Pilot and Passenger Injuries Associated with Powered Parachutes

Nathan W. Skelley; Lauren M. Yarholar; Lars C. Richardson

BACKGROUND: Powered parachutes are becoming a popular form of sport flying. No previous study has reviewed injuries in this sport. The purpose of this study was to describe the injuries associated with powered parachute flying, the flight factors involved in an incident, and the impact an incident has on current sport involvement.

METHODS: National Transportation Safety Board incident reports involving powered parachutes between 2004 and 2015 were reviewed. Internet searches were performed to contact involved pilots to find further information.

RESULTS: There were 71 incidents reported involving 117 people. Of these, 10 incidents involved 14 fatalities (12.0%). Of the 14 fatalities, 11 (78.5%) occurred in midflight. Pilot error was the most common finding for an incident and accounted for 53/71 incidents (74.6%). The main error was misjudging the distance required for takeoff and landing. This accounted for 37/71 incidents (52.1%). Orthopedic extremity injuries were the most common severe injuries reported. Surgical intervention was needed in 43.8% of injuries and 48.0% of those involved fractures. The median return to work was 14 d (range 0–180 d). Only 4/53 (7.5%) of the pilots contacted continued to fly powered parachutes.

DISCUSSION: Powered parachute participants are at risk for unique injuries compared to other forms of flight. A powered parachute injury can have a significant impact on future pilot involvement in the sport. This study provides evidence for design changes in the aircraft and helps direct pilot training. This information can improve the safety and well-being of participants so they can continue to fly powered parachutes.

KEYWORDS: powered parachute, sport pilot, ultralight, injuries, orthopedic, parachutist, accident investigation, passenger health.

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In 1964, the “Irish Flyer” was the first motorized ram-air parachute to be used for recreational or sport powered parachute flight.[6] This sport has dramatically increased in popularity over the last several decades. Manufacturers and pilots estimate approximately 5000 to 10,000 people participate in powered parachute flight in the United States.[2,15] The low cost, independence from airports, and minimal training requirements have contributed to the sport’s popularity. A powered parachute can cost between $5000 for a single-seat and up to $30,000 for the latest two-seat model.[3,6] This price range has made the sport accessible to a large population that was not able to pilot fixed wing aircraft because of the associated costs and training. Additional people have participated in powered parachute flight as passengers and bystanders. As powered parachutes have grown in popularity, so have the number of injuries associated with the sport.[13]

Powered parachutes provide a unique flying experience compared to other aircraft.[6] The aircraft’s open design, constructed with a tube-based frame, exposes the pilot to the outside environment. The pilot has the ability to fly within reach of trees or to altitudes over 10,000 ft (3048 m).[6] The powered parachute aircraft is composed of a single-seat or two-seat cart with wheels, a motorized propeller on the back of the cart, and a ram-air parachute that is inflated over the aircraft to provide lift for flight. This design allows powered parachutes to be flown from any large area or open field—thus eliminating the need for an airport runway for takeoffs and landings. The aircraft have not only been used for personal flight, but are also utilized by

From the Department of Orthopaedic Surgery, Barnes-Jewish Hospital, Washington University in St. Louis School of Medicine, St. Louis, MO; the Division of Plastic and Reconstructive Surgery, Saint Louis University School of Medicine, St. Louis, MO; and the Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Cambridge, MA.

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Address correspondence to: Nathan Skelley, M.D., MGH Sports Medicine, 4th Floor, 175 Cambridge Street, Boston, MA 02114; nskelley@mgh.harvard.edu.

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the military, police departments, emergency medical services, farmers, archaeologists, and photographers.[6,9,11]

Powered parachutes are relatively easy aircraft to learn to fly (**Fig. 1**).[6] In a typical flight, the parachute is laid out behind the machine in preparation for flight. The motorized propeller is started and creates a forward thrust. The propeller inflates the parachute over the airframe or cart and the inflated parachute functions as a wing. Increasing the throttle accelerates the craft to approximately 30 mph when it becomes airborne. The aircraft cruises at a steady 30–40 mph while in flight depending on the wind direction. The pilot sits within the cart of a single-seat aircraft or in the front seat of a two-seat cart, which allows for a passenger in the back seat. This pilot position is necessary in order to control left and right steering rods at the nose of the aircraft with the pilot's feet. These rods pull on steering lines connected to the parachute to control turning and maneuvering the aircraft. A hand-controlled throttle is located by the pilot's side to regulate engine power for ascent and descent. The pilot also has a hand controlled steering post to control the aircraft's front wheel for maneuvering on the ground during takeoff and landing.

