Editors' Choice

CASE REPORT

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Surgical removal of an intracranially migrated acupuncture needle: a case report and literature review

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ABSTRACT

Acupuncture is a popular alternative therapy worldwide and is generally safe. However, serious acupuncture-related complications can occur. Intracranial complications caused by a migrated acupuncture needle are extremely rare. Herein we report a surgical case of intracranial acupuncture needle migration and discuss the key technical aspects of the procedure. We additionally performed a review of the relevant literature. A 55-year-old woman presented with migration of a broken acupuncture needle via the posterior cervical skin. Computed tomography (CT) showed that the needle migrated intra- and extradurally via the atlanto-occipital junction. CT angiography revealed that the needle tail was located adjacent to the right distal horizontal loop of the vertebral artery. Meanwhile, the needle tip was positioned in the premedullary cistern adjacent to the medulla oblongata via the right lateral medullary cistern. Emergent surgical removal was conducted. Intradural exploration was required as the needle was not found in the epidural space. The needle penetrated the adventitia of the right intradural vertebral artery. We failed to pull out the needle toward the epidural space. After the needle was completely pulled into the intradural space, it was successfully removed without bleeding complication. Postoperative CT showed no evidence of residual needle fragment. The patient was discharged home without any sequelae. To the best of our knowledge, this is the first case of penetrating vertebral artery injury caused by radiologically confirmed acupuncture needle migration. An intracranially migrated needle should be removed urgently to prevent further migration causing brainstem, cranial nerve, and vessel injuries. The surgical strategy should be selected according to needle location and direction.

Keywords: acupuncture-related complication, foreign body, intracranial complication, penetrating injury, vertebral artery injury

Abbreviations:
CSF: cerebrospinal fluid
CT: computed tomography
CTA: computed tomography angiography
VA: vertebral artery

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INTRODUCTION

Acupuncture is the stimulation of specific points on the skin (acupuncture points) commonly via the insertion of fine needles. Currently, it is increasingly used worldwide as an alternative and complementary medical modality for pain control. Acupuncture is usually safe; however, serious complications, including pneumothorax, cardiac tamponade, and transverse myelopathy, can occur.[1-3] To date, intracranial complications caused by acupuncture needle migration is extremely rare.[4-8] Herein we describe a surgical case involving penetrating injury of the intradural vertebral artery (VA) caused by an intracranially migrated acupuncture needle. A literature review about intracranial complications caused by radiologically confirmed acupuncture needle migration was performed.

CASE REPORT

A 55-year-old woman with no significant medical history presented to our hospital immediately after migration of a broken needle via the posterior cervical skin (day 0). To relieve headache and stiff neck, the patient had repeatedly undergone self-acupuncture on the posterior neck using a disposable, fine 4-cm stainless steel needle with a shaft. However, the joint between the needle and shaft had accidentally detached during self-acupuncture, followed by complete needle migration into the posterior neck region. On day 0, her vital signs and neurological findings were normal. A needle puncture mark was not found on the posterior cervical skin. The initial computed tomography (CT) on day 0 revealed that the needle migrated intra- and extradurally via the atlanto-occipital junction. There was no evidence of hemorrhage and cerebrospinal fluid (CSF) leakage. CT angiography (CTA) on day 0 showed that the right distal horizontal loop of the V3 segment of the VA was surrounded by the vertebral venous plexus. The needle penetrated the vertebral venous plexus (Fig. 1). The needle tip was positioned in the premedullary cistern adjacent to the medulla oblongata via the right lateral medullary cistern (Fig. 1).

Three-dimensional CTA on day 0 showed that the needle was adjacent to the proximal right V4 segment (Fig. 2A, B). The tail of the needle was located between the right distal horizontal loop and the posterior arch of the atlas (Fig. 2C). The lengths of the needle located in the intradural space and epidural space were about 2.5 and 1.5 cm, respectively. The left VA was

