

# Case Report

## ATV Handlebar Impalement of the Upper Extremity: A Not So Humerus Case Report

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### ABSTRACT

All-terrain vehicle (ATV) ownership in Newfoundland and Labrador, Canada has been increasing over the past two decades, likely owing in part to the province's predominantly rural geography and increasing utilisation in the tourism and recreation industries. As such, accidents while operating these recreational vehicles have become increasingly common and are frequent presentations to rural emergency departments. Our case documents a healthy 59-year-old female who sustained a significant upper extremity penetrating injury sustained while operating a recreational ATV. This case emphasizes the importance of utilization of human resources standardized management pathways in NL.

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### INTRODUCTION

A steady increase in all-terrain vehicle (ATV) ownership has been observed over the past several years due in part to significant interplay within the tourism and recreation industries. Secondary to increasing utilisation, there has been a rise in the occurrence of serious ATV-related trauma, morbidity, and mortality.<sup>1-3</sup> ATV accidents are commonplace presentations to rural emergency departments (EDs). Approximately half of the residents of the province of Newfoundland and Labrador (NL) are considered to live rurally, residing in geographic areas with a population of fewer than 10,000 individuals.<sup>4</sup> As such, NL reported increased incidence of ATV-related injuries and fatalities compared to other Atlantic Canadian provinces.<sup>2</sup> Here, we present a unique case of a low-speed ATV rollover in rural NL, resulting in a penetrating upper extremity trauma with prolonged recovery course.

### CASE PRESENTATION

A healthy 59-year-old female presented to a rural ED via emergency medical services following a single vehicle accident while operating a recreational ATV. The patient lost control on loose gravel and careened over the oncoming trail embankment, resulting in a right-sided rollover which pinned her under the ATV. The patient was wearing a helmet and did not suffer head trauma or loss of consciousness. However, her right arm was entrapped and impaled by the handlebars of the ATV.

Arrival of the rescue team revealed the patient to be in significant pain with embedding of the handlebars into the medial portion of the right arm above, yet not traversing, the antecubital fossa and appeared to involve the distal upper extremity. Trailside extraction was performed by volunteer firefighters who utilized a hydraulic rescue tool, commonly referred to as "jaws of life," to carefully sever the ATV handlebar and clear the vehicle from her antecubital fossa. The patient described paresthesia along the ulnar nerve distribution into the right fourth and fifth digits while denying pain in her neck or additional extremities. She was boarded and cervical collar was applied while the foreign body was secured with gauze and cling to minimize movement. The patient verbalized an allergy to penicillin and was injected with ketorolac for pain relief and immediately transferred via ambulance to the nearest rural ED.

Initial assessment revealed the ATV handlebars embedded in the arm just distal to the antecubital fossa and did not traverse the axilla (Figure 1). Normal vascular and neuromotor examinations were documented, with palpable ulnar and radial pulses on serial exams. On musculoskeletal examination, flexion and extension of all digits of the right hand was preserved but the patient had weak to absent abduction. Antibiotics were not administered upon presentation to the ED.



**Figure 1.** Initial assessment revealing ATV handlebars impaled into the right antecubital fossa.

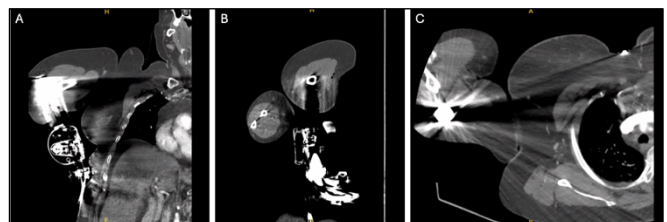
Advanced trauma life support (ATLS) protocols were then implemented with immediate laboratory trauma investigations notable only for slight hypokalemia of 2.9. A complete blood count (CBC) revealed leukocytosis of 20.2 with stable hemoglobin and platelet counts of 137 and 353, respectively. Computerized Tomography (CT) of the full spine, chest, abdomen, and pelvis revealed no acute traumatic injury. Further x-rays of tibia, fibula, femur, knee, and ankle were also unremarkable. X-ray of the right humerus, elbow, and radius/ulna revealed the obvious handlebar foreign body without evidence of fractures (Figure 2). Upper extremity angiography was attempted, however, non-diagnostic due to the combination of inability to appropriately position the extremity with the CT gantry, as well as significant beam hardening artifacts from the handlebar (Figure 3).

Trauma management included morphine 10 mg IV along with dimenhydrinate 25 mg IV. Potassium chloride 40 meq IV in 1 L of Normal Saline was given over 4 hours to correct the hypokalemia. A tetanus 0.5 ml

intramuscular injection and insertion of a foley catheter were completed prior to stat consult to local general rural surgeon. Following discussion with the tertiary trauma centre and plastic surgery, a plan was developed for surgical exploration and removal of the ATV handlebar foreign body to be managed locally, irrespective of presumed nerve injury.



