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TERRORISM

Contents

Medico-legal Aspects

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Introduction

Very few words today have more meanings than the word "terrorism." In a 1983 study Alex Schmid compiled all the definitions, and found there were a minimum of 109. It is believed that today more than 200 definitions of this word may exist (some representative definitions are given in Table 1). Notwithstanding the definition problem, most people think that they can recognize a terrorist act when they see one. The core meaning of the term is clear to most of us, even if its exact frontiers are not. If in the name of some political or ideological cause, a bomb goes off in an aircraft, a plane is hijacked, a parliament building is attacked, a suicide bomber blows himself up in a crowded area killing innocent citizens, or an airliner is rammed into a high-rise building, most people justifiably recognize it as terrorism. In the modern era, terrorist acts manifest in a number of ways such as torture, arson, robbery, kidnapping, hostage-taking, murder, bombings, aircraft sabotage, hijacking, and the use of weapons of mass destruction (WMD) such as chemical and biological agents. "Target Blue" ambush slayings of police officers may also be resorted to by some groups. Police officers may be selected at random, not because of who they are, but of what they represent. However the acts which are encountered most frequently, and those in which a forensic scientist/pathologist is involved in one way or the other are bombings, aircraft sabotage, and, to some extent, use of chemical and biological agents.

The term "antiterrorism" describes defensive measures that reduce the vulnerability of individuals and property to a terrorist incident. "Counterterrorism" is a proactive step describing offensive measures taken to prevent, deter, and respond to terrorism.

Torture

Torture as a weapon of terrorism is not often seen now, although at one time organizations such as the Irish Republican Army (IRA) resorted to this very frequently. Small groups may still want to resort to this simple but effective technique to make a political statement. Common methods of torture include beating, whipping, burning and scalding, sexual torture, electrical torture, and certain specialized procedures such as "falanga" (beating of the soles of feet with canes or rods), "knee-capping" (a technique developed by the IRA to cripple rather than kill informers; the victim is shot through the knees, from posteriorly generally), "submarining" (repeated dipping of the victim in foul liquid such as sewage or urine mixed with feces), and "telefono" (repeated slapping of the sides of the head with open palms; this ruptures the tympanic membranes and damages the inner ear). It is vital for forensic physicians and forensic pathologists to be able to distinguish signs of torture.

Terrorist Bombings

Bombing is undoubtedly the most common method employed by terrorists. Typically the bomb is left indoors in public places or placed in a vehicle ("blind date" bombings). From 1969 till 1983, there were at least 220 incidents of terrorist bombings worldwide, which killed 463 persons and injured an additional 2894. Since then incidents of bombings and resulting deaths have increased exponentially. In the USA, there was an increase by 400% in the bombing attempts from 1984 (803 bombing incidents) till 1993 (3163 bombings). A number of devices have been used by terrorists. These include improvised explosive devices (IED), napalm bombs, Molotov cocktails, and a number of other such devices. Napalm bombs and Molotov cocktails are basically incendiary bombs, which primarily cause burns rather than explosive effects. Napalm generates a temperature of 1100 °C (1800 °F), and consists of a combination of oil and gasoline in a jelly form. Phosphorus and magnesium are sometimes added to the mixture, which can raise the effective temperature as high as 2150 °C (3500 °F), or higher.