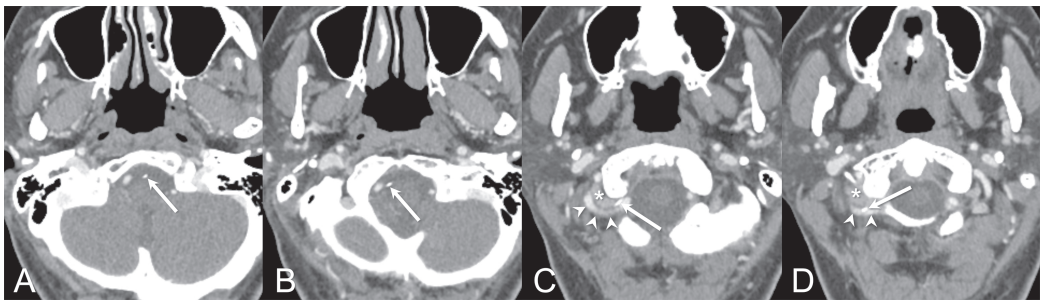

Fig. 1 Preoperative computed tomography angiography

Fig. 1A: The needle tip (arrow) was positioned in the premedullary cistern adjacent to the medulla oblongata.

Fig. 1B: The needle (arrow) was located in the right lateral medullary cistern.

Fig. 1C, 1D: The right distal horizontal loop of the V3 segment of the vertebral artery (arrowheads) was surrounded by the vertebral venous plexus (asterisks). The needle (arrows) penetrated the vertebral venous plexus.

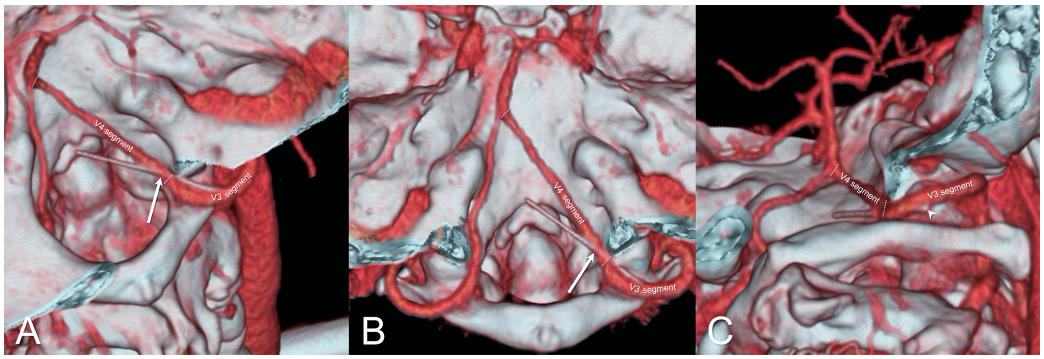

Fig. 2 Preoperative three-dimensional computed tomography angiography

Fig. 2A, 2B: The needle was adjacent to the proximal right V4 segment (arrows).

Fig. 2C: The needle tail was located between the right distal horizontal loop and the posterior arch of the atlas (arrowhead). Notably, the left VA was located in the long axis direction of the migrated needle.

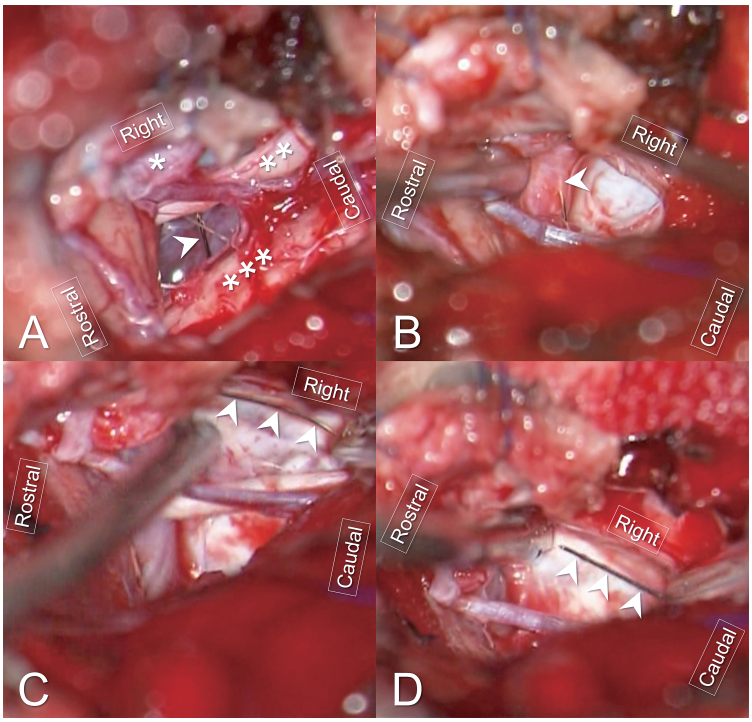

Fig. 3 Intraoperative images captured with a video

Fig. 3A: The needle (arrowhead) was found in the right lateral medullary cistern. The right intradural vertebral artery (VA) (single asterisk), accessary nerve (double asterisks), and medulla oblongata (triple asterisks) were visualized.

