Case Report

Spinal subarachnoid hemorrhage after percutaneous kyphoplasty: a case report and literature review

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Background: Spinal intradural (subdural and subarachnoid) hematoma following percutaneous kyphoplasty is an extremely rare complication. In this report, we describe a case of subarachnoid hemorrhage with delayed paralysis after kyphoplasty and review the literature on similar cases to describe the complications of kyphoplasty and vertebroplasty (VP).

Case Description: An 80-year-old man underwent percutaneous kyphoplasty at a local hospital an osteoporotic vertebral fracture (OVF) at the T12 and L1 level. On the second day after kyphoplasty for T12 OVF, he developed paralysis of the lower limbs. At his initial visit to our clinic, he had a complete loss of sensation below T11 and complete paralysis of both lower extremities. Thoracolumbar magnetic resonance imaging revealed an intradural hematoma on the ventral side of the spinal cord, in the spinal canal from T5 to T12, compressing the spinal cord. Thoracolumbar computed tomography showed a fracture line in the medial cortex of the right pedicle at T12 and a tract from the spinal canal to the vertebral body. An emergency posterior decompression from T11 to L1 was performed. A small hole was found on the right side of the pedicle at T12, and tear of the nerve and subarachnoid hematoma were observed in the vicinity of the T11 nerve root. The subarachnoid hematomas were removed. Postoperatively, the neurological symptoms improved rapidly. Eventually, he was able to walk and was transferred for rehabilitation.

Conclusions: Percutaneous surgery through the pedicle might cause hematoma and bone cement leakage into the spinal canal. This can be a serious complication: hence prevention is important.

Keywords: Percutaneous kyphoplasty; spinal subarachnoid hemorrhage; osteoporotic vertebral fracture (OVF); rare complication; case report

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Introduction

Percutaneous balloon kyphoplasty (PBKP) is a standard procedure for the relief of pain caused by an osteoporotic vertebral compression fracture. Although PBKP is considered a minimally invasive treatment with a short duration of surgery, various complications and technical failures are known to occur (1). Among these, spinal intradural (subdural and subarachnoid) hematomas has extremely rarely been reported. Spinal intradural hematomas and bone cement leaks that can occur during PBKP are among the most serious iatrogenic complications. Symptoms might appear immediately after the procedure or several days later. These include severe neurologic symptoms that could be effectively managed with prompt surgery. Prevention is of utmost importance because complication can be very serious. There are very few reports of cases