Table 1 Some representative definitions of terrorism and terrorist acts

1. Terrorism is premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine state agents, usually intended to influence an audience. (US State Department)
2. Terrorism is the unlawful use of force or violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives. (FBI)
3. An action of violence is labeled ''terrorist'' when its psychological effects are out of proportion to its purely physical result. (Raymond Aron)
4. It is not possible to give a precise definition of terrorism or to lay down what constitutes terrorism. But . . . it may be possible to describe it as use of violence when its most important result is not merely the physical and mental damage of the victim but the prolonged psychological effect it produces or has the potential of producing on the society as a whole . . . If the object of the activity is to disturb harmony of the society or to terrorize people and the society, with a view to disturb the even tempo, tranquility of the society, and a sense of fear and insecurity is created in the minds of a section of the society or society at large, then it will, undoubtedly be held to be a terrorist act . . .. (Supreme Court of India, in *Mohd. Iqbal M. Sheikh* v. *State of Maharashtra* (1998) 4 SCC 494)
5. Terrorism is the use or threatened use of force designed to bring about political change. (Brian Jenkins)
6. Terrorism constitutes the illegitimate use of force to achieve a political objective when innocent people are targeted. (Walter Laqueur)
7. A terrorist act is an act done by using weapons and explosive substances or other methods in a manner as to cause or likely to cause death or injuries to any person or persons or loss or damage to property or disruption of essential supplies and services or by any other means necessary with intent to threaten the unity and integrity of India or to strike terror in any section of the people. (Prevention of Terrorism Act 2002 [India])
8. Terrorism is the premeditated, deliberate, systematic murder, mayhem, and threatening of the innocent to create fear and intimidation in order to gain a political or tactical advantage, usually to influence an audience. (James M. Poland)
9. Terrorism is the unlawful use or threat of violence against persons or property to further political or social objectives. It is usually intended to intimidate or coerce a government, individuals or groups, or to modify their behavior or politics. (US Vice-President Gore's Task Force, 1986)
10. Terrorist acts are acts where they are committed intentionally by individuals or groups against one or more countries or their institutions or population in order to threaten them and seriously undermine or even destroy their political, economic or social structures. (The European Commission, September 2001)
11. Terrorist acts are criminal acts intended or calculated to provoke a state of terror in the general public, a group of persons or particular persons for political purposes. These acts are in any circumstance unjustifiable, whatever the consideration of a political, philosophical, ideological, racial, ethnic, religious or other nature that may be invoked to justify them. (United Nations General Assembly, 1996 [GA Res. 51/210], commonly referred to as the ''GA 1996 definition of terrorism'')
12. The intentional use of violence – real or threatened – against one or more noncombatants and/or those services essential for or protective of their health, resulting in adverse health effects in those immediately affected and their community, ranging from a loss of well-being or security to injury, illness, or death. (A Proposed Universal Medical and Public Health Definition of Terrorism, proposed by 21 medical specialists from 16 different countries in *Prehospital and Disaster Medicine* 2003; 18(2): 47–52.)

The Molotov cocktail has been a favorite of guerillas and terrorists. It consists of a bottle full of gasoline and a rag which serves as a wick. The wick is lit and the bottle is thrown at the target. Various chemicals and acids may be added to this cocktail to increase its destructive potential.

Letter bombs are explosive devices sent through the mail in parcels. They consist of the detonating fuse, the explosive, the electronics for initiation and the energy source. They cause injuries – sometimes fatal – to the unsuspecting person who opens such parcels.

For a forensic pathologist investigating terrorist bombings, it is important to realize that terrorist explosions may kill or maim in a number of ways. Terrorist bombs typically are small. They are typically delivered either in suitcases or parcels, weigh in the range between 1 and 15 kg (2 and 30 lbs), or in vehicles (car bombs), weigh up to 200 kg (500 lbs). What makes them deadly is not their size, but the fact that (1) they can be hidden effectively, often at places where a large number of people congregate and (2) they are often charged with penetrating devices such as nuts, bolts, and nails which can fly about and cause injuries, much like missiles from a gun. Blast wave generation from the bomb can also cause damage, especially to air-containing organs such as lungs, ears, and intestines; since it is the gas–solid interphase where most of the blast energy is dissipated. A blast may also throw a victim about, causing him to strike surrounding objects. Conversely surrounding objects may also fly around and cause injuries to the victim.

A blast is essentially an expanding hot sphere of gas generating from the high explosive contained within the bomb. It can have an initial pressure of approximately 6.895×10^{10} pascals (10 million PSI, 6.805×10^{5} atm). Human beings are endangered at 6.895×10^{5} pascals (100 PSI, 6.805 atm) or above. The destructive capacity of the blast is due to this force (known as blast loading). This pressure (or the blast load) dissipates rapidly into the surrounding medium causing in quick succession the following three phases: (1) a positive pressure phase, (2) a negative pressure phase (lasting about five to six times the duration of the positive pressure phase),

and (3) the mass movement of wind (blast wind) (Figure 1). Most of the damage is due to the positive pressure component of the blast. The negative pressure component is always much weaker than the positive pressure component, and can never be greater than 15 psi, since this would produce a perfect vacuum. The positive pressure component however can theoretically rise to any value, depending on the amount of high explosive used.