Fig. 3B: The needle penetrated the adventitia of the right VA (arrowhead).

Fig. 3C, 3D: The needle (arrowheads) was cautiously pulled in caudally toward the intradural space using a microforceps. Consequently, the needle (arrowheads) was completely pulled into the intradural space without causing bleeding complication.

located in the long axis direction of the migrated needle (Fig. 2B). To prevent further needle migration and infection, emergent surgical removal was performed on day 0. This study was approved by the institutional review board, and a written informed consent for treatment was obtained from the patient.

Surgical removal

Caution was taken not to cause further needle migration during surgery. Under general anesthesia, midline suboccipital craniotomy with C1 laminectomy was performed. The right side of the posterior atlanto-occipital membrane was dissected. However, the needle could not be found in the extradural space. After dural incision, the needle was identified in the right lateral medullary cistern (Fig. 3A). The lower cranial nerves were intact. However, the needle penetrated the adventitia of the right V4 segment (Fig. 3B). First, we attempted to pull out the needle toward the epidural space using a microforceps. Nevertheless, the needle did not move at all. Second, the needle was cut with a microscissors in the intradural space; however, this procedure was not successful because the needle was stiff. Thus, the needle was cautiously pulled in caudally toward the intradural space using a microforceps (Fig. 3C). After the needle was completely pulled into the intradural space (Fig. 3D), it was removed without causing bleeding in the VA.

Primary dural closure was performed in which the total operative time was 228 min and estimated blood loss was 150 ml. The needle length was about 4 cm. The needle tip remained sharp, and the needle tail was dull (Fig. 4).

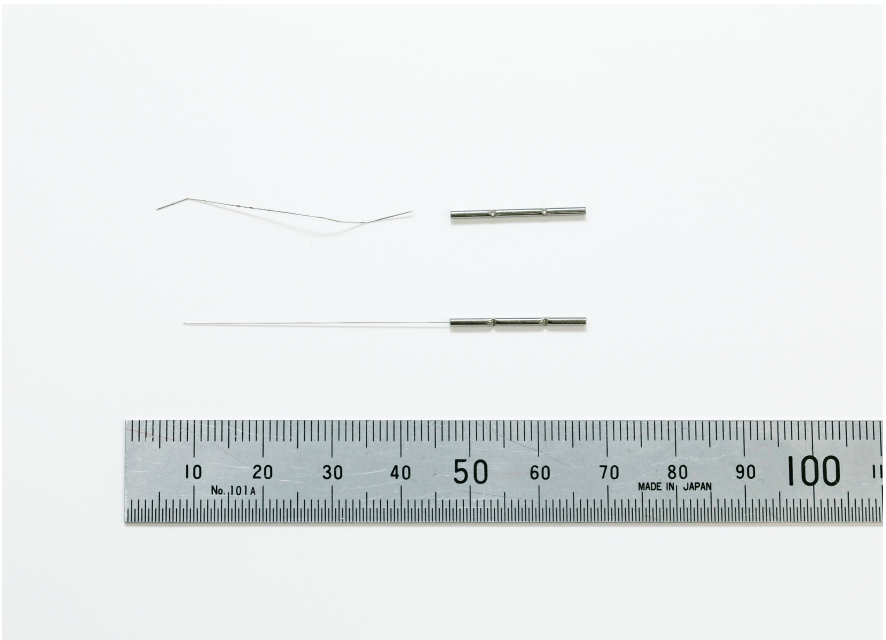

Fig. 4 Photograph of the acupuncture needle
Removed acupuncture needle in the current case (upper) and unused identical needle (lower).