A powered parachute is classified by the Federal Aviation Administration (FAA) as an ultralight aircraft. The FAA Title 14 Code of Federal Regulations Part 103 specifies the rules for flying an ultralight aircraft.[5] If the pilot meets those requirements, no license is needed to fly. FAA requirements increase to fly a two-seat machine. The FAA regulates all flight operations in the United States; however, there is no independent governing organization for just the sport of powered parachute flying. Powered parachute pilots have been made accountable for assessing the risks involved and assuring their own personal safety.

Without a governing body or overseeing organization, the sport of powered parachutes remains largely unmonitored. This places a large population of people at potentially great risk for injury or death (**Fig. 2**). The National Transportation Safety Board (NTSB) is the U.S. federal agency that investigates civil aviation accidents and maintains a record of all flight-related incidents. The NTSB gains information from publically listed reports, government organizations, and self-reporting by pilots. NTSB investigators contact pilots or visit the crash site to perform investigations. Reports are usually compiled over several months to acquire all necessary safety information before being entered into the NTSB database. The NTSB flight database has the most comprehensive record of powered parachute incidents.

Therefore, the purpose of this study was to review NTSB incident reports for injuries associated with powered parachute flight to improve the understanding and safety of the sport for pilots, passengers, bystanders, and the physicians taking care of these individuals. The goals of this study were to:

1. Describe the injuries and fatalities associated with powered parachute flight;
2. Identify the flight factors related to reported incidents; and
3. Determine the impact an incident injury has on return-to-work and current flying status.

METHODS

This study was approved by our Institutional Review Board (IRB#: 201,507,033). Each subject provided informed consent before participating. We reviewed all National Transportation Safety Board incident reports between 2004 and 2015 which involved powered parachute aircraft. The reports were completed by NTSB investigators after self-reports by involved parties or NTSB discovery.

The narrative reports were reviewed and data was collected associated with general demographics, time of day of the incident, weather conditions, phase of flight, primary cause of the incident, type of incident, and pilot experience. The phase of flight for an incident was recorded as one of three periods in a typical planned flight: takeoff, midflight, and landing. Takeoff included the time points from starting the engine, inflating the parachute, taxiing, and reaching a cruising altitude. Landing included the final descent of a planned landing, touchdown until stop, and engine off. Midflight was the period between these two time points. The primary cause for an incident was categorized as either pilot error, aircraft malfunction, weather related, or unknown. The type of incident was categorized as impacting a ground structure, pilot loss of control resulting in impact, midair collision, aircraft roll-over, water immersion, or unknown. The type of injury, safety device usage, loss of work, and current flying status were obtained by contacting the pilots from information in the NTSB reports.

The NTSB reports did not include contact telephone numbers; therefore, the lead author

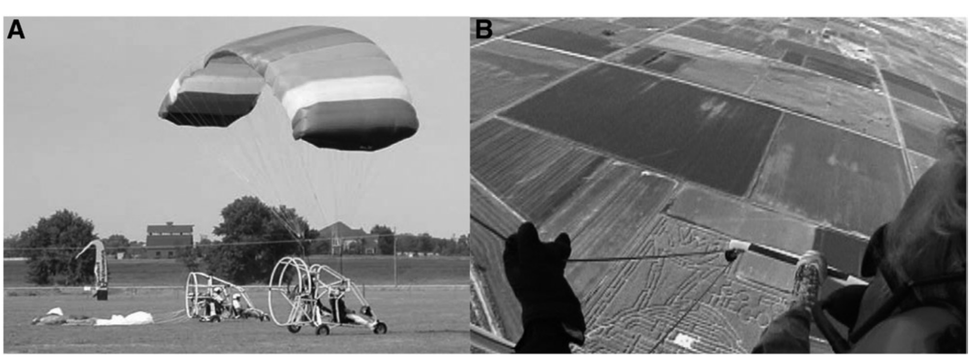

Fig. 1. A) Two powered parachutes preparing for takeoff. The aircraft on the left has the engine off and parachute laid out behind the aircraft. The aircraft on the right has started the propeller and inflated the parachute, preparing to increase engine throttle for takeoff. B) The pilot controls the powered parachute by using their feet to push on rods connected to steering lines attached to the corners of the parachute. For additional maneuverability, they can use their hands to provide additional pull or drag.