Blast front is the term used to denote the leading edge of the blast wave; blast overpressure denotes the maximum positive pressure achieved during the positive pressure phase; and blast strength denotes the ratio of blast overpressure to the ambient atmospheric pressure. Blast front propagates at supersonic speeds ranging from 3000 to 8000 $m\,s^{-1}$ (speed of sound in air is 340 $m\,s^{-1}$), but it loses its pressure and velocity exponentially with the distance from the source. The pressure generated by explosions is inversely related to the cubed distance from the focus of detonation. This is the reason that terrorist bombs, even though small, are lethal at very short ranges (Tables 2 and 3).

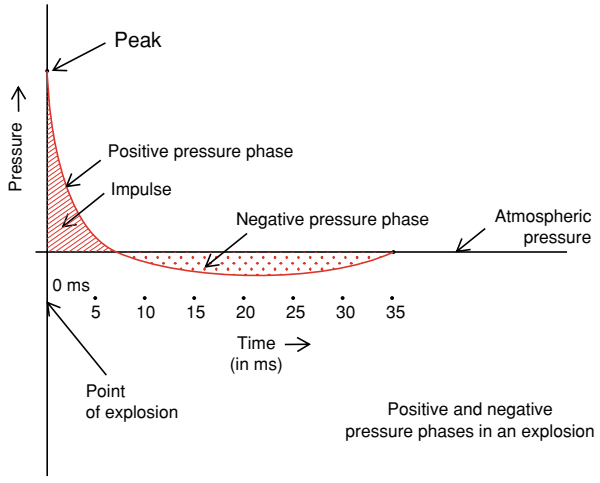

Figure 1 Dissipation of blast pressure into the surrounding medium.

Table 2 Exponential fall of pressure from the distance of the source of detonation (30 kg (70 lb) charge)

Distance (m (feet))	*Pressure (kg cm^{-2} (psi))*
4.20 (14)	7.48 (110)
5.4 (18)	4.08 (60)
9.0 (30)	1.02 (15)
15.0 (50)	0.40 (6)

Table 3 Some representative pressures in pounds per square inch (psi)[a]

• 1 psi	Breaks windows (1 psi is also the pressure below 2.3 feet of water)
• 1.55 psi	Normal diastolic blood pressure in man
• 2.32 psi	Normal systolic blood pressure in man
• 3 psi	Breaks walls
• 5 psi	Lowest pressure at which rupture of the human ear drum (most vulnerable organ to pressure) can occur
• 6 psi	Pressure produced by a 70 lb high explosive at a distance of 50 ft
• 15 psi	Pressure produced by a 70 lb high explosive at a distance of 30 ft
• 15 psi	Rupture of human ear drum occurs in 50% of the cases
• 30 psi	Pressure required in the tire of an average-sized car
• 60 psi	Pressure produced by a 70 lb high explosive at a distance of 18 ft
• 70 psi	Pulmonary damage seen in 50% of the victims
• 80 psi	Lethal in 50% of cases
• 100 psi	Endangers life of a human being in almost all cases
• 110 psi	Pressure produced by a 70 lb high explosive at a distance of 14 ft

[a]Normal atmospheric pressure at sea level is 14.7 psi (it decreases by 1 psi for every 2343 feet as we go up). All the units given above are in PSIG and not in PSIA. It is important to appreciate the difference between PSIG or ''pounds per square inch Gauge'' and PSIA ''pounds per square inch Absolute''. PSIA = PSIG + Normal atmospheric pressure. When we fill up our car tires at, say, 30 psi, the gauge used to measure the pressure ignores the normal atmospheric pressure. This is the PSIG, i.e. ''the pressure as measured by gauge''. This is also the pressure, as we normally understand it, in our day-to-day life. If we were to measure ''absolute pressure'' in our car tire, we would have to add normal atmospheric pressure (14.7 psi) to it. Thus a tire at 30 psi (PSIG), would be at 44.7 PSIA. Saying that a pressure of 15 psi causes rupture of the human drum, means that the ear drum is exposed to 15 psi of pressure ''over and above'' the normal 14.7 psi, to which it is always exposed.