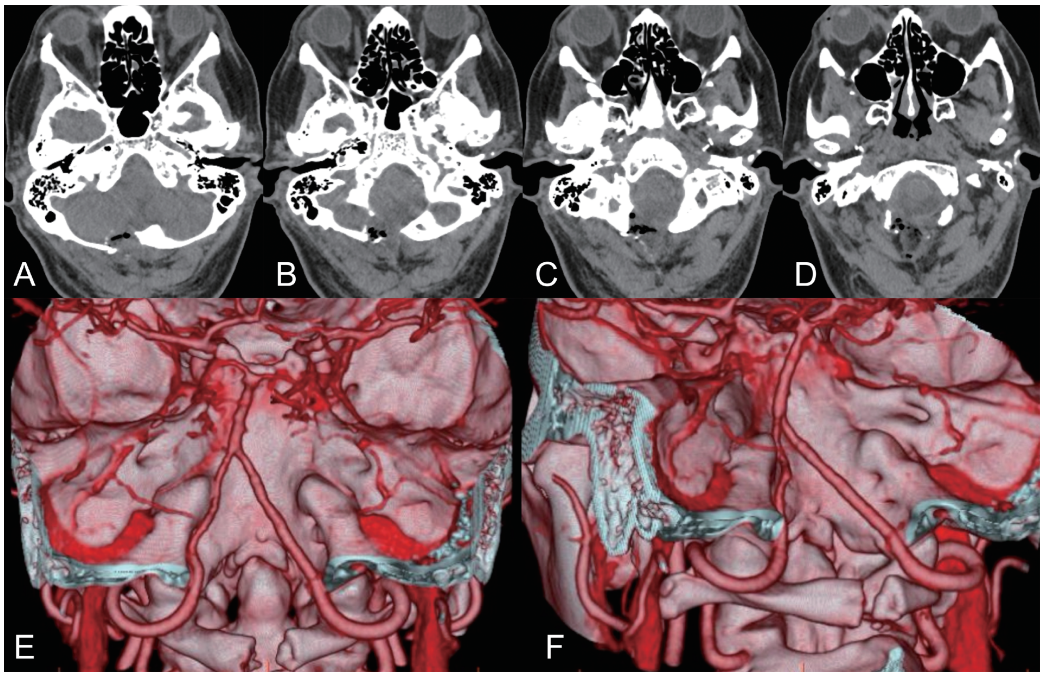

Fig. 5 Postoperative computed tomography (CT) and three-dimensional CT angiography (3D-CTA)
Fig. 5A–D: No evidence of residual needle fragment or intracranial hemorrhage was obtained on immediate postoperative CT.
Fig. 5E, 5F: No evidence of vertebral artery dissection or pseudoaneurysm formation was obtained on 3D-CTA (day 15).

Postoperative course

Immediate postoperative CT confirmed no evidence of residual needle fragment and intracranial hemorrhage (Fig. 5A–D). The patient did not develop postoperative neurological deficits. On day 15, CTA showed no evidence of VA dissection/pseudoaneurysm formation (Fig. 5E, F). On day 30, the patient required surgical repair for postoperative CSF leakage due to inadequate dural closure. Watertight dural closure was achieved using pericranium and fibrin glue. On day 52, magnetic resonance imaging revealed no evidence of metal artifacts, brainstem injury, hemorrhagic lesion, ischemic stroke, and CSF leakage. No evidence of VA dissection/pseudoaneurysm formation was obtained on magnetic resonance angiography. On day 69, the patient was discharged home without any sequelae. The patient is doing well 2 years after the surgery.

DISCUSSION

Acupuncture has been practiced in China for over 3,000 years and is currently gaining popularity worldwide as a complementary medicine for various health conditions, such as low back pain, neck pain, osteoarthritis/knee pain, and headache.[9] In most countries, acupuncture is performed by licensed acupuncturists or medically trained professionals (eg, medical doctors, physiotherapists, nurses, and midwives).[10] In Japan, this treatment is only provided by licensed acupuncturists.[11] Acupuncture for low back pain, frozen shoulder, neuralgia, rheumatoid arthritis, cervico-brachial syndrome, and/or neck sprain are covered by public health insurance when the

Table 1 Cases involving intracranial injury caused by radiologically confirmed acupuncture needle migration

