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CASE REPORT

Spinal cord injury without radiological abnormality due to a fall while using an abdominal roller: A report of two cases

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Abstract

Background: In recent years, various home-use health devices have gained popularity. The abdominal roller is one of these. Spinal cord injury without radiological abnormality is known to occur even with relatively minor injuries, but there are few reports of such injuries caused by a roller.

Case Presentation: Two cases of spinal cord injuries caused by a roller are reported. In both cases, injuries occurred during the standing rollout by a patient in an inebriated state, and the patients were rushed to an emergency department.

Conclusion: Because the use of abdominal rollers may result in extremely serious disabilities, it is necessary to emphasize the appropriate use of such equipment.

KEYWORDS
abdominal muscles, central cord syndrome, equipment safety, exercise, spinal cord injuries

INTRODUCTION

Spinal cord injury (SCI) without radiological abnormality is known to occur even with relatively minor injuries.[1] As Segal et al.[2] reported in their study of 11,975 patients with central cord syndrome (CCS) from 2009 to 2012, 55% of all patients with CCS admitted to the hospital were treated non-operatively, and the in-hospital mortality rate was 2.6%. CCS sometimes leaves severe sequelae.

In particular, middle-age and older people may have cervical spine diseases such as asymptomatic cervical myelopathy, and in such cases, low-energy injuries may result in serious cervical SCI.[3] In recent years, various home-use health devices have been marketed and have gained popularity because of the lack of exercise caused by the coronavirus disease 2019 pandemic and the health-consciousness of the public. Moreover, the National Consumer Affairs Center of Japan has reported health hazards from these devices,[4] but there are few reports from the medical perspective. In this report, two cases of incomplete SCI without radiological abnormality caused by the use of abdominal rollers are described.

CASE REPORT

Case 1

A man in his 40s with hypertension was transported by ambulance because of difficulty walking. He had no particular symptoms before the injury. After drinking 1500 mL of beer and 500 mL of canned shōchū (80 g alcohol equivalent) at a friend's house, he tried an abdominal roller, but lost his balance and struck his left cheek on the floor.

On physical examination, there was a bruise on his left cheek. Manual muscle testing (MMT) was 4 in the upper limbs and 3 in the lower limbs, and he complained of numbness and paresthesia in the thorax, abdomen, and both upper limbs.

Radiography and computed tomography (CT) showed no fracture, but there were osteophytes on the posterior parts of

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the vertebral bodies between C5 and C6. T2-weighted magnetic resonance imaging (MRI) showed a high signal intensity area in the spinal cord at the C5/6 level, and the spinal canal was stenotic (Figure 1A).

Frankel C cervical SCI without radiological abnormality was diagnosed. He was treated with conservative therapy with a cervical collar. Two hours after the injury, his MMT grade improved to 5 in the upper extremity and 4 in the lower extremity. Three days later, the patient still had mild numbness in both upper limbs and the thorax and abdomen, as well as mild muscle weakness in the left hand's fingers. He was transferred to a hospital for rehabilitation on the 13th day of admission.

Case 2

A man in his 50s with hypertension and diabetes mellitus was transported to our emergency department by ambulance because of difficulty walking. After drinking five glasses of whisky and soda (140 g alcohol equivalent) at a friend's house, he tried an abdominal roller. He lost his balance and struck his forehead on the floor.

On physical examination, there was a bruise on his forehead with no neck tenderness. His MMT grade was 3 in the upper limbs and 4 in the lower limbs, and he complained of numbness and paresthesia in the thorax, abdomen, and both upper limbs.

Radiography and CT showed neither fracture nor osteophytes. T2-weighted MRI showed a high signal intensity area in the spinal cord at the C5/6 level, and the spinal canal was stenotic at the C4/5 and C5/6 levels (Figure 1B).

Frankel C cervical SCI without radiological abnormality at the C4/5 level was diagnosed. He was also treated with conservative therapy with a cervical collar. Numbness and weakness of the muscles were reduced immediately after admission. Although he had mild numbness and paresthesia in the fingertips of both hands, he was discharged from the hospital 4 days after the injury.

