Parachute Deaths in Southern Arizona

Rose Cronin, David C. Winston

ABSTRACT

Introduction: Parachuting is said to be a relatively safe activity. We sought to undertake a study to assess parachute-related deaths in our jurisdiction.

Methods: A retrospective study of parachute-related deaths in Southern Arizona was conducted by searching the Pima County Office of the Medical Examiner database between 2001 and 2016. This search revealed 24 deaths.

Results: The decedents ranged from 19 to 61 years of age, with a median age of 36 years. Twenty-two of the decedents were male. The racial breakdown was 22 white, one Asian, and one not recorded. The manner of death in all cases was classified as an accident. All deaths were due to multiple blunt force injuries and only one case was found to have no injuries to the head or neck. The most common circumstances were failure of chute deployment (seven), mid-air collisions (three), and becoming entangled with other parachutists (three). Six deaths occurred during military training. Four of the nonmilitary decedents were described as “experienced” parachutists and one case involved a tandem jump team with a survivor. Natural disease was found in four cases with three having moderate coronary artery atherosclerosis. Toxicology was performed in 21 of the deaths with three positive for cannabinoids, one positive for 7-aminoclonazepam, and one positive for 3,4-methylenedioxymethamphetamine (MDMA).

Discussion: Parachuting is a relatively safe activity, with very few deaths. Investigation of these deaths should include a complete autopsy with toxicology as well as a thorough scene investigation and evaluation of the jumper’s equipment. *Acad Forensic Pathol.* 2017 7(4): 649-656

AUTHORS

Rose Cronin, University of Arizona Honors College

Roles: Data acquisition, analysis and/or interpretation, manuscript creation and/or revision, approved final version for publication, accountable for all aspects of the work, principal investigator of the current study.

David C. Winston MD PhD, Pima County Office of the Medical Examiner and University of Arizona Arizona Health Sciences Center

Roles: Project conception and/or design, data acquisition, analysis and/or interpretation, manuscript creation and/or revision, approved final version for publication, accountable for all aspects of the work, general supervision, writing assistance and/or technical editing.

CORRESPONDENCE

David C. Winston MD PhD, 2825 E. District St, Tucson AZ 85714, dcwinston@gmail.com

ETHICAL APPROVAL

As per Journal Policies, ethical approval was not required for this manuscript

STATEMENT OF HUMAN AND ANIMAL RIGHTS

This article does not contain any studies conducted with animals or on living human subjects

STATEMENT OF INFORMED CONSENT

No identifiable personal data were presented in this manuscript

DISCLOSURES & DECLARATION OF CONFLICTS OF INTEREST

This work was presented at the 2017 NAME Annual Meeting. The authors, reviewers, editors, and publication staff do not report any relevant conflicts of interest

FINANCIAL DISCLOSURE

The authors have indicated that they do not have financial relationships to disclose that are relevant to this manuscript

KEYWORDS

Forensic pathology, Parachute deaths, Blunt force injuries

INFORMATION

ACADEMIC FORENSIC PATHOLOGY: THE OFFICIAL PUBLICATION OF THE NATIONAL ASSOCIATION OF MEDICAL EXAMINERS

©2017 Academic Forensic Pathology International • (ISSN: 1925-3621) • <https://doi.org/10.23907/2017.055>

Submitted for consideration on 19 Oct 2017. Accepted for publication on 7 Nov 2017

INTRODUCTION

Parachuting is an activity in which a participant jumps from a plane or from height and consists of a period of freefall followed by the deployment of a parachute (1). While it is often performed as a thrill sport for pleasure as a bucket list item, some individuals compete in regional, national, and international competitions. Parachuting is also utilized for military training and operations. Parachuting is considered to be relatively safe, with only 21 deaths reported out of 3.2 million jumps in 2016 in the United States (2). Southern Arizona is a popular location for parachuting due to the clear desert weather and is home to one of the largest facilities for skydiving in the world (3). The purpose of this study is to examine parachute deaths that occurred in Southern Arizona over a 16-year period to document injuries sustained and the circumstances that led to the death.

