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Upper extremity injuries associated with all terrain vehicle accidents: A multicenter experience and case review☆

Christopher M Reid[a], Angel Rivera-Barrios[b], Marion Tapp[b], Aladdin H Hassanein[c], Fernando A Herrera[b,d,*]

[a] Division of Plastic Surgery, University of California San Diego Medical Center, San Diego, CA 92103, United States
[b] Division of Plastic Surgery, Medical University of South Carolina, Charleston, SC 29425, United States
[c] Division of Plastic Surgery, University of Indiana, Indianapolis, IN 46202, United States
[d] Ralph H. Johnson Veterans Administration Medical Center, Charleston, SC 29425, United States

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ABSTRACT

Background: All terrain vehicle accidents are a common cause of trauma admission and often associated with extremity injuries. However specifics of injury patterns to the upper extremity has not previously been described. A multicenter, retrospective study was conducted to determine the frequency and distribution of upper extremity injuries sustained from ATV accidents.
Methods: Medical records of all patients presenting to two trauma centers with ATV related upper extremity trauma from 2001 to 2013 were reviewed. Patient records and radiographic data were analyzed for detailed extremity injury data. The identified injuries were classified by: anatomic location (shoulder, arm, elbow, forearm, wrist, hand) and structures involved (fracture/dislocation, amputation, nerve, artery, soft tissue). In addition, patient demographic information, length of stay (LOS), airway status, intensive care unit (ICU) stay, Glasgow coma scale (GCS), use of safety equipment, and associated injuries
Results: Two hundred seventy-seven patients with upper extremity injuries secondary to ATV accidents presented from 2001 to 2013. The frequency and distribution of ATV related upper extremity injuries classified by anatomic location demonstrated 18% of injuries involving the shoulder, 20% arm, 16% elbow, 18% forearm, 40% wrist, and 24% hand, with 30% of patients having injuries that involved more than one anatomic location. Injuries classified by structure involved indicated 73% of injuries were fracture/dislocations, 4% nerve injury, 2% vascular injury, and 36% soft tissue injury.
Conclusion: The most common upper extremity injuries experienced in ATV injuries were fractures/dislocations with one third of patients having injuries that involved more than one anatomical location. Less than half of the patients were documented as having worn safety equipment, illustrating a need for increased awareness and enacted of measures to improve safety and prevent accidents.
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Introduction

Each year, all-terrain vehicle (ATV) accidents are implicated as a cause of severe injury and death for a multitude of adults and children [1–3]. The Consumer Product Safety Commission (CPSC) developed more stringent regulations to address the dangers of ATVs in 1985 following data suggesting ATV related deaths increased three-fold, from 32,000 to over 100,000 deaths, in 1983 to 1985 alone [4]. The CPSC regulations included age requirements for use of ATVs, a nationwide training program for new owners and their families, and voluntary standards to make ATVs safer for the public [2,5]. By the 1990s, ATV related injury rates decreased almost 50% as a result of these new regulations, but the absolute number of injuries and deaths still remained high [2,4–6]. All-terrain motorized vehicles, popular for use in off-roading, have a straddle seat for the operator, handlebars for steering control, and low pressure tires allowing for speeds up to 50 mph or more [4]. Due to the inherent danger of operating these motorized vehicles, more young people are killed in ATV related accidents than by bicycle accidents [6,7]. In 2013, there were over 99,600 emergency department visits associated with ATVs in the United States with 25% including children younger than 16 years old, and 426 of these injuries resulting in death. [4] The three major mechanisms of injury include falls (32%), loss of stability/rollover (33%), and

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* Corresponding author at: Medical University of South Carolina, United States.
E-mail address: herreraf@musc.edu (F.A. Herrera).

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collision (27%) resulting in various head, musculoskeletal, orthopedic, and thoraco-abdominal injuries. Although rarely lethal, upper extremity injuries can have significant morbidity as well as cause substantial increase in medical costs in part due to long rehabilitation periods and delayed return to work.

Although prior investigations have examined major injuries, none have examined the patterns and frequency of upper extremity injuries. We performed a multicenter, retrospective study in order to identify the frequency, distribution, and specific patterns of upper extremity injuries sustained from ATV accidents.

Methods

A retrospective analysis of all patients presenting at two academic trauma centers with ATV-related injuries from 2001 to 2013 were reviewed. Patients who did not sustain an upper extremity injury directly related to an ATV accident were excluded from the study. Patient records and radiographic data were analyzed for detailed upper extremity injury data. Any identifiable upper extremity injury was classified by anatomic location into one of the following areas: shoulder, arm, elbow, forearm, wrist, or hand. Injuries were also classified according the structure involved as fracture/dislocation, amputation, nerve, artery, or soft tissue injury. Patient demographic information, length of stay (LOS), airway status, intensive care unit (ICU) stay, Glasgow coma scale (GCS), use of safety equipment, associated injuries, were reviewed and analyzed. Frequencies were recorded and compared based on location and injury type.

