, neck, shoulders and top of the thoracic spine (T1). The base of the cranium was largely intact and some of the facial bones including the right and left zygoma, the maxilla, and the posterior part of the mandible were present. It was also possible to see some dentition *in situ*.

The location of Soldier F meant that there was a high probability that any disassociated remains from him were extensively commingled with those from Soldier E and possibly Soldier C. However, the sheer level of disruption he had sustained meant that there were many bones no longer present in his body which were present in the other five soldiers. This meant that disarticulated duplicated fragments could be assigned to him with confidence. Duplicated elements which could only have belonged to him included eight thoracic vertebrae, five lumbar vertebrae, and some fragments from the left and right *os coxa*. Multiple fragments of ribs, limbs, hand and foot bones, also found in Zones 2, 4 and 5, could not be assigned to Soldier F with any degree of confidence because other soldiers were also missing these body parts.

It was possible to physically fit some fragments recovered from the rear of the vehicle to Soldier F. These included part of the left scapula and shaft of the left humerus, and the left and right clavicles. It was also possible to make some tentative reassignments based on observations of the remains *in situ* during the excavations. The removal of the seat at the rear of the vehicle on the right-hand side had revealed the remains of Soldier F lying on top of the debris; immediately around the cranium and the neck had been a collection of cranial fragments arranged in the correct anatomical positions together with some

some loose dentition. These fragments were lifted individually but labelled as probably belonging to Soldier F.

Following completion of a written and photographic summary, the burnt fragments were packaged in bubble wrap either individually or in groups depending on their size and condition. They were then placed in plastic bags which were labelled according to skeletal element and zone. The bags were put into boxes which were also labelled by zone, and each box was produced as an exhibit. This methodology was adopted to minimise damage during transit, to maintain continuity and to facilitate re-association of the fragments in the UK. The body bags and boxes of associated fragments were then placed in coffins and an attempt was made to organise them so that there was one soldier per coffin. The large number of fragments which could not be attributed to an individual soldier had to be accommodated however, so those boxes were placed in coffins with smaller body parts where there was space available. The repatriation service at Camp Bastion began at approximately 03.30hrs on the 20th March 2012 and the flight transporting the remains left for the UK at 05.30 hrs. The remains of the soldiers were escorted by RMP officers, funeral directors from Albin International Repatriation, and the forensic anthropologist.

Postmortem Examinations and Positive Identification in the UK

All fallen British service personnel from operational environments are repatriated to the UK for coroners' inquests. They are flown into RAF Brize Norton in Oxfordshire therefore they are subject to the jurisdiction of the Oxfordshire coroner.

The 'Warrior Six' arrived back in the UK on the 20th March 2012 and their postmortem examinations commenced that same evening at the John Radcliffe Infirmary in Oxford. They were managed by the RMP forensic team and led by two Home Office forensic pathologists highly experienced in the examination of casualties from Iraq and Afghanistan. Also present were the RAF dental team who were trained in forensic odontology and experienced in the examination of burnt and disrupted remains.

The deploying forensic anthropologist attended the examinations in the UK and provided the other experts with contextual information relating to the excavation, location and condition of the remains, plus details of the packaging and labelling of body parts and fragments in Afghanistan. Additional anthropological assistance included further identification of the fragments of burnt bone and physical reconstruction of some of the body parts, together with a second anthropologist who joined the team. The second forensic anthropologist also peer reviewed the decisions made in Afghanistan.

As part of the wider peer review process, the deploying forensic anthropologist explained the rationale for the presumptive assignments to the forensic pathologists and the coroner with the following outcomes:

1. Decisions made in relation to Soldiers A, B and D were accepted. Attempts were made to confirm the identity of some of the reassigned fragments by DNA analysis but these failed due to the calcined state of the remains. A written justification for the reassignments was produced by the forensic anthropologist and this was approved by the coroner.
2. The decisions relating to the re-assignment of fragments to Soldier F (based on mechanical fits and duplicated skeletal elements) were accepted by the forensic pathologists and coroner. The cranial fragments associated with Soldier F were successfully reconstructed and, as it was possible to obtain a full DNA profile from one of the fragments, the entire cranium could then be repatriated to Soldier F.
3. Closer examination of Soldier E and his CT imagery gave a precise indication of which parts of the pelvic girdle were missing. This enabled decisions to be made regarding some of the pelvic

fragments which could have belonged to either Soldier E or Soldier F. These decisions were accepted by the forensic pathologists, but later rejected by the coroner.

4. Some of the more tentative assignments made in Afghanistan, particularly in relation to Zone 6, were not accepted by the forensic pathologists. It was therefore agreed that some of the commingled fragments which had been assigned to Soldiers C, D and E on a preliminary basis, should remain as commingled 'common tissue'. This was because it was felt there was simply not enough evidence to state conclusively that the fragments could only have come from one of the three individuals.

Full DNA profiles which matched those of the six soldiers were obtained from each of the incomplete bodies and large body parts.

Conclusions

The strategy adopted for the excavation of the remains from the Warrior vehicle in Afghanistan maximised the chances of full recovery of all the body parts belonging to the six soldiers. It also facilitated the repatriation of a significant number of calcined fragments to the main body parts, which would not have been possible by DNA analysis. This reduced the overall number of fragments that had to be labelled 'common tissue' and it also meant that as much of each body as possible could be returned to the families of the deceased.

The temporary mortuary facility in Camp Bastion and the specialist knowledge of the Service Police team enabled the fragments and body parts to be processed and examined in a controlled manner. This meant that the chances of further damage to the fragile remains and the opportunity for errors surrounding photographs and exhibits was greatly reduced.

The recovery, examination and identification of commingled burnt fragments can be extremely complex and challenging even in normal circumstances. When undertaken in a military theatre of operation under severe time constraints, the magnitude of these challenges is amplified. This case study illustrates that even in a hostile environment, best practice can still be employed providing the correct expertise is utilised at the scene and in the mortuary. It also demonstrates how scientists and police teams can successfully work together to achieve optimum results.

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