Injury, Int. J. Care Injured 47 (2016) 646–652

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

40 years of terrorist bombings – A meta-analysis of the casualty and injury profile

D.S. Edwards [a,b,*], L. McMenemy [a,b], S.A. Stapley [a], H.D.L. Patel [c], J.C. Clasper [a,b,d]

[a] Royal Centre for Defence Medicine
[b] The Royal British Legion Centre for Blast Injury Studies, Imperial College London
[c] St. Bartholomews Health NHS Trust, London
[d] Defence Medical Group (South East), Frimley Park, UK

ARTICLE INFO

Article history:
Accepted 26 December 2015

Keywords:
Terrorism
Bombings: Blast Injury
Suicide

ABSTRACT

Introduction: Terrorists have used the explosive device successfully globally, with their effects extending beyond the resulting injuries. Suicide bombings, in particular, are being increasingly deployed due to the devastating effect of a combination of high lethality and target accuracy. The aim of this study was to identify trends and analyse the demographics and casualty figures of terrorist bombings worldwide.
Methods: Analysis of the Global Terrorism Database (GTD) and a PubMed/Embase literature search (keywords "terrorist", and/or "suicide", and/or "bombing") from 1970 to 2014 was performed.
Results: 58,095 terrorist explosions worldwide were identified in the GTD. 5.08% were suicide bombings. Incidents per year are increasing ($P < 0.01$). Mean casualty statistics per incidents was 1.14 deaths and 3.45 wounded from non-suicide incidents, and 10.16 and 24.16 from suicide bombings ($p < 0.05$). The kill:wounded ratio was statistically higher in suicide attacks than non-suicide attacks, 1:1.3 and 1:1.24 respectively ($p < 0.05$). The Middle East witnessed the most incidents (26.9%), with Europe (13.2%) ranked 4th. The literature search identified 41 publications reporting 167 incidents of which 3.9% detailed building collapse (BC), 60.8% confined space (CS), 23.5% open space (OS) and 11.8% semi-confined space (SC) attacks. 60.4% reported on suicide terrorist attacks. Overall 32 deaths and 180 injuries per incident were seen, however significantly more deaths occurred in explosions associated with a BC. Comparing OS and CS no difference in the deaths per incident was seen, 14.2(SD ± 17.828) and 15.63 (SD ± 10.071) respectively. However OS explosions resulted in significantly more injuries, 192.7 (SD ± 141.147), compared to CS, 79.20 (SD ± 59.8). Extremity related wounds were the commonest injuries seen (32%).
Discussion/Conclusion: Terrorist bombings continue to be a threat and are increasing particularly in the Middle East. Initial reports, generated immediately at the scene by experienced coordination, on the type of detonation (suicide versus non-suicide), the environment of detonation (confined, open, building collapse) and the number of fatalities, and utilising the Kill:Wounded ratios found in this meta-analysis, can be used to predict the number of casualties and their likely injury profile of survivors to guide the immediate response by the medical services and the workload in the coming days.

Introduction

The word "*terroriste*" was first used by Robespierre in reference to supporters of the Jacobins in the French revolution; a group who advocated repression and violence in the fight to establish democracy [1]. Equally suicide bombings are not a modern phenomenon. In the 1st century Roman-occupied Judea saw the rise of the Jewish "Sicarri" ("daggers") sect who used suicide attacks as their principle modus operandii, whilst a thousand years later the Muslim "Hashahsin ("assassins") targeted high ranked political leaders with suicide, or missions with certain death, tactics [2]. In contemporaneous times the explosive device has successfully been used by terrorists globally, with their effects extending beyond the resulting injuries, creating instability in the social, economic and psychological aspects of a community [3].

* Corresponding author at: The Royal British Legion Centre for Blast Injury Studies, Imperial College London, London, SW7 2AZ. Tel.: +442075942765.
E-mail address: taffedwards100@hotmail.com (D.S. Edwards).

http://dx.doi.org/10.1016/j.injury.2015.12.021
0020–1383/

Incidents involving explosions account for the majority of mass casualties seen in terrorist related activities [4]. In addition suicide bombings have increasingly been deployed with devastating effects due to a combination of high lethality and target accuracy [5]. An explosion, through a combination of its blast wave and transfer of energy to its surroundings, creates a unique injury profile compared to non-blast incidents, including blast lung, tympanic membrane injuries, fractures and amputation and as a consequence have been categorised into 4 distinct types (Table 1) [6]. Understanding of the casualty figures and types is required by major trauma centres preparing major incident protocols. In addition to this it has been demonstrated from incidents in the Middle East that differing environments, open space (e.g. a market place), semi-confined space (railway stations), confined space (a contained train carriage or bus) and building collapse, confer different injury rates [4]. This in part is related to the environment limiting the effects of the explosion, but also due to differing blast wave characteristics in open and closed environments. This single piece of information early on in an incident can help to direct management protocols. At the time of an incident casualty figures are dependent on accurate triage in the field. This has been proven to be difficult and inaccurate in the past [7].