Fig. 2. Selected injuries associated with powered parachute incidents. A) LisFranc foot fracture-dislocation with metatarsal fractures 2-5 requiring operative fixation. B) Bimaleolar ankle fracture requiring operative fixation. C) Anterior cruciate ligament and posterior cruciate ligament tears requiring multiligament knee reconstruction. D) Right hip dislocation requiring open reduction and fixation of pelvis. (Images provided by pilots who wished to remain anonymous.)

used additional details contained within the reports to perform internet searches to find contact information for the pilots. Online, publicly listed telephone databases were searched to find the names and addresses that corresponded to aircraft registration addresses listed for the aircraft with the FAA. Mailings requesting telephone follow-up were also sent to the addresses associated with the aircraft registration. Some aircraft were not registered; therefore, local news media websites, based on information in the NTSB reports, were reviewed for similar information. Finally, social media websites were used to contact individuals listed in the reports that did not have telephone numbers or registration addresses listed.

Each incident report was given a National Advisory Committee of Aeronautics (NACA) Score.[7] The NACA score is a seven-category classification system used to assess the severity of injuries associated with aviation accidents. Minor injuries (NACA I, II) did not require emergency medical services, major injuries (NACA III, IV, V, and VI) commonly did require emergency medical services, and NACA VII died from associated injuries. The NACA classification was compared to the accident findings to determine if there was a correlation with injury severity and pilot experience, cause of incident, and type of incident. Pilot experience was classified as novice if less than 40 h were logged as pilot-in-command of the aircraft and classified as experienced if greater than 40 h were logged as pilot-in-command.

The data were analyzed using Chi-squared test, nonparametric, and descriptive statistics. Statistics were performed using IBM SPSS Statistics (IBM Corporation, Armonk, NY). Statistical significance was set at a $P < 0.05$.

RESULTS

During the 12-yr period from 2004 through 2015, there were 71 incident reports available for review. There were 25 incidents which involved single-pilot cases and 46 involved 2-person aircraft for a total of 117 people involved in incident reports. In the study group, 10 incidents involved fatalities with a total of 14 fatalities (12%). The pilots involved in powered parachute accidents were between the ages of 23–77 (median 52, avg. 52.4, SD 12.3). One pilot was female and the remaining 70 (98.6%) were male. There were 24 (33.8%) pilots who had a sport pilot license at the time of the incident. Of the study group, 51 (71.8%) pilots had pilot-in-command hours logged, with 30 (58.8%) pilots classified as novice and 21 (41.2%) classified as experienced.

All incidents occurred within the United States. Of the incidents, 53 (74.6%) occurred during evening and morning hours. There were 18 (25.4%) incidents which occurred between the hours of 10:00 and 16:00. The average wind speed at the time of an incident was 3 kn (range: 0–15 kn). Only one incident occurred at a wind speed greater than 10 kn. That report occurred at 15 kn and resulted in a pilot fatality. Visibility was not cited as a problem in any incident and ranged from 5–12 nautical miles based on the nearest weather recording locations at the time of the event. Temperatures at the time of incidents ranged from 0–36°C (mean 21.3°C) and were also not implicated in any reports as the cause of a crash.

The phase of flight when the incident occurred was categorized as takeoff, midflight, or landing. Takeoff and midflight accounted for the majority of incidents at 31 (43.7%) and 29 (40.8%), respectively. Landing was associated with only 11 incidents (15.5%) ($P = 0.002$).

The primary cause of the incident was described as either pilot error, aircraft malfunction, weather related, or unknown. Pilot error was the most common finding for an incident and accounted for 53/71 incidents (74.6%). The most common reason for pilot error was misjudging the necessary distance required for takeoff and landing. This accounted for 37 of the 71 incidents (52.1%).

There were 15 incidents (21.1%) related to aircraft malfunction. These malfunctions included five cases where the chute failed to successfully inflate or kite for takeoff, three blown-out chute cells, an engine that seized, an unresponsive throttle, broken landing gear, laxity in turning lines, spontaneous chute collapse (without note of wind as a factor), and two failures believed to be related to unknown engine failure.