	Abumi et al[4] (1996)	Hama et al[5] (2004)	Miyamoto et al[6] (2010)	Fukaya et al[7] (2011)	El-Wahsh et al[8] (2018)	Current case
Age (years)/sex	60/F	70/M	47/M	44/M	NA/M	55/F
Acupuncture point	Posterior neck	Posterior neck	Posterior neck	Posterior neck	Posterior neck	Posterior neck
Further needle migration	No	No	Yes	No	Yes	No
Access	Atlanto-occipital junction	Atlanto-axial junction	Atlanto-occipital junction	Atlanto-occipital junction	Atlanto-occipital junction	Atlanto-occipital junction
Needle location	Intradural	Intradural	Intradural	Intra- and extradural	Intra- and extradural	Intra- and extradural
Needle direction	Left posterolateral to right anterolateral	Left posterolateral to right anterolateral	Left posterolateral to right anterolateral	Midline	Midline	Right posterolateral to left anterolateral
Injury site	Medulla oblongata	Cervical spinal cord/ medulla oblongata	Cerebellar tonsil/ medulla oblongata	Medulla oblongata	Medulla oblongata	VA
Intracranial hemorrhage	None	None	Small subpial hemorrhage	Small subpial hemorrhage	None	None
Ischemic stroke	None	NA	None	None	None	None
Symptoms	Motor and sensory disturbances in the right upper extremity[a]	Left facial paresthesia[b]	Discomfort in the posterior neck	Pain in the left face/ lower extremity and dysesthesia in the left lower extremity	None	None
Removal surgery	Yes	No	Yes	Yes	Yes	Yes
Surgery-related complication	No	NA	No	No	No	CSF leakage[c]
Outcome	Recovered	Deteriorated	Recovered	Improved	Without neurological deficits	Without neurological deficits

CSF: cerebrospinal fluid
F: female
M: male
NA: not applicable or not available
VA: vertebral artery
[a]These symptoms developed 18 years after acupuncture treatment.
[b]The symptom appeared 1 year after the needle penetrated the cervical spinal cord and medulla oblongata.
[c]Surgical repair was required for postoperative CSF leakage.

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treatment is advised or approved by a medical doctor.[11]

Acupuncture is generally considered safe when performed by an experienced, well-trained practitioner using sterile needles. However, improperly performed acupuncture can cause serious adverse events.[1-8] To date, there is no law that allows self-acupuncture in Japan. Moreover, the reality is that acupuncture needles are easily obtained via the internet.[6]

Some studies have reported about acupuncture-related spinal complications, including spinal infection, subarachnoid hemorrhage, and spinal cord/nerve root injury.[12,13] However, intracranial complications caused by radiologically confirmed acupuncture needle migration are extremely rare.[4-8] Only six cases, including ours, have been reported in the literature (Table 1). Three patients presented with penetrating injury to the medulla oblongata,[4,7,8] one with injury in the cervical spinal cord and medulla oblongata,[5] one with penetrating injury in the cerebellar tonsil and medulla oblongata,[6] and one with penetrating injury in the VA.

Figure 6 shows the estimated needle entry point and needle trajectory in the present case. To the best of our knowledge, this is the first case report of penetrating VA injury caused by radiologically confirmed acupuncture needle migration.

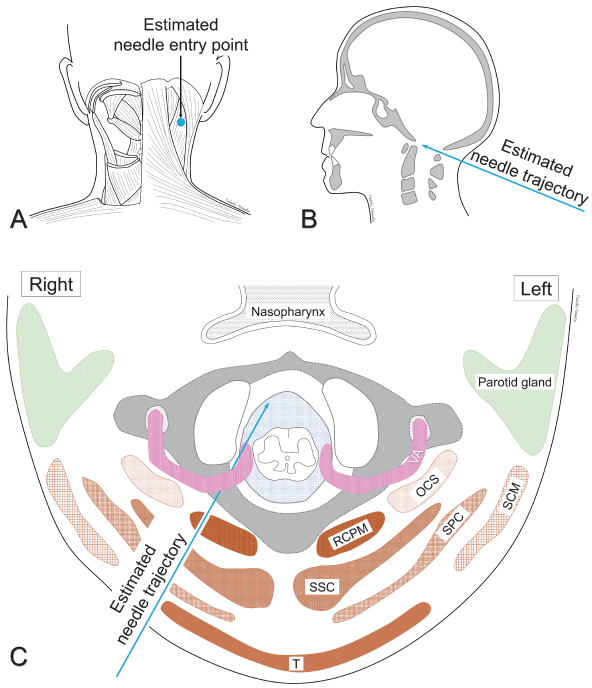

Fig. 6 Schematic diagrams indicating estimated needle entry point (A), and estimated needle trajectory (B, C) in the present case

Fig. 6A: The blue circle indicates the estimated needle entry point.

Fig. 6B: The blue arrow indicates the estimated needle trajectory.

Fig. 6C: Schematic diagram presenting axial plane at the level of the estimated needle trajectory. The acupuncture needle tip may have migrated into the intradural space after penetrating the splenius capitis (SPC), semispinalis capitis (SSC), and rectus capitis posterior major (RCPM) muscles.

