

Tree stand falls: A persistent cause of neurological injury in hunting

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Abstract

AIM: To characterize and compare our current series of patients to prior reports in order to identify any changes in the incidence of neurological injury related to hunting accidents in Rochester, New York.

METHODS: All tree stand-related injuries referred to our regional trauma center from September 2003 through November 2011 were reviewed. Information was obtained from the hospital's trauma registry and medical records were retrospectively reviewed for data pertaining to the injuries.

RESULTS: Fifty-four patients were identified. Ninety-six percent of patients were male with a mean age of

47.9 years (range 15-69). The mean Injury Severity Score was 12.53 ± 1.17 (range 2-34). The average height of fall was 18.2 feet (range 4-40 feet). All patients fell to the ground with the exception of one who landed on rocks, and many hit the tree or branches on the way down. A reason for the fall was documented in only 13 patients, and included tree stand construction (3), loss of balance (3), falling asleep (3), structural failure (2), safety harness breakage (3) or light-headedness (1). The most common injuries were spinal fractures (54%), most commonly in the cervical spine (69%), followed by the thoracic (38%) and lumbar (21%) spine. Eight patients required operative repair. Head injuries occurred in 22%. Other systemic injuries include rib/clavicular fractures (47%), pelvic fractures (11%), solid organ injury (23%), and pneumothorax or hemothorax (19%). No patient deaths were reported. The average hospital length of stay was 6.56 ± 1.07 d. Most patients were discharged home without (72%) or with (11%) services and 17% required rehabilitation.

CONCLUSION: Falls from hunting tree stands are still common, with a high rate of neurological injury. Compared to a decade ago we have made no progress in preventing these neurological injuries, despite an increase in safety advances. Neurosurgeons must continue to advocate for increased safety awareness and participate in leadership roles to improve outcomes for hunters.

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Key words: Neurological sports medicine; Hunting; Tree stand falls; Spine injury; Traumatic brain injury

Core tip: Hunting is a popular sport and hunters have devised numerous ways to increase their advantage against their quarry. Tree stands have been developed to allow hunters better sight and increased protection. However, improper use, faulty construction, and other factors can increase the risk of injury, specifically to the

central nervous system. We present the data obtained at our institution over an eight-year period cataloging the injuries obtained while using tree stands. We have begun outreach to the community with our findings, with the goal of increasing awareness and education to reduce risks and increase hunter safety.

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INTRODUCTION

Hunting is a popular sport and recreational activity nationwide, with nearly 15 million licensed hunters in the United States and approximately 680000 in New York State according to the Fish and Wildlife Service^[1]. Hunting is a favorite pastime for those in the Rochester, NY area that spans all age ranges. Hunters age 12 and above may obtain a hunting license in New York and most use bows or firearms to hunt a variety of wildlife animals. Over time, hunters have developed various methods to improve the leisure of the sport. One such method is the elevated tree stand.

Tree stands, also referred to as deer stands, are elevated platforms or seats that can be built in, nailed, locked, or rested up against a tree. Stands give hunters an advantage of wider visibility, while decreasing the chances of being detected by sight or scent^[2-4]. Hunting tree stands can be commercial or homemade, and are usually installed 15 to 30 feet above ground. Commercial tree stands typically have a two-by-two feet platform seat, and may or may not be attached to the tree by safety belts, a harness, or straps. These safety straps are designed to help prevent the hunter from falling from the tree or stand.

Hunting related accidents and injuries have been largely attributed to falls from tree stands^[2]. This is the most common way hunters are injured, debunking the popular misconception of intoxicated hunters sustaining self-inflicted ballistic injuries^[5]. Estimates reveal that nearly 10% of hunters who use tree stands are injured annually, and more than 75% of tree stand injuries occur while using fixed position or climbing stands^[6]. As much as 75% of the time spent during a hunt is spent on tree stands, and tree stands are considered an essential component of large game hunting^[6]. In North America, nearly 85% of hunters pursue large game (*e.g.*, deer, elk, bear, turkey, *etc.*), suggesting that the overwhelming majority of hunters have or will at some point use a tree stand^[6]. When hunters fall from tree stands, they can reach a velocity of up to 30 mph. Yet these common hunting-related accidents often go unreported as victims only present to hospitals with serious injuries^[3,4,7].

Falls from tree stands can lead to high impact injuries. One study demonstrated that 80% of fall victims required operative interventions, and nearly 10% of falls resulted in permanent neurological deficits or death^[5]. The series of common injuries were fractures to the spinal cord, lower extremities, and traumatic brain injuries. The high morbidity of falls from tree stands have led to a small series of interventions to prevent devastating spinal cord injury through promoting the use of safety harnesses publicly^[8]. It appears these interventions were successful as the incidence of tree-stand associated accidents was significantly reduced.