Only two incidents (2.8%) were associated with weather conditions as the main cause of the incident. One report documented a witness who noted the chute collapsed while in level flight. This was thought to be related to changing wind direction, which resulted in the ram-air parachute collapse and crash. The other weather incident involved a cross wind at the time of takeoff that rolled the aircraft into a tree line.

The types of incidents were recorded as impacting a stationary ground structure, pilot loss of control resulting in a ground impact, midair collision, aircraft rollover, water immersion, and unknown. The majority of incident types involved impacting a stationary object [32 (45.1%)] and pilot loss of control resulting in an impact [27 (38%)] ($P < 0.001$). **Table I** provides a comparison of causes and types of incidents.

Of the 71 pilots, 9 sustained fatal injuries in the incident crash and 3 died in the follow-up period from unrelated conditions, leaving 59 pilots available for follow-up evaluation regarding the types of injuries sustained and treatment required. We were able to contact 53/59 (89.8%) pilots for follow-up information on their injuries as well as the injuries of their 33 (73.3%) passengers. The most common bodily injury associated with powered parachutes was lower extremity trauma (Fig. 2).

There were 261 injuries reported that required medical care. Of those, 191 (73.2%) were in the extremities and 70 (36.6%) involved fractures (**Fig. 3**). Surgical intervention was needed in 43.8% of injuries and 48.0% of those involved fractures. The most common reason for soft tissue injuries was tree limbs or other structures impaling the participants during the crash.

Sufficient data were present on 103 (88.0%) of the pilots and passengers to apply the NACA classification (**Table II**). All pilots and passengers were reported as using seatbelts or shoulder harness safety devices at the time of the incident. There was no correlation between NACA classification and pilot experience ($P = 0.80$). There was also no correlation between NACA classification and the cause ($P = 0.19$) or type of an incident ($P = 0.18$). However, passengers were significantly more likely to experience minor injuries (NACA 0–II) compared to pilots (NACA III–VII) ($P = 0.04$).

Blunt trauma was the most common cause of fatalities (92.8%). One passenger in the water landings asphyxiated, accounting for one of the fatalities. The other water landing required cardiopulmonary resuscitation by nearby boaters, but survived. Of the 14 fatalities, 11 (78.5%) occurred in midflight ($P < 0.001$).

Injuries associated with powered parachute incidents delayed the participants' return to work and impacted their current flying status. There were 41 pilots and passengers who were employed at the time of their incident and stated that they lost a median of 14 d of work (range 0–180, average 25 d, SD 36 d) due to injuries. Only 4/53 (7.5%) pilots noted that they continue to fly powered parachutes at the time of the follow-up interview. One other pilot continues to fly fixed wing aircraft, but does not fly powered parachutes after the incident. All other pilots stopped flying after the powered parachute incident.

DISCUSSION

To our knowledge, this is the first study to describe injuries associated with the sport of powered parachute flight. Our analysis found that musculoskeletal extremity injuries were the most common injuries in NTSB incident reports. The design and operation of powered parachutes places the pilot at unique risks for injury compared to powered parachute passengers and pilots in other forms of ultralight aircraft.[4,7,8] Davidson et al., reviewed other ultralight injuries and found lower extremity orthopedic injuries were the most common.[3] Lower extremity injuries were the most common in our patient population, but powered parachute pilots also had many upper extremity fractures and soft tissue injuries. The powered parachute pilot

Table I. Primary Cause of an Incident Associated with the Type of Incident.

PRIMARY CAUSE OF INCIDENT	TYPE OF INCIDENT: GROUND STRUCTURE IMPACT	PILOT LOSS OF CONTROL	MID-AIR COLLISION	AIRCRAFT ROLL-OVER	WATER IMMERSION	UNKNOWN	TOTAL (%)
Pilot Error	30	13	5	1	2	2	53 (74.6)
Aircraft Malfunction	2	13	0	0	0	0	15 (21.1)
Weather	0	1	0	1	0	0	2 (2.8)
Unknown	0	0	0	0	0	1	1 (1.4)
Total (%)	32 (45.1)	27(38.0)	5 (7.0)	2 (2.8)	2 (2.8)	3 (4.2)	71

