ORIGINAL RESEARCH

Injury Patterns and First Aid Training Among Canyoneers

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Objective.—To identify injury patterns in canyoneering and develop a sense of their frequency.

Methods.—A web-based survey of canyoneers was developed. Questions regarding injuries experienced or treated, first aid training, and first aid supplies carried were included.

Results.—A total of 38 responses were received. Cutaneous injuries were very common (average 2 per person per year), but of apparently low morbidity (no evacuations required). Orthopedic injuries were also common (1 sprain/strain per person every 3 years on average, and major injuries happening to 1 in 2 canyoneers during their career), as were environmental injuries. First aid preparedness, in terms of training and kits, varied quite widely, but there was significant interest in further training.

Conclusions.—Minor cutaneous and orthopedic injuries are common, but fortunately do not often require outside assistance. More significant injuries are less common and usually involve orthopedic trauma or environmental exposure. A first aid curriculum for canyoneering should cover stabilization of fractures, analgesia and evacuation techniques as well as minor wound care.

Key words: canyoneering, first aid, training, injury

Introduction

Over the past 2 decades, outdoor and adventure sports have greatly risen in popularity. In the Southwest United States, the sport of canyoneering has particularly flourished. This sport, in which narrow canyons are descended along the watercourse, involves a combination of various outdoor skills including rappelling and anchor building, hiking, swiftwater swimming, and rock climbing. Furthermore, as there is often no alternative exit to a canyon short of continuing to the end, the traditional evacuation problems of wilderness first aid are compounded. Seeking help is also problematic with the canyon walls impeding most electronic requests for assistance and minimal exit points to send a party member in search of help. Thus, from the perspective of first aid and rescue, canyoneers are required to be highly self-sufficient.

In Zion National Park, one of the most popular canyoneering areas in the United States, backcountry permit

requests have increased markedly over the past 10 years, requiring the park service to develop a new usage plan. Some of the more popular canyons have seen 5-year increases of 500% to 1200% in usage.¹ Between 1999 and 2002, the Zion technical rescue team saw an almost 300% increase in their volume from 8 to 23 rescues.² A rise was also seen in traumatic injuries requiring assistance by Zion rangers, which more than doubled from 8 to 18.

These trends have led to an increasing interest in canyoneering specific first aid training. In order to properly target such training, it was felt that the injury patterns commonly seen must be identified. Furthermore, the target population and baseline training must be adequately defined. To this end, a web-based survey of the canyoneering community was developed, the results of which are reported here.

Methods

STUDY DESIGN

We conducted a web-based survey to determine the injury patterns, first aid training, and first aid equipment of canyoneers. A copy of the survey is available online at www.wemjournal.org.

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Table 1. Respondent demographics

Age (Years)	35 ± 12
Gender:	
Male	34 (89.5%)
Female	4 (10.5%)
Canyoneering Experience (Years)	6.5 ± 6.4
Days Per Year Canyoneering	24.6 ± 26.2
Nationality:	
American	29 (76%)
Australian	8 (21%)
Unspecified	1 (3%)

In order to ensure coverage of the full spectrum of canyoneering injuries, published case reports and trip reports involving canyoneering injuries and rescues were consulted during development of the injury component of the survey. As with many outdoor activities, canyoneering injuries can be divided into 2 main groups: those which are relatively minor, but frequent; and those which are rarer but significantly more severe. As is generally the case with wilderness activities, true frequencies cannot be obtained as the total number of participants cannot be measured. As a proxy, we attempted to calculate the frequency with which respondents encountered various injuries. As minor injuries are more common, we asked how often they had been experienced in the past year. More significant injuries were unlikely to be seen on an annual basis. In order to get some indication of the rates for rare but particularly severe injuries without requiring a prohibitively large sample size, lifetime incidence of significant injuries was also solicited. An attempt was also made to distinguish between injuries sustained by the respondent and injuries that they witnessed but did not personally sustain. Due to the small sample size, injuries sustained and injuries treated were grouped together during data analysis in order to obtain nonzero injury rates.

STUDY POPULATION

Survey respondents were primarily members of 2 American and 1 Australian canyoneering interest e-groups (Yahoo: “canyons,” “canyoneering” and “Oz-Canyons,” E-group bulletin boards). In addition to general announcements and requests for survey response on these groups, individual requests to complete the survey were made to leaders in the United States canyoneering community. European canyoneers were intentionally excluded because the majority of European canyoneering newsgroup correspondence is done in French.