A previous study conducted nearly a decade ago at a Level I trauma center and Medical Examiner's offices in Western New York and central Maryland previously identified 51 cases of tree-stand associated injuries over a 5-year period^[2]. The majority of injuries were spinal and extremity fractures. The most frequent reported reasons for falls were related to errors in placement of the stand with subsequent structural failure, and errors climbing in or out of the tree stand^[2]. The need for hunter education was emphasized and the implementation of trauma prevention programs was suggested.

Our objective was to compile the current series of patients and the frequency and types of injuries they sustained. Additionally we wanted to compare our results to prior reports to identify any changes in the incidence of neurological injury related to tree stand hunting accidents.

MATERIALS AND METHODS

All tree stand-related injuries evaluated at the University of Rochester Medical Center's Emergency Department between September 2003 and November 2011 were reviewed. Information was obtained from hospital's trauma registry, and medical records were retrospectively reviewed for data pertaining to the injuries, with particular emphasis on neurological injuries and any associated details. The patients were identified based ICD-9 codes (*e.g.*, E884.9: fall from one level to another) and further review of the charts allowed us to select only falls that were sustained while hunting from a tree stand. Further data collected from the trauma registry included age, gender, Injury Severity Score (ISS), Glasgow Coma Score at the time of patient arrival, vital signs, intensive care unit (ICU) and hospital lengths of stay (LOS), procedures, and discharge disposition. The study was approved by the University of Rochester Medical Center institutional review board, and all investigators completed training in protection of human subjects.

RESULTS

A total of 54 patients were identified with tree stand related injuries during the study period. Ninety-six percent of tree-stand associated falls occurred in men. The mean age was 47.9 years (range, 15-69). The mean Injury Severity Score was 12.53 ± 1.17 (range, 2-34). The aver-

Table 1 Demographics and categorization of injuries

Metric	If not specified (n = 54)
Age (years with range)	47.9 (15–69)
Male gender	(96)
Average fall (ft with range)	18.2 (4–40)
Average length of stay	6.56 ± 1.07
Disposition	
Home	(72)
Home with services	(11)
Rehabilitation	(17)

Table 2 Reasons reported cause of falls n (%)

Reported reason	Falls (n = 13)
Tree stand construction	3 (23)
Loss of balance	3 (23)
Falling asleep	3 (23)
Structural failure	2 (15)
Lightheadedness	1 (8)
Other	1 (8)

age height of fall was 18.2 feet (range, 4-40 feet) (Table 1). No correlation could be drawn from records between height of the fall and the severity of the injuries. All patients fell to the ground with exception of one patient falling onto rocks, and many hit the tree or branches on the way down. There were no patient deaths related to tree stand falls. The direct mechanism contributing to the fall were documented in only 13 patients, and included tree stand construction (3 patients), loss of balance (3 patients), falling asleep (3 patients), structural failure (2 patients), safety harness breaking (3 patients) or “light-headedness” (1 patient) (Table 2).

The most common injuries sustained were spinal fractures (54%). In these patients, fractures to the cervical spine were the most common (69%), followed by the thoracic (38%) and lumbar (21%) spine. These injuries included burst fractures, compression fractures, dislocations, and spinal cord transections. One patient sustained injuries resulting in immediate C5 quadriplegia, while another was paraplegic. Eight patients went to the operating room for fusion (Table 3). The remaining patients were treated nonoperatively with bracing and pain control.

The tree stand falls resulted in head injuries in 22% of patients (Table 3). Five patients suffered from facial lacerations. In addition, seven patients experienced loss of consciousness throughout the course of injury.

Thoracic injury was a common injury in many of the patients in this group. Pulmonary contusion was noted in four patients (7%). In 10 cases, patients developed a pneumothorax or hemothorax (19%), and eight of these patients were treated with a chest tube (Table 4). The other associated non-neurological injuries include injuries to the thorax such as rib/clavicle fractures (47%), pelvic fractures (11%), and abdominal solid organ injury involving lacerations to the liver, spleen, or kidney (23%) (Table 4).

Table 3 Neurological injuries resulting from tree stand falls

Injury	Patients (n = 54)
Spinal column	(54)
Cervical spine	(69)
Thoracic spine	(38)
Lumbar spine	(21)
Requiring surgery	(15)
Cranial vault/brain	(22)

Table 4 Non-neurological injuries resulting from tree stand falls n (%)

Injury	Patients (n = 54)
Orthopedic	
Upper extremity	10 (19)
Lower extremity	13 (24)
Hip/pelvis	6 (11)
Abdominal	
Liver	2 (4)
Kidney	3 (6)
Spleen	5 (9)
Other	2 (4)
Thoracic	
Pulmonary contusion	4 (7)
Pneumo-/hemothorax	10 (19)
Rib fractures	22 (41)
Clavicle fracture	3 (6)
Scapula fracture	1 (2)
Sternal fracture	3 (6)

Patients endured extremity fractures in 54% of the cases. The common injuries included fractures of the lower extremity affecting the tibia, fibula, foot, and ankle (24%), upper extremity affecting the humerus, radius, and ulna (19%), and hip and pelvis (11%) (Table 4). Fourteen patients went to the operating room for repair of extremity fractures.