Bomb Scene Management

The aim of a forensic scientist at the bomb scene is to gather and deduce as much information as possible. The police would be interested in raising several questions about the incident. Most frequently asked questions are:

1. What were the materials used to make the explosive device?
2. Where was the bomb placed?
3. What was the level of skill or expertise of the suspect?
4. What was the intended target of the bomb?
5. Who made the bomb and who placed it?
6. Was the explosion accidental or was there criminal intent?

7. How was the bomb detonated?
8. Who was the victim or intended victim?

Many of these questions can be successfully answered if certain foolproof protocols are employed, and evidence is collected diligently. It is frequently necessary to know if a low explosive or a high explosive was used. This information can often lead the investigation agencies to look for particular terrorist groups.

A low explosive such as gunpowder burns in a matter of milliseconds and generates a pressure of about 6000 atm. A high explosive such as nitroglycerine, on the other hand, burns in only microseconds and can generate pressures up to 275 000 atm. A low explosive functions by deflagration (very rapid burning), while a high explosive functions by detonation. The burning front in a low explosive moves relatively slowly – typically much slower than the speed of sound; in a high explosive, the burning front moves with supersonic speeds – typically from 900 to 7500 m s^{-1} (3000 to 25000 ft s^{-1}). Low explosives typically need some sort of confinement to produce destructive effects as in a pipe bomb; high explosives do not need such kind of confinement. Destructive effects with high explosives are much worse. The difference between a low and a high explosive has been graphically described with this simile: "It is the difference between being bumped into by a pedal cyclist or being knocked for six by an express train."

The first response after a bombing incident should always be to call for emergency services. Their services include extinguishing fires, rescuing the survivors, administering first-aid, and transporting casualties to the nearest hospital. Next the bomb scene manager takes control and determines the seat of explosion, which usually can be identified by the presence of a deep crater. Fragments will be found scattered all around the seat of explosion. The distance of the farthest fragment is determined from the center of the crater. To this is added, one-half of distance, and this gives the radius of the inner cordon (Figure 2). The area inside the inner cordon may only be visited by bomb scene manager, exhibits officer, and the members of the forensic team. An outer cordon is placed outside this. The area between the inner and outer cordon is used by police teams, members of emergency services, press, etc. Falling debris, especially pieces of glass, can often pose dangers to the team working within the inner cordon, so it is essential to wear protective gear including helmets.

Collection of Physical Evidence

Physical evidence to be collected from the site of explosion includes power sources such as batteries (ranging in size from Polaroid film batteries to car batteries), timers (chemical, mechanical, and electronic), detonators and igniters, switches, circuitry (such as wires and printed circuit boards, etc.), adhesive tapes (used in the construction of several bombs; these usually survive the explosion), explosive device containers, and other bomb-making equipment such as rolls of tape, rubber gloves, and booby traps.