Table 2. Minor injury frequencies: Events seen on average in 12 months

Cuts and Scrapes	2.06
Minor Orthopedic (Sprain/Strain)	0.32
Cactus/Flora	0.32
Heat Injury	0.22
Hypothermia	0.16
Major Orthopedic (Fracture)	0.14
Falls	0.14

STUDY PROTOCOL

A web-based survey instrument was prepared and posted as a page on the World Wide Web linked to a popular canyoneering website. The survey contained questions on demographic data, level of first aid training, first aid preparedness, and injury patterns (see Appendix). Survey responses were automatically sent to an email account created for the purpose of data collection. Data were then entered into a Microsoft Excel[®] spreadsheet and analysis was performed using standard descriptive statistics. As the web-based survey instrument allowed text answers, when a text descriptor such as “many” was entered for a numeric survey value, that subject was not included in data analysis for that question. However, there were no questions for which this led to the exclusion of more than 2 subjects. Responses were collected between February and September 2002.

Results

A total of 38 surveys were completed, representing approximately 250 person years of canyoneering experience. Respondent demographics are shown in Table 1. The average age of respondents was 35 years, and 89.5% of respondents were male. The number of days spent canyoneering in the past year averaged 24.6 (range, 1–91 days), with a strong positive correlation between years of experience and days spent canyoneering each year ($R = 0.70$).

Annual incidences of minor injuries are depicted in Table 2. These are average numbers of injuries treated or received by the respondent in the 12 months prior to survey completion. As might be expected from the canyon environment, which is frequently made of abrasive sandstone, minor cutaneous injuries are most common in general, with the special case of cactus spines being of concern in the deserts of the Southwestern US. Minor orthopedic problems such as sprains, strains, and finger injuries are also very frequent. Environmental exposure was also rather frequent, being experienced by approximately 1 in 5 canyoneers each year.

Table 3. Major injury frequencies: Average career incidence

Heat/Dehydration	2.36
Hypothermia	1.58
Major Orthopedic (Fracture)	0.57
Falls	0.3
Drowning	0.14
Animal Bite	0.03
Snakebite	0.03

In general, respondents did not need outside assistance very frequently. Only 2 of those surveyed reported having required outside assistance during their canyoneering career, both after sustaining a lower extremity fracture. Respondents were more likely to have provided assistance to other parties, with 13 of the 38 respondents reporting having done so at some point, 9 of them more than once. Of the 18 episodes for which details were provided, there were 2 major falls requiring litter evacuation of the patient out of the canyon; 13 isolated orthopedic injuries, primarily to the ankle; a concussion; a patient thought to be hypothermic; and a large laceration. Two respondents also reported having helped other parties on “several” occasions for technical reasons such as trapped ropes, improper rope technique and person stuck on rappel. Also noteworthy, rib fractures were named as secondary injuries in 2 of the lower extremity orthopedic cases.

The less frequent injuries are reported in Table 3 as average career incidence (eg, how many times in a career a canyoneer might be expected to see or suffer from the injury described). As noted in Table 1, the average career length in our survey was 6.5 years, with 25 days per year of canyoneering. Environmental exposures are the most common, on average affecting each canyoneer at least once in their career. Unlike rock climbing where falls are an anticipated risk, canyoneering falls are often representative of a problem with a rappel, such as rappelling off the end of a rope or anchor failure. Unfortunately, they are still encountered by about one in three canyoneers in their career, undoubtedly contributing to the large number of enthusiasts who have treated or suffered a broken bone. Finally, although drowning events, such as the well-publicized incident at Interlaken, Switzerland in 1999, are reasonably common in European canyoneering, they are fortunately rather infrequent in the US and Australia.

A number of questions were asked regarding first aid preparedness and training. Thirteen percent of the respondents carried no designated first aid kit. When kits were carried, they were most likely to contain wound care supplies (carried by 86%) or analgesics (79%). The

complexity of the kit carried varied widely, from “duct tape and Demerol” to extensive prepackaged first aid kits.

In terms of training, the formal first aid training level of respondents was highly varied, with the majority having at least cardiopulmonary resuscitation (CPR) or basic life support training (BLS) and over half having at least advanced first aid. On the other hand, 13% of the respondents had no formal training whatsoever. Many respondents were interested in additional training. Specific topics requested included splinting large fractures, hypothermia care, wilderness survival and vertical rope rescue techniques.