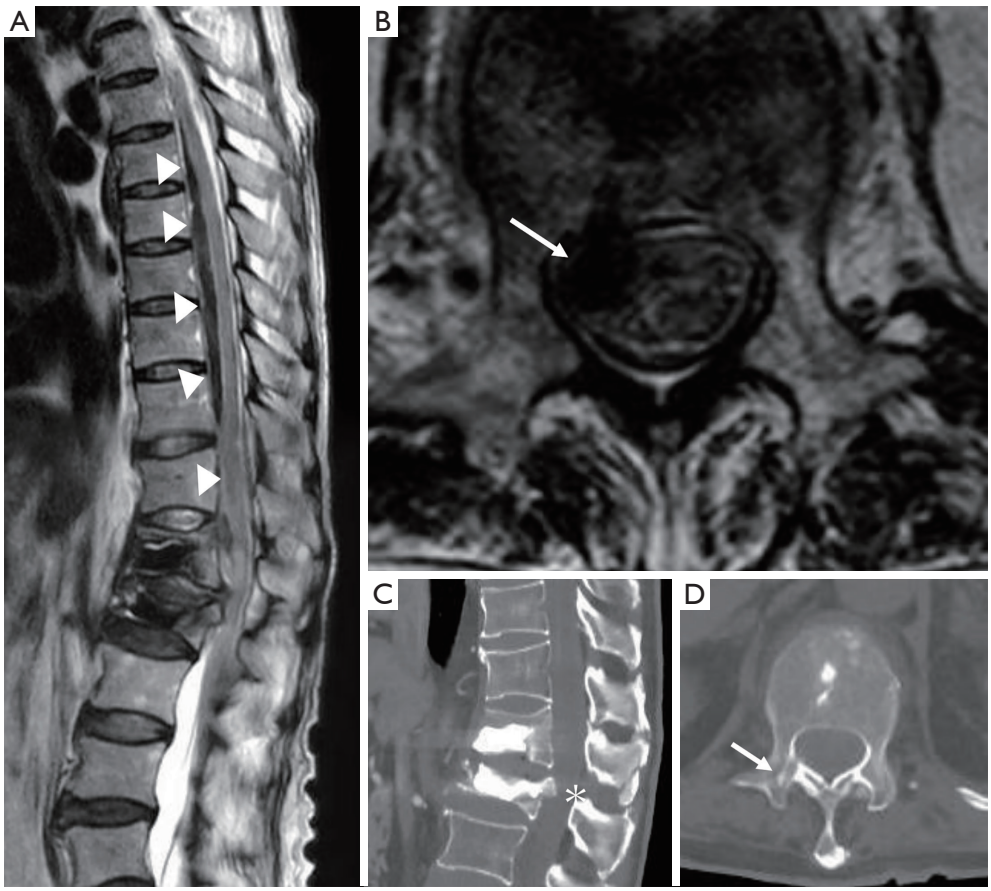

Figure 1 Preoperative imaging findings. (A) T2 weighted sagittal thoracic spine magnetic resonance imaging shows a hematoma on the ventral side of the spinal cord from T5 to T12 (arrow head). (B) At the T12/L1 level. The subdural hematoma is compressing the spinal cord (arrow). (C) Cement is filled in the correct position, and there is spinal canal stenosis at the T12/L1 level (asterisk). (D) Tract at the right pedicle at T12, which seems to have passed through the spinal canal (arrow).

similar to the present case in the literature (2). We report a case of subarachnoid hemorrhage, and based on previous studies, we identify points to be noted and discuss preventive measures. We present the following case in accordance with the CARE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-22-60/rc).

Case presentation

After a fall, an 80-year-old, slightly thin patient visited a hospital for low back pain and was diagnosed with a subacute compression fracture at L1. His medical history included chronic obstructive pulmonary disease, type 2 diabetes mellitus, hyperuricemia, and dyslipidemia, however he was not on antiplatelet or anticoagulant medications. The low back pain was resistant to medical treatment, and the patient underwent PBKP of L1. Subsequently, PBKP of T12 was performed as an additional treatment for prolonged back pain that did not improve with treatment at a local hospital. There were no complications during the first 2 days after the surgery. However, 2 days later, he developed paralysis of both lower limbs. The patient could not be treated at other hospitals and was referred to our hospital for emergency treatment.

Magnetic resonance imaging revealed a massive intradural hematoma ventral to the spinal cord from thoracic spine T5 to T12 (*Figure 1A*,*1B*). Computed tomography (CT) showed that the vertebral body was filled with cement after percutaneous kyphoplasty (*Figure 1C*). However, at the T12 level, a percutaneous kyphoplasty entry pathway was found from the right pedicle, which seemed to have been through the spinal canal (*Figure 1D*).

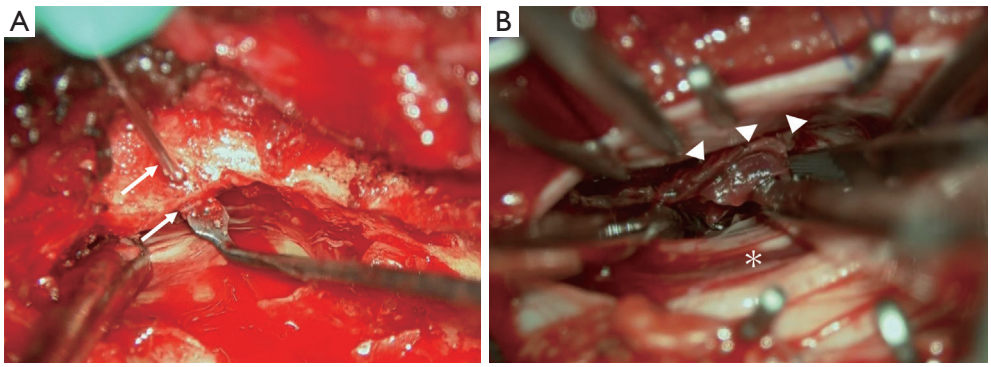

Figure 2 Intra-operative images. (A) Microscopic intraoperative image showing that the percutaneous kyphoplasty trajectory had penetrated into the spinal canal (arrow). (B) Hematoma around cauda equina was removed under microscope (arrow head: subarachnoid hematoma, asterisk: cauda equina).