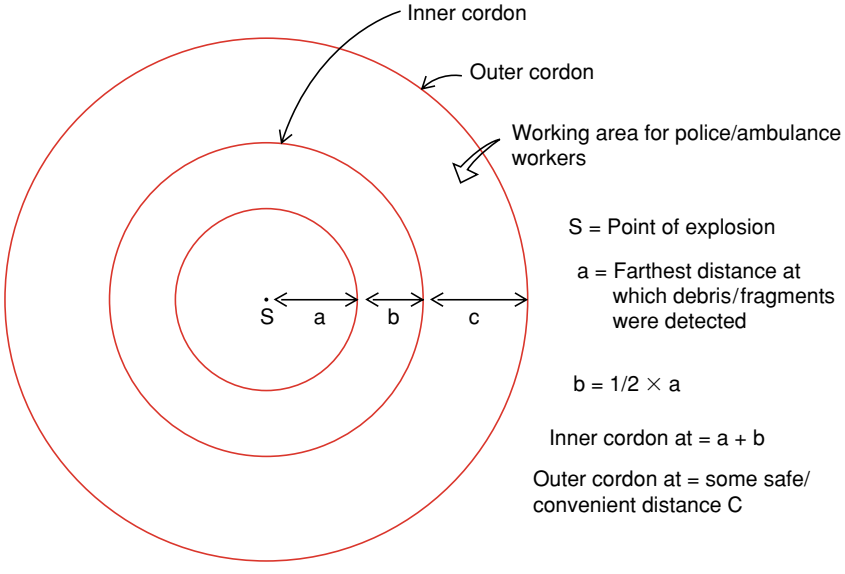

Figure 2 Sketch of explosion site with inner and outer cordons marked.

A careful examination of all this evidence would often lead the investigators towards a particular terrorist group or groups. Additionally, matching of tool marks on one or more of these objects with the tools recovered from suspect's possession can greatly strengthen the prosecution's case.

Collection of Explosive Residues

Particles of explosives recovered from the bomb scene may provide valuable clues. They can often provide clues regarding probable manufacturer and the brand of explosive. If a suspect is later found, the particles recovered from the crime scene may be compared with those found in his/her possession or on the body. Low-explosive residues are best collected by mechanical vacuuming. Collection of high-explosive residues is a more complex task. This is because they burn more completely, leaving only traces, and also because of the availability of a vast variety of different formulations and physical forms. Additionally since a high explosive is likely to involve a much wider crime scene, there is much greater "dilution" of residues than can be expected in the case of low-explosive blasts.

Vapors at the crime scene may be sampled by passing the air through adsorbent materials such as Tenax®. Alternatively a portable pump may be used in conjunction with charcoal. Explosive detectors developed for aviation safety are also very useful. One of the best known is the EGIS explosives detector, a "field portable" instrument which can detect many high-explosive residues such as those of TNT (trinitrotoluene), RDX (Research Department Explosive), PETN (pentaerythritol tetranitrate), NG (nitroglycerine), and EGDN (ethylene glycol dinitrate). An EGIS (Equipment Gesellschaft für Internat Systeme GmbH) explosives detector was used in the Oklahoma City bombing investigation. Basically this instrument uses high-speed gas chromatography, coupled with highly specific chemiluminescent detection, to identify explosive compounds.

When a suspect is later apprehended, there could be traces of the explosive on his person and/or on the vehicle that was used to transport the bomb. Hand swabs and fingernail scrapings are taken in the same way as of that from a shooting suspect. Isopropanol is a suitable solvent. Many high explosives such as RDX are absorbed by the skin and may be detected up to 1 week after the incident. Clothing may also present traces of explosives. Suspects' premises may also contain material which may match that recovered from the scene of the bombing.

Detection of Bomber's Signature

Often a terrorist group can be identified by some definitive design feature or a unique choice of materials for making bombs. This is usually referred to as the "bomber's signature." The unique feature could be the design of the firing circuit, an improvised explosive, a combination of components, or a particular type of target. Sometimes the identifier can be quite unique. The "Unabomber" in the USA always included the initials "FC" on an internal component of his devices. The initials were deliberately placed so that they would survive the blast and fall into the hands of the investigators. Advanced psychological profiling techniques can now help in charting the personality of the bomber.

Dealing with Human Bodies

Human bodies lying around must be handled with great care. Life may still be present in people presenting an outward appearance of death. All such persons must be examined by medical personnel. Only when death is confirmed by medical personnel, should the work of transporting the bodies to the mortuary begin.

Dead bodies lying at the scene may belong to the terrorists. Hands, feet and head may have been severed from the body due to the explosion. To preserve all possible evidence – and to avoid contamination – both hands, feet, and head of such bodies are bagged separately in nylon bags and sealed with tape. The bodies are then transported to the mortuary.

Autopsy

The postmortem examination in terrorist deaths can conveniently be divided into five important phases, each having a distinct and specific role. These are: (1) identification of bodies and preparation of a correct total body count, (2) radiological examination, (3) collection of surface evidence, (4) collection of internal samples, and (5) documentation of injuries.