DISCUSSION

The abdominal roller is a health device mainly used for strengthening the abdominal muscles. It has a simple structure of one or two tires with two handles and can be easily purchased for home use. There are two ways to use it: the kneeling rollout (Figure 2A) and the standing rollout (Figure 2B). In the kneeling rollout, the user grips the handles of the abdominal roller while kneeling on the floor and rolls the

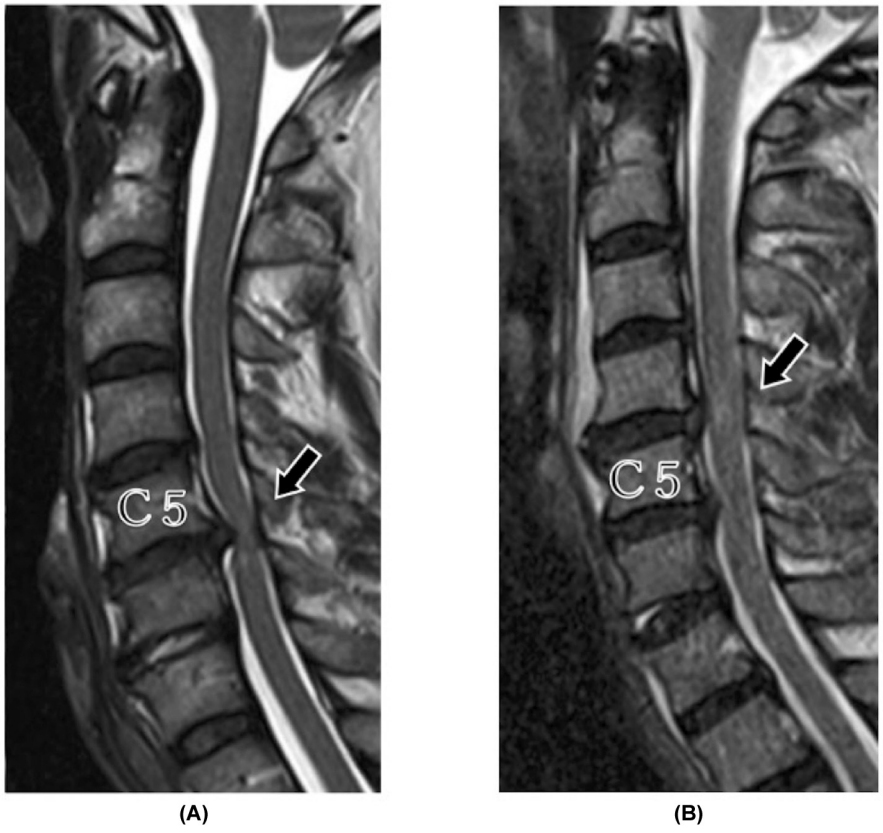

FIGURE 1 Magnetic resonance imaging T2-weighted image (A: case 1, B: case 2). (A) A high signal intensity area in the spinal cord at the C5/6 level, and the spinal canal is stenotic. (B) A high signal intensity area in the spinal cord at the C4/5 level, and the spinal canal is stenotic at the C4/5 and C5/6 levels.