Spinal canal stenosis was observed at the T12/L1 level; below L1, the spinal fluid signal was confirmed, and no hematoma was observed.

Physical examination on admission revealed complete paralysis of the lower body (MMT 0/5) with loss of temperature and pain sensation below T11. Due to the difficulty in inserting a urinary catheter, bladder function could not be assessed. The patient had a loss of sensation around the anal area and complete paralysis of the anal sphincter. The intraspinal pressure was thought to be significantly increased, and significant spinal cord compression was suspected.

The patient underwent surgery in the prone position under general anesthesia. A bilateral laminectomy was performed from T11 to L1. The lamina and yellow ligaments were incised, exposing the dura mater. There was no epidural hematoma, and a tight dura was noted. The right pedicle at T12 was observed, and a small foramen was clearly seen near the pedicle, probably through the spinal canal (*Figure 2A*). The dura was incised from T11 to T12. There was no subdural hematoma, but a tense arachnoid was visible, and a spinal subarachnoid hematoma was observed at this point. The arachnoid was incised, and the hematoma was removed from around the cauda equina with careful washing (*Figure 2B*). Once the hematoma was removed, the flow of the spinal fluid was observed from the cranial side, indicating that adequate decompression was achieved. The dura was closed using absorbable sutures.

Postoperative images indicated adequate decompression, and neurological signs showed considerable improvement. Motor function improved from complete paraplegia to MMT4/5 in the lower limbs. The patient's recovery was good, and he was able to ambulate with a walker. Finally, the patient was transferred to a rehabilitation hospital.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

PBKP has been frequently performed for osteoporotic vertebral fracture (OVF) in recent years and is widely recognized as a minimally invasive procedure. The incidence of OVF is the highest among osteoporosis-related fractures, and it has been proven that repeated OVF leads to decreased quality of life and increased mortality. The 5-year survival rate for patients clinically diagnosed with vertebral fractures is reported to be about 28%, which is higher than that for hip fractures (3). PBKP is a surgical procedure that usually has satisfactory results, including low risk of complications and decrease in pain, when performed carefully and for appropriate indications. Complications associated with vertebroplasty (VP) include cement leak, pulmonary embolism, infection, epidural hematoma (4), and vertebral fracture, which are not uncommon. There have been many reports of leakage of bone cement into and out of the dura mater (5-7), epidural hematoma, and intradural hematoma related to the conventional VP method (8-11). PBKP, a modified form of VP, has therapeutic advantages

Table 1 Previous reports of intradural hematoma following percutaneous vertebroplasty or kyphoplasty

Author	Age, gender	Type of hematoma	Fracture level	Cause of fracture	Initial treatment	SIH onset	Symptoms	SIH level	Additional treatment	Result
Cosar *et al.* (8)	18 yr, male	SDH	L2-L4	Traumatic	Vertebroplasty	12 hours	Paraparesis	T1-L2	Hemilaminectomy T1-L2	Good
Cosar *et al.* (8)	75 yr, female	SDH	L1	Osteoporotic	Vertebroplasty	12 hours	Paraparesis	T12-L3	Laminectomy T12	Good
Lee *et al.* (9)	40 yr, female	SDH	T11-T12	Traumatic	Vertebroplasty	2 weeks	Back pain	T10-L5	Conservative	Good
Mattei *et al.* (10)	49 yr, female	SDH	T8	Traumatic	Vertebroplasty	Immediate	Nomoparesis	C7-T9	Laminectomy T7-T9	Good
Tropeano *et al.* (11)	63 yr, male	SDH	L1-L3	Oncological	Vertebroplasty	2 weeks	Paraparesis	conus	Laminectomy L2-L3	Good
Becker *et al.* (12)	63 yr, male	SAH	T12	Osteoporotic	Kyphoplasty	2 days	Complete pareplegia	T8-L3	Laminectomy T8-L3	Good
Our case	80 yr, male	SAH	T12, L1	Osteoporotic	Kyphoplasty	2 days	Complete pareplegia	T5-T12	Laminectomy T11-L1	Good

SIH, spinal intradural hematoma; SDH, spinal subdural hematoma; SAH, spinal subarachnoid hematoma.

such as correction of local kyphosis and a low risk of cement leakage due to lower cementing pressure.