OCS: oblique capitis superior muscle

SCM: sternocleidomastoid muscle

T: trapezius muscle

The posterior neck is the common site of acupuncture-related spinal complications.[6] Similarly, in all patients with intracranial complications, the acupuncture point is the posterior neck. This may be attributed to the following: First, headache and stiff neck, as in the current case, are the most typical complaints among patients seeking acupuncture.[6] Second, the nuchal acupuncture points are used as they are effective for headache and stiff neck.[6] Third, neck movements can lead to needle migration.[4,6] In cases of spinal complications, the acupuncture needle mainly migrated into the spinal canal via the atlanto-axial junction.[6] Meanwhile, in five of six cases involving intracranial complications, the needle migrated into the cranium via the atlanto-occipital junction (Table 1). This may be attributed to the fact that the atlanto-occipital junction is anatomically closer to the cranium than the atlanto-axial junction.

An intracranial migrated needle should ideally be removed urgently to prevent acute-onset complications (such as further needle migration that can cause brainstem injury, cranial nerve injury, and/or vessel injury) and delayed-onset complications (such as secondary gliosis, cavity formation, infection, and/or granuloma in the surrounding nerve tissue).[6] A review article showed that patients with central nervous system complications associated with acupuncture needle migration who underwent surgical removal had a significantly better outcome than those who did not.[6] Indeed, in two of six cases involving intracranial complications, further needle migration was radiologically observed, and two patients developed delayed-onset neurological deficits (Table 1). Five patients who underwent surgical removal had favorable outcomes. In contrast, one patient who was treated conservatively developed delayed progressive neurological deterioration (Table 1).

To safely remove intracranially migrated needles, operators should confirm the needle location and direction via preoperative radiological imaging. Magnetic resonance imaging as a preoperative diagnostic tool must be avoided because acupuncture needles are commonly made of stainless steel.[8] Thus, non-contrast CT and three-dimensional CTA are useful diagnostic modalities for patients with acupuncture-related intracranial complications. Surgical removal may be anatomically straightforward in patients with intracranial needle migration via the posteromedial dura at the foramen magnum level. However, in patients with intracranial needle migration via the posterolateral dura at the level of the foramen magnum, surgical removal can be technically challenging because there are intra- and extradural anatomical structures that can complicate surgery, including the VA, posterior inferior cerebellar artery, lower cranial nerves, and vertebral venous plexus. Meanwhile, in patients with intra- and extradural needle migration, the pull-out maneuver in the epidural space will be a simple and reliable method. El-Wahsh et al showed that the pull-out maneuver in the epidural space under direct visualization via durotomy was a useful option because it can facilitate immediate hemostasis during removal.[8] However, in the current case, intradural manipulation was required as the needle was not found in the epidural space. The needle tail might have migrated in the vertebral venous plexus. The pull-out maneuver in the intradural space could have failed due the following reasons: 1) the end of the needle tail was dull, and 2) the needle tail was not exposed. Moreover, operators should be aware that it is technically difficult to cut a stainless steel needle in a limited intradural surgical field. In the current case, the migrated needle could be removed from the intradural space with the pull-in maneuver, and several technical strategies can be used. First, operators should be aware about the length of the needles that migrated to the epidural space (ie, the length of the needle that must be pulled in). If the needle located in the epidural space is longer, the procedure can be more challenging. Second, operators must simulate the direction in which the needle is pulled in. In our case, the contralateral VA could be injured if the needle was pulled in along the long axis direction of the migrated needle. The VA union and/or ipsilateral VA could be injured if the needle was pulled in cranially. Therefore, the migrated needle was pulled in caudally toward a space without major arteries, resulting in its successful removal.

A retrospective review of patients with penetrating spinal injuries showed that the development of CSF leakage was more common in patients who underwent intradural exploration than in those managed conservatively.[14] Additionally, posterior fossa surgeries are more frequently associated with CSF leakage compared to supratentorial surgeries.[15] In our case, the patients experienced postoperative CSF leakage requiring surgical repair due to inadequate dural closure. The dura must be repaired with great caution during the surgical removal of the infratentorial intracranial migrated needle.

AUTHOR CONTRIBUTION

DA and YH served as co-first authors and contributed equally to this work.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

ETHICS APPROVAL

This study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

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