Case Report

Injuries During a Massive Tug-of-War Game

“Tug-of-war” may cause a variety of sports injuries, which has rarely been reported previously. This report describes an uncommon case of a previously fit 64-year-old male who presented with abrupt onset of loss of consciousness after falling down in a game of massive tug of war involving 1,500 participants as the rope snapped apart. Computed tomography (CT) scan of his abdomen revealed liver and spleen rupture. Spinal cord injury due to traumatic herniation of intervertebral disc at C5-6 level and bilateral brachial plexus injuries in jury were also noted after exploratory laparotomy with primary reattachment of the biceps. After two-year comprehensive rehabilitation programs, the patient recovered to ambulate with assistive device, and resumed partially dependent daily living activities.

CASE REPORT

In this massive tug-of-war game, one previously fit and active 64-year-old male sustained severe abdominal pain and fullness after the rope was snapped apart. He was unconscious with shock upon arrival at the emergency department. On examination, swelling over right side abdomen and right upper quadrant ten derness with rebound sensation and guarding were noted. Computed tomograph of his abdomen demonstrated liver and...
spleen rupture. Primary repair of the liver and splenectomy was performed immediately.

Weakness over four limbs developed after laparotomy when the patient was in the intensive care unit. He had a Foley catheter. Extravasation, laxatives and enema were also given because of constipation. Digital examination revealed decreased anal tone. Muscle power over the bilateral upper limbs, as measured by the Medical Research Council (MRC) system, revealed a grade of 1/5 over elbow flexion and shoulder abduction, and a grade of 0/5 over elbow extension, wrist flexion and extension, finger flexion and extension. No grasping was noted. The lower limbs achieved an MRC grade of 0/5 over hip flexion and extension, knee flexion and extension, plantar flexion and dorsiflexion. Pin prick and light touch sensation was absent below the bilateral C5 dermatomes. Deep tendon reflexes were all absent. A Magnetic Resonance Imaging (MRI) of the C-spine revealed enhanced signals in the C5-6 spinal cord on T2-weighted images, which suggested a compressive myelopathy due to traumatic herniated disc at this level (Fig. 1).

Five weeks after admission, the patient received discectomy over C5-6 and C6-7 and anterior spinal fusion. One month later, his muscle power had improved to grade 2/5 over bilateral hip and knee extension and flexion. Deep tendon reflexes had all significantly increased. Decreased anal tone was still noted. An urodynamic study showed detrusor-external sphincter dysynergia; therefore, it was necessary to perform intermittent catheterization every four hours. Rehabilitation programs also started, including a passive range of motion exercise, strengthening exercise, balance training and activities of daily living (ADL) training.

However, weakness over the bilateral upper limbs persisted. The patient achieved an MRC grade of only 1/5 over elbow flexion and extension and a grade of 0/5 over wrist and finger flexion and extension. Two months after admission, an electrophysiologic study showed severe diffuse axonopathy of the bilateral brachial plexuses.

Spasticity over bilateral lower limbs developed about three months after injury, measuring 2 over bilateral hamstring muscles and 3 over bilateral gastrocnemius muscles on the modified Ashworth scale of spasticity (Table 1). The patient took up to 40 mg of baclofen per day, in divided doses, and 2 mg of clonazepam per night. He also underwent a passive range of motion and stretching exercise with anti-spasticity splint use; but the problem persisted. A spastic gait was

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**Fig. 1.** A Magnetic Resonance Imaging (MRI) of the C-spine revealed enhanced signals in the C5-6 spinal cord on T2-weighted images, which suggested a compressive disc at this level.

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**Table 1. Clinical scale of spastic hypertonia**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>No increase in tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension</td>
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<tr>
<td>1+</td>
<td>Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the range of motion</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in muscle tone through most of the range of motion, but affected part(s) easily moved</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in muscle tone, passive movement difficult</td>
</tr>
<tr>
<td>4</td>
<td>Affected part(s) rigid in flexion or extension</td>
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still noted and influenced the patient’s ambulation to a significant extent. Therefore, bot ulism toxin A was injected with 150 units over left gastrocnemius and 50 units over right gastrocnemius muscle. The follow-up evaluation in four weeks showed the decrease of spasticity over the afore mentioned muscles to 1 on the modified Ashworth scale.

Unfortunately, severe cramping pain over the left shoulder and right fore arm area developed four months after the injury. No tender or trigger points were found. The patient took non-steroid anti-inflammatory drugs and received transcutaneous electrical stimulation, but the condition did not improve. Neuropathic pain was suspected, and the symptom was relieved after the administration of a 50 mg of imipramine per night and 100 mg of carbamazepine twice a day. How ever, he began to develop drowsiness, dry mouth, nausea and vomiting. The dose of imipramine was then adjusted to 25 mg per night. The pain persisted but became more tolerable than before.