Since the introduction of PBKP, there have been reports of bone cement leaks (12,13), but no serious cases have been reported. There have been sporadic reports of epidural hematomas (7) and only one case of subarachnoid hematoma has been reported (2). We summarized previous reports of spinal intradural hematoma after percutaneous kyphoplasty or VP (*Table 1*). The low incidence of postoperative epidural and intradural hematoma suggests that PBKP is superior to VP in terms of safety. Previously medically-induced spinal subarachnoid hematoma due to lumbar puncture has been reported, and the mechanism is remarkably similar to that of the subarachnoid hemorrhage associated with PBKP in the present case. Puncture of the outermost layer of the dura during lumbar puncture has a risk of injury to the radial artery and vein, and might be a possible cause of iatrogenic spinal subarachnoid hematoma. In the present case, the source of the hematoma was identified as the radial artery or vein based on the presence of a hematoma mass and contusion of the nerve tissue near the T12 nerve root. Considering the imaging and intraoperative findings, we concluded that the cause of the subarachnoid hematoma was a medial deviation of the needle in the pedicle, a simple error associated with the procedure. When the bleeding is massive and rapid or normal dilution is mechanically impeded, it can lead to a frank hematoma (14).

The most difficult part of the PBKP procedure is the process from the puncture of the needle to the placement of the introducer. Although needle puncture in two directions with C-arm fluoroscopy is usually recommended, it can also be performed with single-plane fluoroscopy. Before initiating the procedure, it is important to clearly delineate the right and left pedicle with anteroposterior (A-P) fluoroscopy and align the spinous processes in the middle of the cortical lines inside the pedicle on both sides. The needle is inserted into the pedicle under A-P fluoroscopy, and the needle tip is placed into the vertebral body in the lateral view before passing through the medial cortex of the pedicle, thus preventing the needle from entering the spinal canal. Once the introducer is placed within the vertebral body, it is then essential to precisely check the position of the posterior wall of the vertebral body with the lateral C-arm to prevent the slowly injected cement from leaking into the spinal canal. We are confident that compliance with these important aspects will prevent complications such as bone cement leakage and hematoma in the spinal canal. In some cases, it is difficult to visualize the inside of the pedicle on fluoroscopy, such as in patients with morbidity obesity or patients who originally have atrophic pedicles at the level of the upper lumbar vertebrae.

The likelihood of intradural hematoma associated with PBKP is estimated to be comparable to the risk of percutaneous pedicle screw (PS) insertion. The reported

rates of misplacement of thoracic and lumbar PSs percutaneously placed under 2D fluoroscopy range from 8% to 40%, and a study among 502 cases, three had a medial deviation of the PS, and one of them required revision surgery (15). Although lateral deviation of the percutaneous PS is usually reported more frequently, Spitz *et al.* (16) reported an overall accuracy of 96.7% in their report of percutaneous PS without a guidewire. In one case of grade 3 deviation, the patient had osteoporosis, and the screw insertion site was confirmed to be inside the original hole formed by the pedicle probe, and medial deviation was also noted. If the cortex of the medial side of the pedicle is fractured due to advanced osteoporosis, the needle might stray into the spinal canal: hence it is advisable to consider modifying the technique by limiting it to the contralateral side. If the internal plane of the pedicle cannot be cleanly delineated on A-P fluoroscopy, penetration of the pedicle using CT-based navigation or other safeguards is necessary. Umebayashi *et al.* (17) reported that 3D fluoroscopic PBKP can safely increase the injection volume of polymethyl methacrylate (PMMa) compared to the usual C-arm 2D method. In PBKP, the use of safety tools such as CT-based or robot-assisted navigation should be pre-planned in cases with poor pedicle delineation on C-arm fluoroscopy.

In conclusion, early management of a patient with complete paralysis of the lower extremities due to a spinal subarachnoid hematoma associated with complications of PBKP resulted in a favorable neurological outcome. Percutaneous surgery through the pedicle might cause hematoma and bone cement leakage into the spinal canal. This can be a serious complication: hence prevention is important.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-22-60/rc

Peer Review File: Available at https://jss.amegroups.com/article/view/10.21037/jss-22-60/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-22-60/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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