METHODS

The database of the Pima County Office of the Medical Examiner was searched for deaths that occurred while parachuting between January 1, 2001 and December 31, 2016. Of the 15 Arizona counties, this office serves as the medical examiner for three counties in southern Arizona and as a referral office for eight other Arizona counties. Investigative summaries, autopsy reports, and toxicology results were reviewed. Basic decedent demographics included age, race, sex, and home town. The injuries were divided by body section: head and neck, thorax and abdomen, and extremities. Injuries of the head and neck and thorax and abdomen were further classified into fractures, presence of blood in body cavities, and organ injuries. Collation of extremity injuries was limited to fractures. A spreadsheet was constructed utilizing a “1” for injury and “0” for no injury. An additional category for number of rib fractures was created to calculate the average number of rib fractures, when present.

RESULTS

This search produced 24 deaths that occurred while parachuting. Of these 24 deaths, 22 decedents were

male. Twenty-two decedents were Caucasian, one was Asian, and one race was not recorded. The decedents ranged in age from 19 to 61 years, with a median age of 36 years. The cause of death in all cases was due to multiple blunt force injuries, and all manners of death were certified as accident.

The breakdown of injuries by body section is summarized in **Table 1**. Rib fractures were documented in 19 decedents and were the most common skeletal injury; the average number of rib fractures per decedent was 19.1. Eighteen parachutists had fractures of the lower extremities and 13 had fractures of the upper extremities; only one parachutist had upper extremity fractures without lower extremity fractures. Palpable foot fractures were identified in only three deaths. Skull fractures were identified in 17 decedents, subarachnoid hemorrhages were described in 16 deaths, and seven had subdural hemorrhages. Hemothoraces were detected in 18 deaths, ten decedents had a hemopericardium, and 17 had a hemoperitoneum. The liver was the most commonly damaged organ, with trauma noted in 15 deaths. Brain injuries were described in ten deaths. The aorta was lacerated in 12 deaths, with the thoracic aorta involved in all cases and the abdominal aorta involved in two.

All of these incidents occurred at certified sky diving facilities. The top three circumstances of death included failure of chute deployment (seven), mid-air collisions (three), and becoming entangled with other parachutists (three). Six deaths occurred during military training. Due to the classified nature of the military training, very little information was released to our office regarding the circumstances of the incident. Therefore, the circumstances of these deaths were categorized as “military” in **Table 1**. Four of the non-military decedents were described as “experienced” parachutists. One case involved a tandem jump team with a survivor.

Natural disease identified included two decedents with coronary artery atherosclerosis, one with coronary artery atherosclerosis and a follicular carcinoma of the thyroid, and one with prostatic hyperplasia. Toxicology was performed in 21 of the deaths

with three positive for cannabinoids, one positive for 7-aminoclonazepam (7.6 ng/mL), and one positive for 3,4-methylenedioxymethamphetamine (MDMA) (0.38 mg/L). Two decedents were positive for ethanol (one blood and one bile) but both had a negative vitreous ethanol.

DISCUSSION

Whether one participates in parachuting for a thrill, competition, or military training, it is a relatively safe activity provided one utilizes a certified facility (2). Because these deaths are so rare, and few nonmilitary

offices have experienced parachutists on staff, it is important to have a comprehensive investigation utilizing the expertise of parachute experts (1, 4-6). All of the deaths in this study were investigated with the cooperation of experts from either the skydiving facility or the military.

A recent review article documented the physics, equipment, sequence, and malfunctions of skydiving and BASE (building, antenna, span, and Earth) jumping (1). After exiting the plane, the parachutist has to decide how long of a free fall he wants to experience. At around 12 seconds of freefall, the parachutist