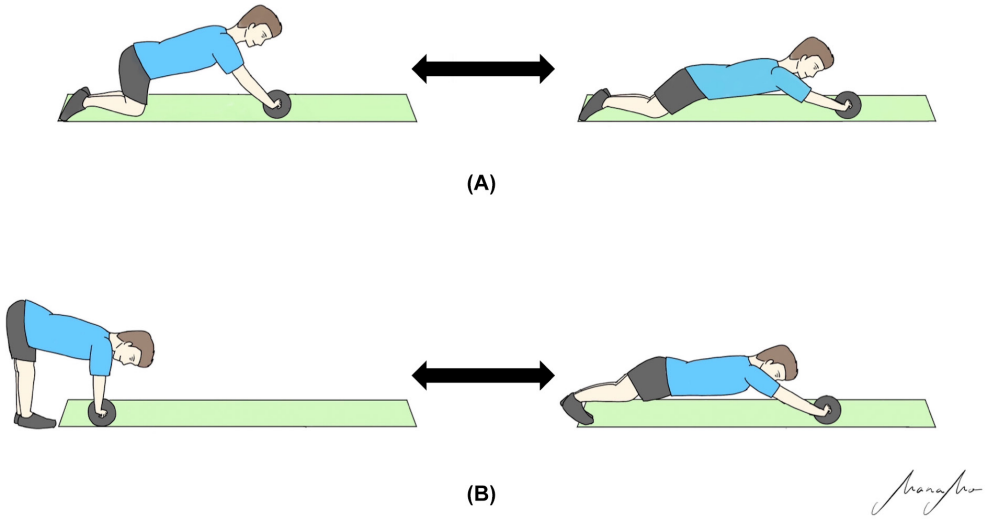

FIGURE 2 How to use an abdominal roller (A: the kneeling rollout, B: the standing rollout). (A) The user grips the handles of the abdominal roller while kneeling on the floor and rolls the wheel forward and backward while keeping the back straight. (B) The user does the same motion without kneeling on the floor.

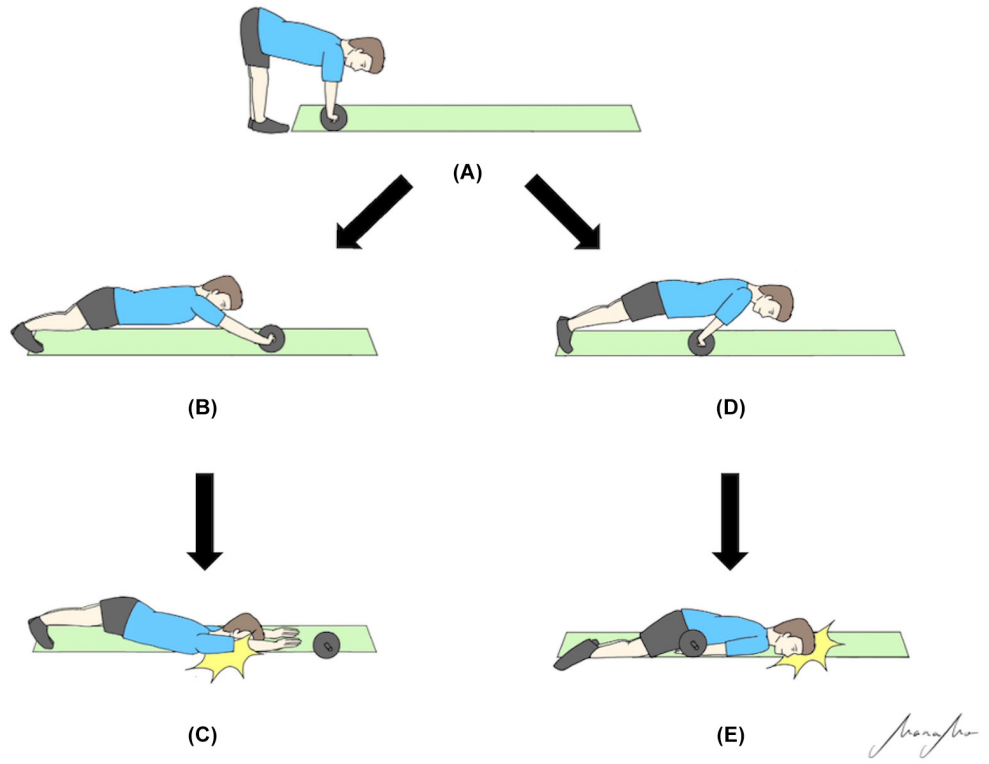

FIGURE 3 The two types of injury mechanism with an abdominal roller. (A)→(B)→(C): Extension of the upper extremities type (EUE type). (A)→(D)→(E): Flexion of the upper extremities type (FUE type).