The average hospital LOS was 6.56 ± 1.07. One patient required ICU care for 3 d. The discharge plans were home (72%), home with services (11%), and rehabilitation placement (17%) (Table 1).

DISCUSSION

Hunting in the American outdoors remains a unique and popular recreational activity for all ages during various times of the year. A myriad of game animals (*e.g.*, rabbit, pheasants, deer, *etc.*) are hunted with a variety of weapons from bows to shotguns or rifles^[9]. Hunters have become increasingly savvy in their techniques to evade detection from their prey; one tool has been the use of tree stands or elevated platforms. Tree stands have given hunters an advantage of wider visibility without revealing their position by sight or scent^[2,3]. However, with this advantage comes the increased risk of injury associated with falls during the use of these stands. The tree stands may be difficult to carry, offer minimal room for movement, and do not protect against poor weather^[10]. Tree stands are typically located 15 to 30 feet above ground and can be

attached to the tree by nails, locks, or straps. The patients in our study fell from a similar height (mean fall height of 18.2 feet). As these individuals fall, the impact surface of their landing can be on hard surfaces, logs, and parts of hunting equipment adding another factor to the injury^[5].

One particular study outlines that the duration of the impact force from the nature of the surface is the most important predictor of injury severity^[3]. Several other studies in the literature report serious injuries related to tree stand fall^[2,8]. By and large, the incidence of tree stand falls and related injuries has become one of the leading causes of hunting-related incidents. This information debunks the popular misconception that intoxicated hunters sustain self-inflicted ballistic injuries as a leading cause of hunting-related incidents. In 2010, Crockett *et al*^[5] discovered that 50% of the patients in their series sustained falls from tree stands compared to 29% that endured gunshot wounds in central Ohio. In our study we sought to characterize a current series of patients and compare them to prior reports in order to identify any changes in the incidence of neurological injury related to such hunting accidents. These efforts would help highlight areas to prevent the dangerous injuries from tree stand falls and improve patient safety measures through education.

There are several types of tree stands available. Some are made by commercial manufacturers using metal materials and others are homemade by hunters using wood. Only stands approved by the Tree Stand Manufacturers Association should be used, as many of the homemade types are discouraged due to deterioration of wood over time^[11]. The Tree Stand Manufacturers Association (TMA), a group of corporations organized for the promotion of safe hunting practices, estimates millions of tree stand units are sold each year in the United States. One limitation of our study is that the type of tree stand used by our patients was not information available to us.

We identified 54 cases of tree stand related injuries over an 8-year period at the University of Rochester Medical Center. Our result remains consistent with the previous study done at this trauma center that detected 27 cases over a 5-year period^[2]. Our current study observed that tree stand falls continues to make up a significant portion of hunting related accidents. Consequently, prior efforts to reduce the morbidity and mortality associated with tree stand falls have not been successful. This evidence suggests that tree stand safety must remain a priority for hunters and health care providers. The most common mechanisms of the injury pattern noted in our study were due to tree stand construction, structural failure, loss of balance, falling asleep, structural failure, and the safety harness breaking. In some cases patients were unsure of how they had fallen as some were amnesic to the incident. All of these contributing factors of injury indicated that further instruction is required in New York State to ensure the safety of licensed hunters. New York requires a mandatory hunter education course for a minimum 10 h in length^[12]. While hunters are mandated to take a course, we recommend stronger measures to

ensure hunters acquire the information needed to safely operate tree stands (*e.g.*, periodic testing of proper use by Safety Course instructors).

Due to the large number of patients injured as a result of preventable causes, an educational safety course is warranted and further instruction to hunters is necessary to ensure more compliance with these guidelines. During these Hunter's Safety Courses offered by the state or county governments the quantity and severity of these neurological injury patterns, extended hospitalizations, and permanent disability needs to be addressed in more length to provide greater awareness. Additional instruction on adherence to the regulations while hunting should be emphasized; for example, the need to exercise extreme precaution when entering or exiting the tree stand, and the need to wear a safety harness at all times. Emphasis on proper techniques need to be made to ensure hunters pay more attention when they hoist or lower items from the tree stand in a safe manner. Hunters should avoid hunting when fatigued, use communication devices, restrict alcohol or drug while hunting, hunt in groups, and only hunt during times specified by local or state regulations.