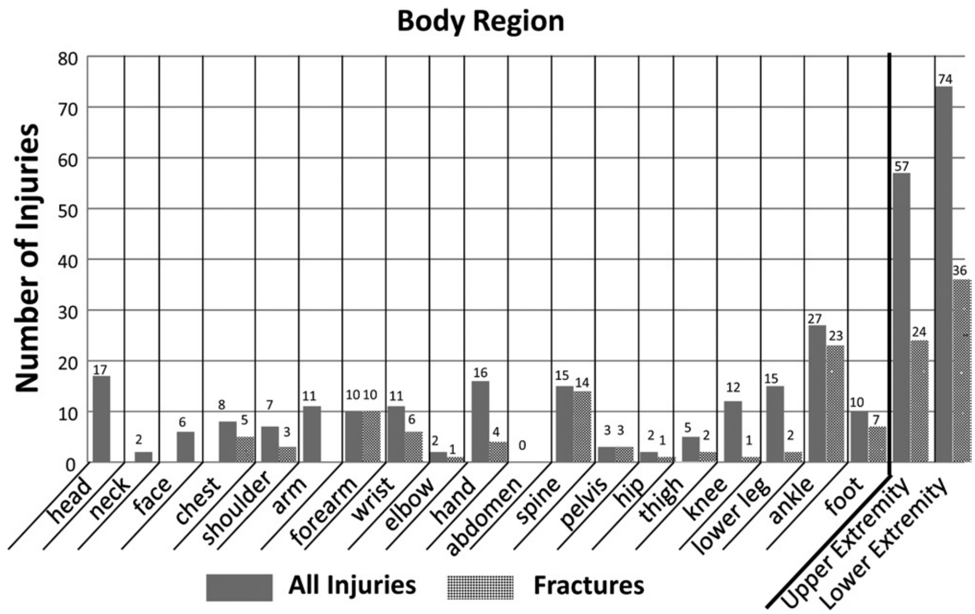

Fig. 3. Powered parachute pilot and passenger injuries associated with the sport. Upper extremity = shoulder to hand, lower extremity = hip to foot.

maneuvers the aircraft with their feet on steering rods and by pulling on the steering lines with their hands. In a crash scenario, this places the extremities in an exposed and vulnerable position for injury. Similarly, the airframe is exposed to the elements, which allows for blunt injury and soft tissue injuries associated with trees and structures contacting the participants. The airframe can also pose a danger to the participant's head as the use of a helmet is the greatest and sometimes only protection against head trauma. Finally, given the nature of motorized sports and the altitude associated with flying, participants are at a higher risk for high-energy trauma when incidents occur.[3]

Table II. NACA Injury Classifications.

CATEGORY	DESCRIPTION	PILOTS (%)	PASSENGERS (%)
NACA 0	No injury requiring medical attention.	4 (6.3)	11 (27.5)
NACA I	Slight injury. No acute medical intervention necessary.	10 (15.9)	10 (25.0)
NACA II	Slight to moderately severe injury. Further diagnostic examination needed or outpatient medical investigation, but usually no emergency medical measures necessary.	15 (23.8)	8 (20.0)
NACA III	Moderate to severe but not life-threatening disorder. Emergency medical measures usually on the site.	13 (20.6)	3 (7.5)
NACA IV	Severe injury where rapid development into a life-threatening condition cannot be excluded. Emergency medical care is required.	7 (11.1)	2 (5.0)
NACA V	Acute vital (life-threatening) danger.	3 (4.8)	1 (2.5)
NACA VI	Cardiopulmonary disruption and/or resuscitation required.	2 (3.2)	0 (0.0)
NACA VII	Death.	9 (14.3)	5 (12.5)
Total		63	40

NACA: National Advisory Committee of Aeronautics (Adapted from Feletti et al. 2014[7]).