To date few articles summarise the detail of casualty figures of terrorist explosions globally, with no meta-analyses since 2002 [4]. Since then New York, Madrid and London have been notable high profile targets of terrorist bombings. In addition trends in terrorism related violence have moved from Europe, in particular Northern Ireland, in the 1970–80s, to the Middle East in current times. The aims of this study were to (1) identify trends in the mechanism and geography of terrorist attacks, (2) analyse the demographics and casualty figures of terrorist bombings worldwide, (3) to ascertain differences in the casualty figures and injury profile between (a) suicide and (b) non-suicide incidents and (c) the environment of detonation. Such data can be used for future major incident planning.

Methodology

The study had two arms. Firstly the Global Terrorist Database (GTD) was accessed and interrogated for explosive related terrorist incidents throughout its entire timeline. The GTD is an open access unclassified database of all terrorist incidents since 1970 [8]. It is managed by the University of Maryland, the National Consortium for the Study of Terrorism and Responses to Terrorism and the Center for Terrorism and Intelligence Studies. It was established in an effort to increase understanding of terrorist violence so it can be more readily studied and defeated. Variables scrutinised included, date of incident, country of incident, suicide or non-suicide detonation, and death and wounded rates.

Secondly a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) type search was performed using the OvidSP platform using two separate search resources (PubMed/MEDLINE and Embase) to identify research articles that examined injury patterns and casualty figures from terrorist bombings worldwide [9]. This database was searched for references using the search terms "terrorist", and/or "suicide", and/or "bombing" as keywords. Primary and secondary exclusion criteria were then used to filter the search. Primary exclusions included audiovisual, lecture, book, and biography publications. Secondary exclusions included letters, retracted articles, comments, editorials, and conference papers. Manual strategies subsequently used to establish relevance were (1) title review, (2) Medical Subject Headings [10] term review, (3) abstract review and finally (4) full article review to ensure adequate presentation of incident results and findings relevant to our analysis. Data extracted included explosion environment, suicide or non-suicide detonation, number of casualties (deaths and injured) per incident, and injury types, categorised into Primary, Secondary, Tertiary or Quaternary blast injury types (Table 1). Where duplication of incidents were found between two or more articles if possible data was extracted and separated and if not possible eliminated. Statistical analysis was performed using Student's *t*-test when comparing the means of normally distributed continuous data using SPSS statistics Version 20.1 (SPSS Inc, Chicago, IL, USA) with significance set at $p < 0.05$.

Table 2
Comparison of the number wounded to killed in non-suicide and suicide related terrorist explosions – statistically significant ($P < 0.05$).

		Mean	Ratio (Kill:Wounded)
Non-suicide bombing	Wounded	3.45	1:3
	Killed	1.14	
Suicide Bombing	Wounded	24.16	1:2.4
	Killed	10.16	

Results

The Global Terrorism Database included 58,095 terrorist incidents worldwide involving explosion over a 43 year period. 95% of recorded terrorist explosions were non-suicide type. Suicide attacks resulted in 8.9 times more fatalities and 7 times more injuries than a non-suicide attack. The kill:wounded ratio was statistically higher in suicide attacks than non-suicide attacks, 1:1.3 and 1:1.24 respectively ($p < 0.05$)(Table 2). Over the entire dataset the average number of incidents per year was 2000, with the majority occurring in the Middle East and South Asia (which included Afghanistan and Pakistan), 15,634 and 13,335 respectively. Western Europe comprised 13.2% of all incidents ranking 4th overall (Table 3). Year on year the number of incidents is increasing with 6665 occurring in 2013 ($p > 0.05$)(Fig. 1), however incidents in the Middle East and South Asia contributed to this increase.

The literature search revealed 572 related articles to terrorist/suicide bombings. After application of the described exclusion criteria 41 articles, detailing 167 bombings, were included in our final analysis (Fig. 2). A summary of author(s) and year of

Table 1
Classification of injuries sustained from a blast type explosion.

Hierarchy of injury	Mechanism of injury	Injuries sustained
Primary	Interaction of the supersonic blast wave with gas containing structures of the body	Tympanic membrane rupture Blast lung
Secondary	Direct trauma to the body caused by fragments which have been energized by the explosion.	Fragmentation/penetrating injuries
Tertiary	Mass movement of the body or objects against a body caused by the blast wind	Fractures Amputations
Quaternary	Miscellaneous causes of injury	Burns Crush Injury Inhalation Injuries