wheel forward and backward while keeping the back straight. In the standing rollout, the user does the same motion without kneeling on the floor. Generally, the kneeling rollout is recommended, because the standing rollout is difficult to perform safely if the practitioners do not have sufficient muscle strength. Ota et al.[5] found that muscle thickness of the total trunk muscles was significantly less in the 50s and 60s age groups than in the 20s age group. This suggests that middle-age and older people may not have enough muscle strength to perform the standing rollout safety. Middle-age

and older patients may also have subclinical cervical spine disease, and in such cases, even a minor injury may cause cervical SCI.[2] Both cases were injured while attempting the standing rollout, and they were also middle-age. In addition, both patients were inebriated. Tator et al.[6] reported that about 25% of SCI cases in adults were related to alcohol consumption. Therefore, the risk factors for SCI caused by the device may be age and alcohol consumption.

We consider that there are two types of mechanism of abdominal roller injury in which the face is impacted. The first type is that the upper limbs are extended and the roller leaves the body (extension of the upper extremities type [EUE type]) (Figure 3 (A)→(B)→(C)). The second type is that the roller is placed close to the knee (flexion of the upper extremities type [FUE type]) (Figure 3 (A)→(D)→(E)).

In general, extension injuries of the cervical spine have a worse prognosis than flexion injuries.[7,8] Cervical SCI caused by abdominal rollers is caused by extension of the neck regardless of the injury type, which may have serious results. Injuries from home health equipment in the United States are most commonly reported on treadmills, cycling machines, and elliptical machines.[9] However, no report of cervical SCI caused by abdominal rollers could be found. Because abdominal rollers are readily available for purchase, there may potentially be many serious health problems caused by inappropriate use of abdominal rollers.

CONCLUSION

Use of abdominal rollers may result in extremely serious disabilities. Therefore, it is necessary to emphasize the appropriate use of such equipment.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interests for this article.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

Approval of the research protocol: This case report has been approved by a suitably constituted Ethics Committee of Jichi Medical University (Approval No. 22–008), and it conforms to the provisions of the Declaration of Helsinki.
Informed consent: Informed consent was obtained from both patients by the opt-out method prescribed by the hospital.
Animal studies: N/A.

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REFERENCES

1. Sekhon LHS, Fehlings MG. Epidemiology, demographics, and pathophysiology of acute spinal cord injury. Spine. 2001;26(24S):S2–S12.
2. Segal DN, Grabel ZJ, Heller JG, Rhee JM, Michael KW, Yoon ST, et al. Epidemiology and treatment of central cord syndrome in the United States. J Spine Surg. 2018;4:712–6.
3. McKinley WO, Seel RT, Hardman JT. Nontraumatic spinal cord injury: incidence, epidemiology, and functional outcome. Arch Phys Med Rehabil. 1999;80:619–23.
4. *National Consumer Affairs Center of JAPAN: About affairs of home exercise equipment*. Published June 21, 2012. Accessed February 12, 2023. https://www.kokusen.go.jp/pdf/n-20120621_1.pdf. (in Japanese)
5. Ota M, Ikezoe T, Kato T, Tateuchi H, Ichihashi N. Age-related changes in muscle thickness and echo intensity of trunk muscles in healthy women: comparison of 20-60s age groups. Eur J Appl Physiol. 2020;120:1805–14.
6. Tator CH, Duncan EG, Edmonds VE, Lapczak LI, Andrews DF. Changes in epidemiology of acute spinal cord injury from 1947 to 1981. Surg Neurol. 1993;40:207–15.
7. Thompson C, Gonsalves JF, Welsh D. Hyperextension injury of the cervical spine with central cord syndrome. Eur Spine J. 2015;24:195–202.
8. Xu M-L, Zeng H-Z, Zheng L-D, Jin C, Zhu SJ, Yang YT, et al. Effect of degenerative factors on cervical spinal cord during flexion and extension: a dynamic finite element analysis. Biomech Model Mechanobiol. 2022;21:1743–59.
9. Graves JM, Iyer KR, Willisa MM. Emergency department-reported injuries associated with mechanical home exercise equipment in the USA. Inj Prev. 2014;20:281–5.

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