Table 1: Body Compartment Fractures and Internal Injuries by Case

Case	Skull Fractures	Vertebral Fracture	Thorax Fractures	Abdominal Fractures	Extremity Fractures	Brain Injuries	Brain Hemorrhages	Thoracic Internal Injuries	Abdominal Internal Injuries	How Injury Occurred
A	1	0	1	0	1	1	1	1	0	Chute fail
B	1	0	1	0	0	0	0	1	1	Chute fail
C	1	0	1	1	1	1	1	1	1	Hard landing
D	1	0	1	1	1	1	1	1	1	Hard landing
E	0	0	1	1	1	0	0	1	1	No info
F	1	1	1	1	1	0	1	1	1	Collision
G	1	0	1	0	1	0	1	1	1	Collision
H	1	0	0	1	1	1	1	1	1	Military
I	1	0	1	1	1	1	1	1	1	Military
J	1	1	1	1	1	0	0	1	0	Entangled
K	0	0	1	1	1	0	0	1	0	Military
L	1	0	1	1	1	1	1	1	1	Military
M	0	0	1	0	0	0	0	0	1	Military
N	1	0	0	0	1	1	1	0	0	Wind gust
O	1	0	1	1	1	0	1	1	1	Entangled
P	1	0	1	1	1	0	1	1	1	Entangled
Q	1	0	1	0	0	1	1	0	0	Collision
R	0	1	0	0	0	0	1	0	0	Military
S	1	0	1	0	1	1	0	1	1	Chute fail
T	1	0	0	0	1	1	0	1	1	Chute fail
U	0	0	1	0	0	0	1	1	1	Chute fail
V	0	0	1	0	1	0	1	1	1	Chute fail
W	0	1	0	1	1	0	0	1	1	Chute fail
X	1	0	1	1	1	0	1	1	1	High speed landing fail

reaches terminal velocity (approximately 120 miles per hour or 54 m/s) (1). Most recreational parachutists will freefall for 45-60 seconds before deploying the parachute between 3000 and 5000 feet above the earth (7). Once the parachutist deploys the parachute, proper inflation of the parachute depends on catching the air stream. Advances in technology have led to many safety features (8). The current style of parachute used by most skydivers is the rectangular ram-air canopy as compared to the classic round parachute. Ram-air canopies are a series of inflatable tubes that are connected side-by-side along their length, as a result they have better directional control and provide softer landings. An automatic activation device (AAD) can deploy the main or reserve canopy at a preset altitude

and a reserve static line can activate the reserve chute if the main parachute has to be jettisoned. The specialized fabrics of the jumpsuit can be altered to control descent speed and tighter suits will allow for a faster fall rate. Helmets and goggles are required for all student jumpers and worn by most experienced jumpers. Griffith and Hart documented an increase in landing-related deaths due to the increased use of high performance parachutes by civilian jumpers (9). Only three deaths in this study were landing-related.

Because of massive trauma, the cause of death is usually relatively obvious when the body is viewed either at the scene (**Images 1 and 2**) or on the autopsy table. Regardless, a complete autopsy provides doc-

Image 1: Scene photo of parachutist at impact site.

umentation of the injuries, identifies significant natural disease, and provides specimens for toxicology. The injuries commonly found in other types of blunt force deaths such as motor vehicle collisions are commonplace in parachute deaths. Because of the similarities, these injuries are usually well documented by forensic pathologists. One limitation of this study is that extremity fractures were identified either by observation of compound fractures or palpation of the extremities and only rarely confirmed by postmortem radiography. Assessment of fractures of the extremities, especially the bones of the hands and feet, can be difficult to determine by palpation alone. As more offices, including this one, are adding whole body radiography and computed tomography scanners, future

studies of parachute-related deaths will give more details regarding skeletal injuries. Of note, one case in this series had a fractured humerus in which the distal portion was found embedded in the ground (**Image 3**) adjacent to the decedent while the proximal portion remained in the upper arm. A radiograph of the upper arm confirmed the absence of the distal humerus (**Image 4**).

It is possible that someone may experience a catastrophic natural event during the descent that may render the parachutist unable to continue a safe free fall and chute deployment. However, proving that an aortic or coronary artery dissection, ruptured berry aneurysm, or ruptured cardiac ventricle occurred prior

Image 2: Scene photo revealing significant cranial trauma.

to impact of the parachutist may be difficult, if not impossible, to determine in the presence of massive trauma. None of these immediately incapacitating natural events were documented in the deaths reviewed for this study. Three of the decedents did have moderate coronary artery disease but there was no gross evidence of an acute dissection or healed, subacute, or acute myocardial infarct. One case report identified an acute dissection of the left anterior descending coronary artery related to an unusually “hard opening” with strong compression of the chest that presented as intense retrosternal chest pain approximately one hour after a successful jump (10). Another case report described a professional parachutist who presented with chest pain not temporally related to a jump; a type A aortic dissection was diagnosed and surgically repaired and he was discharged with a reported complete recovery (11). In light of a negative medical

history, these authors proposed the etiology of this aneurysm was traumatic due to a large number of high velocity landings related to his career as a professional parachutist (11).