Ten months after the injury, the patient received explorative surgery for right brachial plexus due to no significant improvement in his motor function after 8 months of intensive rehabilitation and the unfavorable EMG report that revealed diffuse fibrillations in sampled muscles of upper limbs indicating that brachial plexopathy might also be a culprit. After neurolysis, he received further rehabilitation programs, including hand function training and ADL training to increase grip function. To enhance upper limb function, the patient was fitted with a forearm orthosis with a pivot shift. A stand-up wheelchair was also used to improve his standing balance.

Before discharge, the patient could ambulate for 20 meters with a walker under waist belt support after the comprehensive rehabilitation programs that persisted for two years. His activities of daily living recovered partially and he started to use assistive devices to feed and groom himself.

**DISCUSSION**

In the massive tug-of-war event involving around 1,500 participants, a total of 42 were injured when the rope was broken. Most of them suffered from abrasions and contusion injuries when falling down. Among them, five men were severely injured, including two men with left upper arm amputations, one man with a wrist fracture, and one man with a right hand amputation from the web space between the first and second digits. The most devastating injury was described in this report, consisting of liver and spleen rupture with C5-6 spinal cord injury as the initial presentations. A bilateral brachial plexus injury was also found in the subsequent investigations. A bilateral brachial plexus injury might also be hyperextension of the neck under inertial force as the patient fell down.

While most people fell down as the rope was broken, the impact of stepping might have contributed to the contusion in the right side of the abdomen and the spinal cord of this patient, which led respectively to ruptures of the liver and spleen and to compressive myelopathy. The other mechanism of the spinal cord injury might be hyperextension of the neck under inertial force as the patient fell down.

On account of the asymmetrical motor and muscle tone recovery over four limbs after diskectomy, superimposed bilateral brachial plexus injury was suspected since the patient was closest to the breaking point. The pulling force on the accessory cord from the other 39 participants standing behind him might have produced severe traction injury to the bilateral brachial plexuses when the patient was gripping the cord tightly with hands (Fig. 2). Right brachial plexus exploration was performed since he was right handed, but the patient refused further surgical intervention over the left brachial plexus. The operative findings showed no nerve rupture. The spinal nerves remained intact except some scar tissue at upper and mid trunks. More over, the somatosensory evoked potentials were negative at scalp re-

![Fig. 2. The display of the bar ray in the game of tug-of-war. The position of the reported case is blackened.](image-url)
cordings as stimulating C5 to T1 spinal nerves. From this point of view, the patient might sustain in complete C5 spinal cord injury with motor neuron depletion. However, the double injuries can not be excluded since this case wrapped the rope around his arms during pulling and the pre-operative EMG demonstrated a diffuse peripheral neuropathy. After discharge, however, the hand function over the right upper limb turned out to be much better than that of the left upper limb.

Severe cramping and painful shooting sensations, which developed over the right and then the left arm, were considered as neuropathic pain since it responded well to imipramine while non-steroid anti-inflammatory drugs and transcutaneous electrical stimulation use did not take effect. The characteristic of delayed onset and the distribution over the bilateral C5 and C6 dermatomes also supported the assumption of its neurogenic origin.

Significant progress has been made in the understanding of the pathophysiology of neuropathic pain. Nevertheless, consensus has not yet been reached over the most effective therapeutic procedures for such conditions. To date, amitriptyline or nortriptyline and other such conventional antidepressants are still the primary therapy for neuropathic pain. Unfortunately, the side effects that many patients suffer from prevent them from receiving the amount which would most effectively reduce their pain. In this case, the side effects of drowsiness developed after the dose of imipramine was increased to 50 mg per night. Carbamazepine was added as a result.

Oral medications frequently used in the treatment of spasticity include baclofen, benzodiazepines, tizanidine, clonidine, dantrolene and gabapentin. The patient took up to 40 mg of baclofen in divided doses per day, and 2 mg of clonazepam per night, but the muscle tone did not decrease. Gait pattern was improved in double support and heel strike phases, but significant improvement in his knee extension has been impeded by hamstring spasticity during gait cycle.

Although there are definite rules on tug-of-war games in formal athletic competitions, these rules are usually not strictly observed in casual informal games, which lead to high risk in causing injuries. First of all, only eight participants should be weighed before the game and the toal weight over both sides should meet. Additionally, the post-event investigation also revealed that the main cord used in this game all lowered not more than one hundred participants for safety reasons. More over, it was found that the rope, after earlier re-peated uses, might have been worn out before the game. The de-fected rope was unable to sustain the force exerted by more than 1,500 participants. These factors might all have contributed to this tragedy. To sum up, the rules in tug-of-war games should be obeyed faithfully to prevent any accidental. Otherwise, unexpected multiple injuries with severe intractable complications are possible with an informal masive tug-of-war game.

REFERENCES