Discussion

This survey has helped to identify the common injury patterns in the US and Australian canyoneering. As might be expected from the uneven terrain and the abrasive sandstone environment, cutaneous injuries are somewhat common. Fortunately, these are of relatively low morbidity, and most canyoneers seem to be adequately prepared with bandaging supplies and analgesics. No effort was made to investigate the incidence of infection of these wounds. However, this might prove interesting with respect to wound care, as canyoneers often find themselves wading through standing water and in other relatively “dirty” environments.

The more serious common injuries tend to be orthopedic. It is difficult to assess preparedness for these injuries as splinting materials are usually improvised from other equipment and the environment and are not necessarily a first aid kit component. Clearly, the availability of good analgesia would help in the treatment of these injuries and evacuation of the victim. Fortunately, the responses regarding first aid kits indicate that canyoneers seem well prepared in this sense. One surrogate measure for the severity of orthopedic injuries is the need for assistance with evacuation. By this measure, it would appear that the orthopedic injuries seen by respondents were somewhat minor, as they generally did not require outside assistance for their injuries. It is unclear how this relates to the large increase in technical rescues seen by the Zion National Park search and rescue team. The possibility that there is a subset of less experienced canyoneers who are prone to injury and rescue by the Zion rangers and who were not adequately represented in survey respondents must be considered.

The final common injury pattern was environmental injury, largely from temperature (both heat and cold). While it is true that hypothermia does not come quickly to mind as an injury to expect in the desert Southwest of the United States, cold exposure is often an issue in

canyoneering due to the shaded nature of slot canyons (which often receive a minimal amount of direct sunlight daily) and the large amount of time spent wading or swimming in the canyon's watercourse. Even when minor, both heat and cold injury can lead to significant morbidity by affecting the judgment and coordination required to proceed through the wilderness environment. It would be worthwhile to mention this potential risk of canyoneering on information for novices and to include a significant component on environmental exposure in a canyoneering first aid course.

Having identified the injury patterns, the question of preparedness must be considered. Fewer than 1 in 5 canyoneers has any wilderness specific first aid training. One in 8 has no first aid training whatsoever, and 1 in 8 carries no first aid kit.

With the results of this survey, a canyoneering first aid curriculum can be envisioned. Such a course would concentrate on extremity injuries, splinting and evacuation; wound care; analgesia; and heat/cold exposure. This might be supplemented with a review of basic rope skills and trip planning in an effort to help avoid injuries in the first place. Web-based training materials were frequently requested.

Limitations

As with most survey data, this study suffers from several limitations. Although the canyoneering community is rather small, the sample size likely represents only a small percentage of US canyoneers. The data on injury patterns are vulnerable to recall bias and could not be validated for medical accuracy. Furthermore, it is possible that some events were separately reported by more than 1 witness. Although the free-text explanations provided by respondents gave no indication of this, the possibility remains. However, the intent was not to develop a rigorous epidemiology of canyoneering injuries, but rather a sense of the most common injury patterns as an aid to the development of a first aid curriculum. To this

extent, the relative frequency can be considered valid, as there is no particular reason that a certain type of injury would be more frequently over-reported than another. The information on first aid kit contents is similarly limited, as subject responses were freeform and subject to a great deal of variability in level of detail. Nonetheless, while not easily amenable to formal technical analysis, a sense of the range of kits carried can be readily obtained. Finally, the issue of bias among respondents cannot be neglected, as canyoneers who have suffered a significant injury while canyoneering or who are most interested in further first aid training might be more likely to respond to a first aid survey. Although this might diminish the epidemiological strength of this study, it is not necessarily a limitation in developing a first aid course for these individuals.

Conclusions

As canyoneering continues to grow in popularity in the US and abroad, the canyoneering community will be well served by improved canyoneering specific first aid training. In part due to the remote location of many canyoneering activities, self-rescue is often the primary option available to canyoneers, as evidenced by the relatively low incidence of reported rescues. As such, canyoneers must be self-sufficient in their first aid needs. Canyoneers are frequently subject to minor skin wounds and minor orthopedic injuries. More severe injuries are fortunately significantly less common and generally involve fractures and environmental injuries. This knowledge can be used to refine the curricula of first aid coursework targeted towards canyoneering enthusiasts.

References

1. Zion National Park. General management plan. Available at: <http://www.nps.gov/zion/pr/zion.pdf>. Accessed April 20, 2006.
2. Zion National Park. SAR annual report 2003; Springdale, UT.