The manner of death for all cases in this report was classified as accident, which is not unexpected. An online search of the National Library of Medicine did not reveal any case reports or case series of suicide or homicide during parachuting activity. In July 2017, United Press International online documented a Florida man who texted his wife a message that he was not going to use his parachute before dying in a parachuting incident; his death was classified as a suicide (12).

The proliferation of small video cameras that are easily mounted on helmets or chest straps can assist investigators with what actually occurred. One parachutist in

Image 3: Scene photo of distal humerus embedded in ground.

Image 4: Radiograph of upper arm documenting the absence of distal humerus.

this current series had a helmet mounted camera. This high-definition camera recorded the descent and there was a moment in the sequence where some jostling of the camera was noted. Others parachuting at the time verified this occurred at the point of impact with another parachutist. Because the camera was mounted on the helmet, the actual contact was not recorded.

CONCLUSION

As long as parachuting remains relatively safe, this activity will remain popular. Even as technology evolves and additional safety features are instituted, human error will still lead to deaths while parachuting. Investigation of these deaths should include a complete autopsy with toxicology as well as a thorough scene investigation and evaluation of the jumper's equipment.

REFERENCES

- 1) Burke MP, Chitty J. Forensic analysis of parachute deaths. *Am J Forensic Med Pathol*. 2017 Mar; 38(1):83-9. PMID: 28045694. <https://doi.org/10.1097/PAF.0000000000000291>.
- 2) USPA [Internet]. Fredericksburg (VA): United States Parachute Association; c2017. Skydiving safety; [cited Sept 12, 2017]. Available from: <http://www.uspa.org/facts-faqs/safety>.
- 3) Skydive Arizona [Internet]. Eloy (AZ): Skydive Arizona; 2017 [cited 2017 Sep 12]. Available from: <https://www.skydiveaz.com/about>.
- 4) Hart CL, Griffith JD, Randell JA. An analysis of U.S. parachuting fatalities: 2000-2004. *Percept Mot Skills*. 2006 Dec; 103(3):896-900. PMID: 17326520. <https://doi.org/10.2466/pms.103.3.896-900>.
- 5) Griffith JD, Hart CL. A summary of U.S. skydiving fatalities: 1993-1999. *Percept Mot Skills*. 2002 Jun; 94:1089-90. PMID: 12186229. <https://doi.org/10.2466/pms.2002.94.3c.1089>.
- 6) Vidovic M, Rugai N. Are hook turns a major obstacle to safe skydiving? A study of skydiving fatalities in the United States from 1992-2005. *Percept Mot Skills*. 2007 Dec; 105:795-802. PMID: 18229535. <https://doi.org/10.2466/pms.105.3.795-802>.
- 7) USPA [Internet]. Fredericksburg (VA): United States Parachute Association; c2017. FAQs; [cited Sept 12, 2017]. Available from: <http://www.uspa.org/facts-faqs/faqs>.
- 8) USPA [Internet]. Fredericksburg (VA): United States Parachute Association; c2017. Equipment; [cited Sept 12, 2017]. Available from: <http://www.uspa.org/facts-faqs/equipment>.
- 9) Hart CL, Griffith JD. Rise in landing-related skydiving fatalities. *Percept Mot Skills*. 2003 Oct; 97:390-2. PMID: 14620223. <https://doi.org/10.2466/pms.2003.97.2.390>.
- 10) Brugger N, Saguner AM, Zbinden S, Khattab AA. LAD dissection following parachute belt trauma during BASE jumping. *Int J Cardiol*. 2012 Aug 23; 159(2):e25-6. PMID: 22204851. <https://doi.org/10.1016/j.ijcard.2011.11.060>.
- 11) Buchholz S, Quaden RB, Schmitz C, Überfuhr P. Professional parachuting: the risk of acute aortic dissection. *Interact Cardiovasc Thorac Surg*. 2011 Sep; 13(3):361-2. PMID: 21680552. <https://doi.org/10.1510/icvts.2011.274076>.
- 12) Downs R. Skydiver kills self by not opening parachute. United Press International [Internet]. 2017 Jul 16 [cited 2017 Sep 12]; U.S. News. Available from: <https://www.upi.com/Skydiver-kills-self-by-not-opening-parachute/4041500255183/>.