Identification of individual bodies may not only be necessary for insurance claim purposes, but also to identify possible suspects among them. A proper reconstruction of the face may aid in facial identification. Clothing and other personal possessions are also useful in several cases. In addition, standard identification protocols such as hair and eye color, scars, tattoos, dactylography, odontology, anthropology, osteology, and DNA-profiling techniques aid in the correct identification. A correct body count may be done by physical matching of body parts. Sometimes just a single unaccounted body part may indicate an additional body. Finding of tissues like testis,

prostate, and uterus will indicate the sex of the individuals. In badly mangled bodies the presence or absence of Barr bodies and Davidson's bodies in the cell nuclei can indicate true sex. Cases that cannot be resolved by any means may be resolved by means of DNA profiling.

Radiological examination will enable the pathologist to correctly locate and retrieve various shreds of the original explosive device which might have been lodged in the body. This can help in identifying the bombing devices and often "bomber's signatures." A bullet may sometimes be found in the body, which may confound the uninitiated. But it could indicate that the victim was tortured and murdered before the explosion occurred.

Collection of surface evidence includes collection of traces of powder, bomb fragments, and bomb chemicals from the bodies and body fragments using standard protocols. Materials from hands should be collected by standard wiping techniques. Finding stronger concentration of bomb chemicals on the hands than on rest of the body may indicate that the person had handled the bomb just before the explosion and might have been a perpetrator of the incident rather than an innocent victim. Many bomb chemicals tend to stick to clothes for long durations, and an examination of clothing can be very rewarding.

Collection of internal samples includes collection of blood, urine, vitreous humor, bile, stomach and intestinal contents for toxicology, and hair and blood for DNA profiling. Findings of street drugs like cocaine and heroin in the blood may be significant.

Finally the proper documentation of injuries is a vital task of the pathologist. Not only will it establish the cause of death, but also the manner of death and the position of the victim at the time of explosion. Two factors make the deduction of the position of explosion victims possible. Firstly, the explosive force declines exponentially with distance, and is very directional. As observed earlier, the explosive force declines as the cube of the distance. Since injuries are directly proportional to the explosive force, it effectively means that the injuries sustained are inversely proportional to the victim's distance from the seat of explosion. Secondly, if the seat of explosion is on, for example, the right side of a victim, because of the unidirectionality of the explosive force, his right side would be badly mutilated.

The position of the victim at the time of explosion can often indicate if he was indeed the perpetrator of the crime. For instance in one case of explosion that occurred in a car, the driver had the left part of his body totally destroyed, and his colleague (co-passenger) the right part of his body. From these facts, it could be deduced that the bomb was lying between them at the front seat, and they were probably carrying it to some predestined location. This fact immediately pointed to the fact that they could be terrorists rather than innocent victims in whose vehicle the bomb had surreptitiously been placed. In another case, when a terrorist was bending over a bomb, it went off prematurely killing him instantaneously. In such cases, although chest, abdomen, and face showed severe injuries, the umbilicus was completely spared, because during bending forward, it gets trapped in folds of skin.

Six types of injuries (listed below) are seen in explosion victims.

Primary Blast Injuries

These are the injuries that occur as a result of the direct pressure effects of the blast wave on the victim. These are more severe when the blast occurs in a confined space, primarily due to repeated reflection of the blast wave. Organs most likely to suffer damage due to this are those that contain air, for example, auditory apparatus, respiratory system, and gastrointestinal system. Blast waves tend to get reflected at the air–fluid interphase, and since these organs contain such a boundary, they are more liable to be injured. Three mechanisms serving to augment blast injuries are spallation, implosion, and inertial effects. The tendency for a boundary between two different density media to be disrupted when a compression wave in the denser medium is reflected at the interphase is known as spallation. Implosion refers to a violent collapse inward (as of a highly evacuated glass vessel) and is usually applied to the inward collapse of a building that is being demolished in a controlled manner. In the context of primary blast injuries, implosion refers to the forceful compression of a bubble of gas by a shock wave passing through a liquid. This compression causes the bubble to implode, the pressure within the bubble rising up to the levels of shock pressure. When the shock wave passes, this pressure is suddenly released, and the bubble explodes outwards, severely damaging the local tissue. When two adjacent objects of different densities are acted upon by the same force, they may be accelerated differently, causing them to slide against each other. This inertial effect is the classic mechanism responsible for injuries such as retinal detachments seen in terrorist bombings.