**Figure 2.** Plain film radiograph showing ATV handlebars embedded in the right upper extremity.



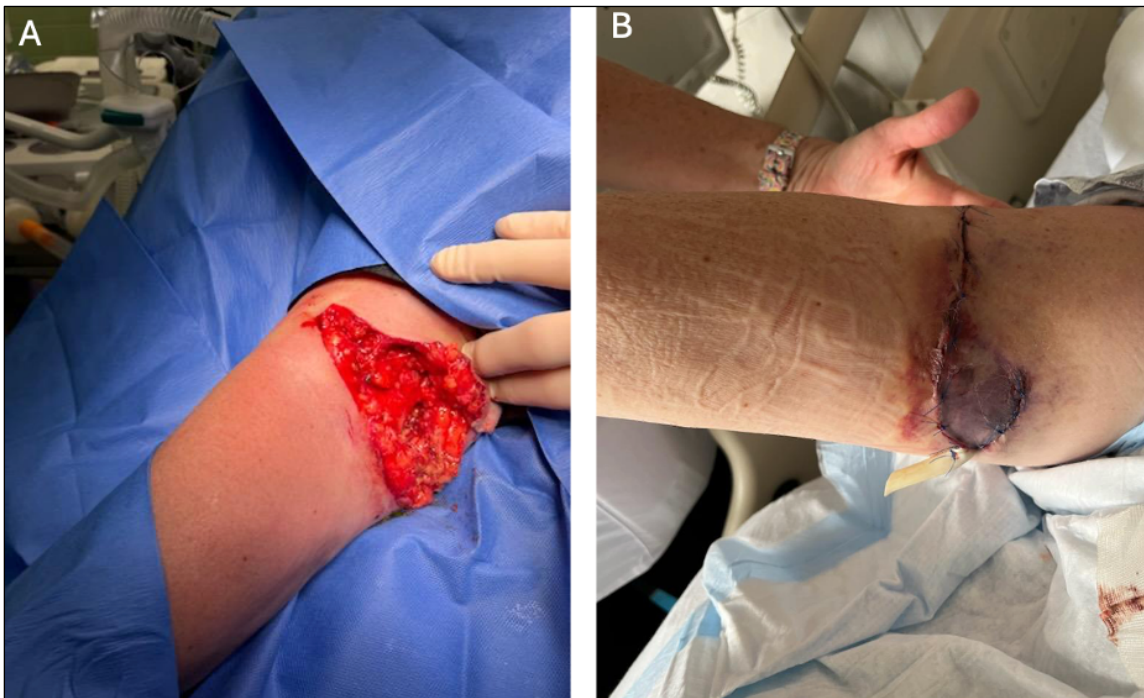
**Figure 3.** Non-diagnostic upper extremity CT angiography displaying difficulty with positioning and significant beam hardening artifacts from the handlebar. A) Coronal plane B) Sagittal plane C) Axial plane.

Patient was transferred to the operative theatre and general anesthetic administered along with intraoperative intravenous ceftriaxone. Careful examination did not reveal any obvious vascular or neurological injury as well as appropriate visualization of brachiocephalic structures. The handlebar was gently removed, and the tourniquet slowly released after which a few small bleeding vessels were cauterized, and the wound irrigated with copious amounts of sterile water. Prior to primary closure some de-vascularized tissue was excised using a combination of hot cautery and sharp dissection, after which a Penrose drain was placed (Figure 4).

Four days postoperatively, the patient was transferred to the tertiary care centre to be assessed by plastic surgery. She reported increased numbness and tingling in all digits of her right hand, and she had obvious claw deformity of the ring and little fingers. Urgent MRI of the right elbow was ordered to determine the extent of ulnar laceration and appropriately prognosticate the present case. Results of the MRI revealed absence of direct transection or laceration of the ulnar nerve, however both the ulnar and median nerves were edematous throughout their imaged lengths, consistent with ulnar and possibly median nerve injuries.

Several days after the MRI, the patient was brought back to the OR for an exploration and release of the right ulnar nerve at the level of the elbow, forearm, and wrist, as well as transfer of the anterior interosseous nerve to the motor branch of the right ulnar nerve. Following this procedure, a slow but gradual improvement of motor and neurological function was observed.