The most common flight factor involved in an incident was pilot error. This was most commonly related to misjudging the distance needed for a safe takeoff and landing. Pilot error was also involved in many of the midflight structural impacts and midair collisions which accounted for the majority of fatalities in the sport. Blunt trauma was the main factor listed in fatalities and consistent with other aviation reports.[16,17]

Many pilots believe that the injuries associated with powered parachutes are less severe than other aircraft because the parachute must be inflated before takeoff and, if the engine fails, the pilot can use the inflated parachute from takeoff to easily land without engine power. These beliefs may hold true, but they are somewhat challenged by our data. Almost half of our incidents occurred during takeoff and five incidents were related to difficulty getting the parachute to inflate during the takeoff period. Similarly, the typical 3-to-1 glide ratio in powered parachutes limits the ability to maneuver in an engine-out scenario.[6] Several of the engine-out landings resulted in treetop landings or water landings, which resulted in severe injuries. It is difficult to stall a powered parachute compared to a fixed wing aircraft; however, our data demonstrates that it is still possible to stall a powered parachute. It is important to note that the pilots involved in these instances commonly expressed the idea that if they maintained a sufficient distance from surrounding structures, the ram-air chute design should have reinflated, preventing the structure impact.

A powered parachute crash can have a tremendous impact on a pilot's return to work and postincident flying status. Most of the orthopedic injuries requiring operative fixation were out of work for 2 or more weeks. Only 4/53 (7.5%) pilots contacted in our follow-up analysis reported that they continued to fly powered parachutes. This was related to multiple factors, but considering the main cause of incidents was related to pilot error, many of these injuries could have been possibly prevented. The return to sport percentage after the incident was much lower than other motorized sports.[7,10]

Our study provides valuable information for powered parachute training and aircraft design. Training should focus on the appropriate assessment of takeoff and landing distances. Similarly, pilots must take an active role in observing and maintaining a safe distance from structures and other aircraft in midflight. Aircraft designs that provide more protection for the arms and legs could prevent extremity fractures. A clear plastic-based shell could also provide cover from soft tissue injuries associated with impacting trees and other structures while preserving the unique freedom and views associated with this form of flight. Following extremity injuries, spine fractures were the next most common injury found in our analysis (Fig. 3). We were not able to assess signs of osteoporosis or bone mineral density in our study. The bone age of the participants could be a confounding variable related to spine fractures, but seat and suspension designs that dampen the axial impact could also help prevent spine injuries. These design modifications may have reduced the number of injuries found in our review and could be the focus for future research.

Although not a primary goal of this study, it is important to note that collateral damage was a factor in several powered parachute incidents. There were nine cases (12.7%) which involved damaging power or telephone lines. At least 12 bystanders were injured and 4 had serious injuries requiring hospital admission. The data were insufficient to classify the type or severity of injuries suffered by bystanders, but several media reports noted head injuries and extremity fractures that required surgery. This collateral damage is most likely related to the accessibility and low altitude of flight associated with this sport.

There are several important limitations to this retrospective study. The follow-up was complicated by fatalities and the inability to contact all participants given the lack of contact information in NTSB reports. There was also a reporting bias in that the low regulation associated with this sport means a pilot could have an injury, but if it is not reported or discovered, it would not create an incident report. Additionally, there could be a recall bias as the injuries and time away from work were reported by the pilots at a later date, sometimes several years after the injury.

Finally, it is important to note that this study focused on incidents associated with powered parachutes between 2004 and 2015. There are approximately 600,000 active certified pilots registered with the FAA and, during a similar time period as our study, there were over 15,000 airplane incident reports and 1800 helicopter reports.[13] The 71 incidents in our study are a relatively low number given the large number of estimated participants in the sport during that time period. The fatalities with powered parachutes were higher than hot-air balloon tours in a similar period.[1] However, the injuries associated with our analysis were comparable or lower than similarly reported injuries in other motorized sports such as all-terrain vehicles, motocross, and paragliding.[10,12,14] Therefore, with the proper conditions, training, and extremity protection, powered parachutes can continue to be a safe sport with certain inherent risks.

In conclusion, powered parachutes are becoming an increasingly popular form of sport flight. The freedom of flight, ability to take off and land without an airport, and the relatively low cost of purchasing aircraft have made this sport available to a large population. Similarly, minimal training requirements and self-monitoring places participants at risk for serious injury and even death. Orthopedic extremity injuries were the most common injuries associated with sport incidents. The design of the aircraft places the upper and lower extremities at risk for injury in a crash scenario. A powered parachute injury can have a significant impact on future pilot involvement in the sport. Training pilots to better predict takeoff and landing distances and being aware of structures during midflight could significantly decrease pilot error and the number of injuries and fatalities associated with the sport. Future research should focus on establishing standardized minimum takeoff and landing distances, appropriate cruising altitudes, and aircraft modifications to protect the extremities. With proper training and extremity protection, the sport can continue to be safely enjoyed with minimal inherent risks to participants.