The organ most sensitive to blast effects is the ear. Classic injuries seen in terrorist bombings are rupture of the tympanic membrane and damage to the

Eustachian tube, the ossicular chain, and to the organ of Corti within the cochlea.

While the ear is the most sensitive organ to blast effects, injuries to the lungs are the greatest cause of mortality. Lungs would often reveal the fatal lesion in cases of deaths. There is some controversy as to whether the shock wave passes to the lungs directly through the chest wall, or through the air via oronasal orifices. Quite probably both mechanisms work together to produce injuries. Main injuries seen are

Table 4 Some significant major terrorist acts in history

Date/Year	*Event*	*Deaths*
1585	Antwerp, Belgium[a]	1000
1925	Bombing of Cathedral in Sofia, Bulgaria	160
1946	Nakam attack in Germany	100s (?)
1969	Cu Chi, Vietnam	15
1970s	IRA bombings, UK	100s
1970s	PLO in Israel	100s
May 30, 1972	Tel Aviv airport shootings	27
Sep. 5, 1972	Terrorist attack in Olympic village in Munich, Germany	17
Jun. 27, 1976; Jul. 4, 1976	Hijacking of an Air France jetliner from Tel Aviv to Entebbe Airport in Uganda	10
1979	Arson attack on a cinema in Abadan, Iran	477
Aug. 1, 1980	Bologna train station, Italy	84
Oct. 23, 1983	Bombing of the US Marine Barracks in Beirut, Lebanon	241
1983	In-flight bomb explosion in Gulf Air airliner, Bahrain	112
Jun. 22–23, 1985	Bombing of Air India passenger airliner over the Irish Sea	329
1986	Paris bombings	20
1987	Bombing of South Korean airliner near the Thailand–Burma border	117
1987	Car bomb in bus station, Sri Lanka	113
Dec. 21, 1988	Bombing of Pan Am flight 103 over Lockerbie, Scotland	278
1989	Bombing of French UTA airliner over Niger	171
1989	In-flight bombing of Colombian Avianca aircraft, near Bogota	107
Feb. 23, 1993	Bomb detonated at the underground parking garage of World Trade Center, New York	6
Mar. 12, 1993	Bombings in Mumbai, India (10 explosions in less than 3 h)	235
Jul. 18, 1994	AMIA (Asociación Mutual Israelita Argentina), Buenos Aires	89
Mar. 20, 1995	Tokyo subway sarin gas attack by Aum Shinri Kyo cult	12
Apr. 19, 1995	Bombing of federal building in Oklahoma City, Oklahoma	168
1997	Car bomb in Kenya, attributed to Bin Laden	213
1998	Massacre in Algeria's Relizane province, attributed to GIA	412
Sep. 11, 2001	Airliners flown into World Trade Center and Pentagon buildings	About 5000
May 14, 2002	Indiscriminate shooting at Kaluchak, India	31
Oct. 12, 2002	A massive explosion from a car bomb destroys a night club at the Kuta beach resort on the tourist island of Bali in Indonesia (most probably connected to the first anniversary of the beginning of the US air strikes in Afghanistan on Oct. 7)	202
Oct. 26, 2002	Chechnyan rebels seize a Moscow theatre, holding 750-plus hostages	118
Sep. 24, 2002	Indiscriminate shooting at Akshardham temple, Gujrat, India	28
Aug. 5, 2003	Car bomb explodes outside Marriott Hotel	13
Aug. 25, 2003	On this Black Monday, two bombs exploded in Mumbai, India. The first one at about 1 PM at the Gateway of India, and the second shortly thereafter at Zaveri Bazaar	52. Injured about 150
Dec. 5, 2003 (Friday)	A female suicide bomber detonates herself inside a crowded train in Southern Russia (near the war-torn region of Chechnya). The morning train from Mineralnye Vody to Essentuki was crowded with students, workers and shoppers headed for a local market at 8 AM. The explosives were packed in a waist-belt	42 (36 died on first day)
Mar. 11, 2004	A series of explosions at three Madrid railway stations. Ostensibly because Spain supported US during its Iraq war. Worst terrorist event in Spain	200
Sep. 1–3, 2004	On the morning of September 1 (Wednesday), a group of militants seize some 1200 people in the main school of the city of Beslan in Russia's Caucasus Republic of North Ossetia. The hostages include students, parents and teachers. Russian forces storm the school on September 3 ending the siege	Over 300 dead, half of them children. More than twice that number are injured