The patient commenced targeted physical therapy at 1-month postoperative with a focus on functional improvement. Electromyography (EMG) studies were completed serially to assess recovery. Five months post-injury the motor response and sensory potential of the ulnar nerve was absent. Repeat EMG studies nine months post-injury showed improvement, with small motor responses from ulnar motor innervated muscles obtained as well as small ulnar sensory responses, which previously were absent. Further EMG studies were completed at 12- and 18-months post-injury, showing improvement in motor response and the patient had improved clinically with better strength and function. At 18-month follow-up the patient reported improved ability to grip objects and lower likelihood of dropping things. However, there was no further improvement in ulnar sensory response and the patient has ongoing paresthesia in the fourth and fifth digits of the right hand. Persistent neuropathic pain symptoms continue to be well managed with Gabapentin 600mg PO TID.



**Figure 4.** Photographs taken in the operating suite: A) Laceration following removal of ATV Handlebars. B) Laceration with visible Penrose drain following primary closure.

## DISCUSSION

The documented case is a unique presentation of penetrating upper limb trauma following an ATV rollover at low speed that resulted in complex and delayed outcomes when considering the prolonged recovery course and residual symptomatology. Incidence of ATV accidents are increasing and can result in considerable morbidity and mortality, particularly following rollover accidents as riders are unrestrained with highly variable posture and positioning.<sup>5</sup> Although the majority of rollover ATV accidents occur at relatively low speeds, such occurrences can still result in significant injury despite riders wearing protective equipment, such as helmets.<sup>1,5</sup> A recent retrospective review by Siman-Tov et al. (2020) found ATV users were more likely to suffer severe injuries than any other form of motor vehicle accident with increased use of hospital resources including surgery, ICU admissions, and prolonged length of stay.<sup>1</sup> Various blunt and penetrating injuries resultant from ATV-associated accidents have been reported in recent literature, including but not limited to, traumatic brain injuries, lung herniation, globe dislocation and optic nerve avulsion as well as laceration of intrabdominal structures.<sup>6-9</sup>

Penetrative injuries are known to occur during ATV accidents and can occur even with blunt objects such as the end of an ATV handlebar.<sup>10</sup> Despite the evident increase in ATV accidents, there has been limited reporting of prior penetrating trauma with resultant nerve injury. Upper extremity nerve injuries following trauma are relatively uncommon and are seen in approximately 3 – 4% of upper limb presentations to EDs.<sup>11,12</sup> Ulnar nerve traumas are associated with particularly poor prognosis regardless of the level of injury when compared with that of the median or radial nerve. Specifically, injuries sustained at or above the elbow level exhibit the worst prognosis, even after attempted repair.<sup>12,13</sup> Such findings are attributable to the role of the ulnar nerve in innervations to intrinsic muscles of the hand responsible for a wide array of motor functioning and daily tasks.<sup>13,14</sup>

The characteristic claw hand deformity seen in the present case was concerning for the ulnar nerve laceration, which is associated with a particularly poor prognosis, compared to a neuropraxia, the most minor form of nerve injury.<sup>15</sup> Despite the absence of significant ulnar nerve trauma on undertaken imaging, the outcome for this patient was complex and delayed associated with residual symptoms at approximately 18 months post-operatively and despite the use of neuropathic medication. Other reports have found the use of advanced imaging techniques, such as CT angiography

to be useful in penetrative trauma with wooden foreign bodies but there was difficulty in commenting on vascular injury in this case using CT angiography with a metal foreign body.<sup>10</sup> Due to limitations in resources, including advanced imaging techniques and sub-specialty care, rural EDs in collaboration with their tertiary care colleagues could consider developing streamlined pathways for advanced imaging of penetrative traumas or consider early transfer to a tertiary care centre for definitive management.

Finally, ATV use in NL has increased substantially in the past two decades, which has been causally linked to rural residence.<sup>3</sup> Significant to this increase in usage, NL has been found to have the highest rate of ATV associated mortality in Atlantic Canada, prompting the need for greater examination of ATV safety and guidelines.<sup>2</sup> Several groups have studied Crush Protection Devices (CPDs), which are intended to reduce injury by decreasing significant contact between an inverted ATV and rider.<sup>5,16</sup> NL currently has no regulations requiring CPD usage for ATVs. In the absence of CPDs, penetrating injuries are more likely to occur when riders are thrown from the vehicle and come into contact with the vehicle or surrounding objects. Penetrative traumas and impalement injuries have been reported in the literature and present a complicated diagnostic and management dilemma, particularly in rural environments where resources are limited, and sub-specialty care and advanced imaging modalities are unavailable.<sup>8,10</sup> Future studies could consider evaluating the effectiveness of CPDs in reducing the risk of contact injuries between inverted ATVs and riders.

## CONCLUSIONS

Trauma sustained while operating recreational ATVs are becoming an increasingly common presentation to rural EDs. We have reported a unique case of upper extremity penetrating trauma that has important implications in the consideration of management pathways from these traumatic injuries while highlighting the need for further examination of ATV safety.

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