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Authors and affiliations: Nathan W. Skelley, M.D., Department of Orthopaedic Surgery, Barnes-Jewish Hospital, Washington University in St. Louis School of Medicine, St. Louis, MO; Lauren M. Yarholar, M.D., Division of Plastic and Reconstructive Surgery, Saint Louis University School of Medicine, St. Louis, MO; and Nathan W. Skelley, M.D., and Lars C. Richardson, M.D., Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Cambridge, MA.

REFERENCES

1. Ballard S-B, Beaty LP, Baker SP. Hot-air balloon tours: crash epidemiology in the United States, 2000-2011. Aviat Space Environ Med. 2013; 84(11):1172–1177.
2. Cunningham G. Powered 'chutes to take flight. Amarillo Globe News. [Accessed February 24, 2016]. Available from http://amarillo.com/stories/2002/03/22/new_chutesto.shtml#.Vs3YmOYp0g8. Published March 22, 2002.
3. Davidson SB, Blostein PA, Maltz SB, England G, Schaller T. Injury patterns related to ultralight aircraft crashes. Am J Emerg Med. 2010; 28(3):334–337.
4. Exadaktylos AK, Sclabas G, Eggli S, Schönfeld H, Gygax E, Zimmermann H. Paragliding accidents–the spine is at risk. A study from a Swiss Trauma Centre. Eur J Emerg Med. 2003; 10(1):27–9.
5. Experimental Aircraft Association. Training guide for powered parachute ultralights. Version 1.2. October 2015. [Accessed April 2016]. Available from http://www.eaa.org/en/eaa/aviation-communities-and-interests/ultralights-and-ultralight-aircraft/getting-started-in-ultralight-flying/ultralight-training-resources/powered-parachute-ultralight-training.
6. Federal Aviation Administration. Powered parachute flying handbook. Oklahoma City, OK: U.S. Department of Transportation; 2007. [Accessed Jan. 2016]. Available at http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs600.
7. Feletti F, Goin J. Accidents and injuries related to powered paragliding: a cross-sectional study. BMJ Open. 2014; 4(8):e005508.
8. Gauler R, Moulin P, Koch HG, Wick L, Sauter B, et al. Paragliding accidents with spinal cord injury: 10 years' experience at a single institution. Spine. 2006; 31(10):1125–1130.
9. Jovicic S, Tirnanic S, Ilic Z, Berkljac N, Jankovic M. Applications of powered paragliders in military, police special forces, searching and rescue units. 6th International Scientific Conference on Defensive Technologies.

October 2014. Military Technical Courier. 2014; 63(2):91–95. Available at https://www.researchgate.net/publication/266737916_APPLICATIONS_OF_POWERED_PARAGLIDERS_IN_MILITARY_POLICE_SPECIAL_FORCES_SEARCHING_AND_RESCUE_UNITS.
10. Larson AN, McIntosh AL. The epidemiology of injury in ATV and motocross sports. Med Sport Sci. 2012; 58:158–172.
11. Ledbetter K. Farm work made easy: powered parachute helps cover fields aerially. [Accessed February 24, 2016]. Available from http://amarillo.com/stories/1998/12/03/fea_farm.shtml#.Vs26YeYp0g8. Published December 2, 1998.
12. Minoyama O, Tsuchida H. Injuries in professional motor car racing drivers at a racing circuit between 1996 and 2000. Br J Sports Med. 2004; 38(5):613–616.
13. NTSB Aviation Accident Database & Synopses. [Accessed February 24, 2016]. Available from http://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx.
14. Pomerantz WJ, Gittelman MA, Smith GA. No license required: severe pediatric motorbike-related injuries in Ohio. Pediatrics. 2005; 115(3):704–709.
15. Powrachute. Powrachute: About Us. Powrachute. July 2011. [Accessed February 24, 2016]. Available from http://powrachute.com/about/.
16. Wiegmann DA, Taneja N. Analysis of injuries among pilots involved in fatal general aviation airplane accidents. Accid Anal Prev. 2003; 35(4):571–577.
17. Wolf BC, Harding BE. Investigative and autopsy findings in sport aircraft-related deaths in southwest Florida. Am J Forensic Med Pathol. 2008; 29(3):214–218.