Results

We identified a total of 277 patients with upper extremity injuries sustained secondary to ATV accidents presenting from 2001–2013. The mean age of the injured patients in our study population was 31 years (range 9–65 years). A gender distribution of 200 males and 77 females was seen. The average length of hospital stay was 5.5 days (range 1–84 days). The average Glasgow coma score in the study population upon admission to hospital was 14.4 (range 3–15). Due to the severity of other associated injuries, one patient in the study population died on arrival.

After review of medical records and evaluation of radiographic images, the frequency and distribution of all upper extremities injuries were classified by anatomic location and injury type. When injuries were identified based on anatomic location, 18 percent involved the shoulder, 20 percent arm, 16 percent elbow, 18 percent forearm, 40 percent wrist, and 24 percent the hand (Fig. 1). Thirty percent of patients sustained injuries involving more than one anatomic location. When injuries were identified based on type, 73 percent were fracture/dislocations (including 15 percent of patients with open fractures), 4 percent included nerve injury; 2 percent included vascular injury; and 36 percent included soft tissue injury (Fig. 2).

Concomitant injuries occurring with ATV related upper extremity injuries were also evaluated. These included 40 percent of patients sustaining traumatic brain injury, 39 percent other orthopedic related injuries (non upper extremity fractures), 11 percent spine injuries, 21 percent thoracic injuries, 9 percent intra-abdominal injuries, 5 percent facial fractures, and 33 percent other related soft tissue injuries (Fig. 3).

We found only 40 percent of patients were reported to have worn helmets or safety gear. Also 12 percent of patients tested positive for alcohol at the time of initial presentation of their injury.

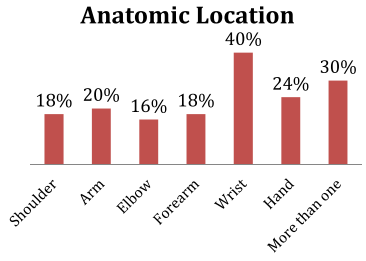

Fig. 1. Anatomic Location of Upper Extremity Injuries.

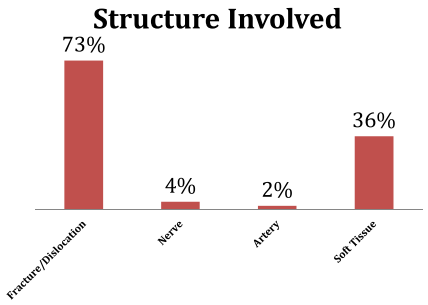

Fig. 2. Specific type of Upper Extremity Injuries.

Case

A 17 year-old female sustained a left upper extremity crush injury after rollover in an ATV accident (Fig. 4). She was taken to surgery emergently as her distal pulses were in question at the time of her presentation. The upper extremity fracture was reduced and stabilized with an external fixator given the degree of contamination. The wound was explored and vascular injury to the brachial artery ruled out and distal pulses were identified. After multiple washouts of the wound the external fixator was changed to an intramedullary rod. An antibiotic spacer was placed in the boney defect, the soft tissue was approximated over the wound and skin graft performed over the muscle (Fig. 5a–b).

Given the size of the boney defect (6 cm) and soft tissue contracture along the posterior medial arm a fibula osteocutaneous free flap was performed with internal fixation several months later. (Fig. 6a–d)

Discussion

All terrain vehicles have become a common recreational activity for many families, and are frequently operated by children and adolescents. However, rules and regulations of their use appear to be loosely enforced. Moreover, the number of ATV related accidents, and injuries associated with this are quite alarming.

Several studies investigating ATV related injuries, including its implications, costs, and safety exist [1,3,8,9]. To our knowledge this is the largest study addressing ATV related upper extremity injuries that also provides specific injury frequency and patterns of

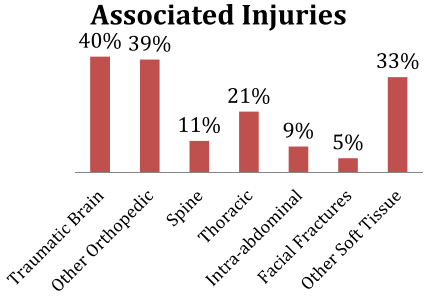

Fig. 3. Injuries Associated with ATV Accidents.

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