[a]The first recorded case of terrorist bombing. Seven tons of gunpowder were detonated to destroy a bridge on the River Schelt, reportedly killing 1000 soldiers.

Sources: (1) Falkenrath RA, Newman RD and Thayer BA (2001). *America's Achille's Heel: Nuclear, Biological, and Chemical Terrorism and Covert Attack, p. 47. Boston: MIT Press.* (2) Frykberg ER (2002) Medical management of disasters and mass casualties from terrorist bombings: how can we cope? *Journal of Trauma* 53: 201–212.

widespread alveolar damage, tears in the visceral pleura, pulmonary hemorrhage, atelectasis, pneumothorax, hemothorax, pneumomediastinum, and traumatic lung cysts. Air emboli are common, which can be due to traumatic alveolar–venous fistulae. Subcutaneous emphysema and chest wall damage, including injuries to the ribs, are also seen.

The blast wave causes rapid expansion of the hollow organs within the abdomen such as stomach and intestines. This can cause gastrointestinal hemorrhage, especially in the lower small intestines or the cecum where gas content is greater. Other abdominal injuries are intestinal perforation, especially at the ileocecal junction, retroperitoneal hemorrhage, and injuries to solid organs.

Injuries to the cardiovascular system include myocardial contusion, myocardial laceration, coronary artery air embolism, and hemorrhage. Injuries to the central nervous system include concussion and various forms of intracerebral hemorrhage.

Secondary Blast Injuries

These are the injuries produced by flying objects produced by the explosion. These injuries resemble classic ballistic wounds, except that the entrance wound is very irregular. Small flying objects striking the body produce the classic triad of abrasions, bruises, and puncture lacerations. This triad is very characteristic of bombings.

Tertiary and Quaternary Blast Injuries

These are produced either when the victim is actually lifted up and thrown around by the blast wind, or when some heavy piece of masonry breaks and falls upon the victim (the latter have often been called quaternary blast injuries). These injuries resemble classic blunt force injuries.

Burns

The characteristic burns seen in explosions are flash burns. They are not due to flames, but rather due to extremely hot gases which strike the victim. Since the duration of exposure is infinitesimally small, these injuries are superficial in nature. Since the heat applied is the same, they are of uniform depth. If an object was in between the seat of explosion and the victim, it would cast its "shadow," just as it would if there were a flash of lightning. Contours of the body also tend to cast their "shadow" over the burnt area. Areas protected by clothing are safe.

Explosive Injury

Typical injury seen in this category is the "dust tattooing," which occurs due to small particles of dust entering the subcutaneous tissues.

Complete Disruption

If the victim is seated over or in very close proximity to the explosive device, his body would be completely disrupted. The individual body parts are thrown wide apart. These are the bodies that are the most difficult to identify.

Current Trends

Although terrorist bombings still remain the most common form of terrorism, new forms of terrorism have emerged in the twenty-first century. The beginnings of this century saw airplanes being used as missiles against tall buildings. Bioterrorism, nuclear terrorism, hijacking, and aircraft sabotage are other forms which forensic pathologists may have to face in the future. Finally, Table 4 lists some of the major terrorist acts recorded to date.

See Also

Ballistic Trauma, Overview and Statistics; **Crime-scene Investigation and Examination:** Collection and Chain of Evidence; Major Incident Scene Management; **Identification:** Prints, Finger and Palm; **Injury, Fatal and Nonfatal:** Explosive Injury; **Mass Disasters:** Principles of Identification; **Torture:** Physical Findings

Further Reading

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