Active awareness to hunters has been proven to reduce the incidence of tree stand related trauma. In Louisiana, letters were sent to licensed hunters, hunting clubs, sporting goods stores, and hunting supply retailers across the state that detailed the risks associated with tree stand use without a safety device^[3,8,13]. In the 3 years following this active awareness campaign, there were no spinal cord injuries from tree stand related incidents. Rochester, NY and other areas with active tree stand hunters will greatly benefit from similar campaign efforts.

Tree stand manufacturers add specific guidelines to the products they produce and encourage the strict use of wearing a full body safety harnesses^[14]. Review of the medical records at Strong Memorial Hospital did not include information regarding safety harnesses. This may be due to recall bias from post-concussive amnesia, or insufficient information surrounding the circumstances of the injury. However prior studies have specifically documented the lack of a safety harness as a contributing mechanism^[2,3], and we speculate that the absence of this information may suggest these safety devices were not used.

Injuries sustained from tree stand falls often require operative or other interventions that can increase the total cost to the healthcare system^[7]. In an era where healthcare costs are carefully monitored, any preventive efforts that can reduce the overall cost of care and diminish the long-term costs for permanently disabled patients should be investigated and pursued. Additionally early identification of injured patients and a thorough assessment of their injuries are critical to improving outcomes^[5]. Though it is tempting to focus on the intracranial and spinal pathologies, non-neurological injuries must not be minimized in the evaluation of these types of patients as tree stand falls do result in significant thoracic, abdomi-

nal, and pelvic trauma. A complete trauma assessment must be performed for each patient and all injuries thoroughly documented and treated in a timely fashion.

While we attempted to catalogue and describe the incidence of all tree-stand related injuries, our work is not without limitations. First, while all injuries that were deemed by the injured party or their associates were brought for hospital evaluation, it is reasonable to assume that hunters who sustained injuries may have declined to seek medical attention. The lack of any obvious trauma following a fall also may have prevented hunters from evaluation. Our series also does not capture those patients who sustained injuries at regional, community hospitals but whose injuries were not severe enough to warrant transfer to our facility. Lastly, while a thorough search for all patients was attempted, using ICD-9 codes as an initial filter may have missed patients whose diagnoses were not accurately documented at the time of their presentation.

From an international standpoint, hunting, as both a source of food and recreation, has been enjoyed by civilizations for thousands of years. Indian emperors would routinely employ elephants to hunt for wild game, and European monarchs often enjoyed fox and boar hunting as a sport while on horseback. However, from our search, tree stands appear to be a more modern invention that are primarily used in North America. Literature searches yielded no published data on hunting accidents outside of North America, and most international hunting and safety organizations focus their attention to this area as well.

In light of this data, more awareness and education are sorely needed. To this end, the authors have utilized the findings from this paper in local print and television media to educate the local community on the continued prevalence of tree stand injuries. A campaign has been initiated in New York to better educate hunters, with the aim of formally incorporating this study's findings in novel educational material for the New York State hunter safety educational curriculum.

Hunting remains an attractive recreational activity and the methodical use of tree stands have made hunters more effective at game hunting. This study reveals that nearly 10 years later, tree stand falls remain a significant cause of life-threatening neurological injury and subsequent disability. Increased awareness by healthcare providers and implementation of prevention strategies is critical to reducing the incidence of injuries sustained while hunting with tree stands. These prevention strategies can be taught during hunter safety education courses. All hunters should be made aware of the preventable risk factors that contribute to injury (structural failure, fatigue, lack of sleep, and drug and alcohol use). Additionally, hunters should be licensed and properly educated on the safe and proper use of tree stand and associated equipment (*e.g.*, safety harness), and ensure that equipment is in proper working condition on a routine basis. Tree stand manufacturers can aid in these hunter education preven-

tion programs by giving more support to efforts for the hunter's safety. Health care providers can also aid safety and education efforts, as physicians who treat these hunters may advocate for these prevention efforts to reduce incidence of neurologic injury during hunting.

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COMMENTS

Background

The role of tree stands in hunting accidents has been investigated to determine the incidence of injuries involving these devices. This study also compared current data with data obtained nearly a decade ago to identify any trends that have changed.

Research frontiers

Neurotrauma, public health.

Innovations and breakthroughs

Despite improvements in medical care, tree stand injuries continue to occur with no real abatement in incidence. Other states have instituted public health campaigns to educate hunters of the risks and these efforts have reduced rates of injury.

Terminology

Tree stands are devices used by hunters to give them a seat at an elevated position in a tree to observe wild game.

Peer review

This is a well-written study on hunting related injuries due to tree stand falls. The topic is interesting, important, and not sufficiently researched and the findings will hopefully raise awareness on safety issues. The study is well-designed and the findings are adequately presented. The discussion is balanced and informative.

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