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SHORT COMMUNICATION

Risk factors related to accidental intravascular injection during caudal anesthesia

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Abstract Recently, ultrasound-guided caudal anesthesia has been performed for postoperative pain management after lumbar spine surgery. Although it is well known that intravascular injection often occurs in the caudal part of the spine, and that this cannot be detected at the time of injection under ultrasound screening, the risk factors for intravascular injection have not been evaluated. To assess the risk index for prediction of accidental intravascular injection during caudal anesthesia, we retrospectively examined the hospital records of patients suffering from chronic low back pain who underwent sacral epidurography. Multivariate logistic regression analysis demonstrated that radicular symptoms of the lumbar spine (OR, 2.511, 95 % CI, 1.097–5.748) and duration of symptoms (OR, 1.006, 95 % CI, 1.002–1.010) were significant and independent risk factors for accidental intravascular injection during sacral epidurography. This study suggests that the incidence of accidental intravascular drug injection during caudal anesthesia would be higher in patients with chronic radicular symptoms of the lumbar spine.

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Caudal epidural block is often performed for perioperative anesthesia and for treatment of chronic low back pain. Recently, ultrasound-guided caudal epidural block has expanded the use of this technique [1, 2]. However, the disadvantage of ultrasound-guided caudal epidural block is that it cannot detect intravascular injection [3].

It is well known that continued inflammation that occurs in the process of back pain and radiculopathy in adults often leads to localized growth of new blood vessels [4, 5]. We hypothesized that it is possible that accidental intravascular injection frequently occurs during caudal block in patients with back pain and radiculopathy. The aim of this study was to assess the incidence and risk factors for accidental intravascular injection of contrast during sacral epidurography and to reveal the risk factors for intravascular injection during caudal block in adults.

This research was performed only in Kyoto Prefectural University of Medicine after approval of the Ethics Committee of this institution. Researchers at other institutes contributed to data analysis. Two hundred and eleven consecutive adult patients undergoing caudal epidurography who were admitted to our department with low back and limb pain from May 2005 to January 2012 were included in this retrospective cohort study. In patients receiving anticoagulant medication, anticoagulant therapy was discontinued 4–5 days before the scheduled procedure, and prothrombin time-international normalized ratio (PT-INR) was checked before caudal epidurography. Antiplatelet agents were, however, continued.

After patients were placed prone on a horizontal operating table, fluoroscopic guidance was used to introduce a 20-gauge Tuohy needle into the sacral hiatus for injection of 5 ml iohexol (Omnipaque), which is a nonionic X-ray contrast agent, with confirmation of absence of backflow of blood through the needle by digital subtraction angiography during the procedure. If accidental intravascular injection of contrast agent was confirmed, the needle was withdrawn and reintroduced. Vascular injection was identified by the visualization of a vascular pattern on live digital subtraction angiography fluoroscopy. All the caudal epidurographies were performed by board-certified practitioners belonging to the Japan Society of Pain Clinicians.

The study was conducted on all patients who underwent caudal epidurography, to assess the risk factors for unintentional intravascular injection of contrast. The variables related to accidental intravascular injection of contrast were assessed. Data were extracted from patients' medical records. We evaluated data such as age, gender, body mass index (BMI), visual analog scale (VAS) scores, duration of symptoms, a history of back pain, persistent pain, sudden pain, nerve root symptoms at the lumbar spinal level (radicular leg pain, hypoesthesia, or dysesthesia in L4–L5 dermatomes) and nerve root symptoms of the sacral spine (radicular leg pain, hypoesthesia or dysesthesia in S1–S5 dermatomes), presence of diabetes mellitus, history of administration of steroids, anticoagulants and antiplatelet agents, PT-INR, platelet count, and history of surgery on the lumbar spine.

Data were analyzed using SPSS for Windows version 11.0 (SPSS, Chicago, IL, USA). First, univariate analysis of risk factors was performed. $P < 0.05$ was considered statistically significant. Next, multiple logistic regression was performed of the variables identified by univariate analysis with a P value < 0.05. In multivariate analysis as well, $P < 0.05$ was considered significant. All values are reported as mean ± SD. Associations between independent variables and outcome variables found on multivariate analysis are reported in terms of odds ratios (OR) with 95 % confidence intervals (CI).

The demographic characteristics of the patients are shown in Table 1. Accidental intravascular injection during caudal epidurography occurred in 88 patients (41.7 %). The remaining 123 patients served as the control group.

Several variables related to caudal epidurography were assessed as risk factors for accidental intravascular injection using univariate analysis (Table 1). Of these, two factors were identified as being significant ($P < 0.05$). These factors included duration of symptoms, which were significantly higher in patients with (106.6 ± 146.4 days) than in patients without (52.4 ± 56.4 days) unintentional intravascular injection ($P = 0.001$), and the presence of nerve root symptoms of the lumbar spine, which were significantly more common in patients with [79/88 (89.8 %)] than in those without unintentional intravascular injection [93/123 (75.6 %), $P = 0.011$]. Then, multiple logistic regression analysis was performed on the variables identified in univariate analysis with a P value < 0.05 (Table 2). This analysis confirmed that the variables independently associated with accidental intravascular injection during caudal epidurography were duration of symptoms (OR, 1.006, 95 % CI, 1.002–1.010, $P = 0.005$) and presence of symptoms of nerve root disease of the lumbar spine (OR, 2.511, 95 % CI, 1.097–5.748, $P = 0.029$).

Table 1 Univariate analysis of risk factors for accidental intravascular injection during sacral epidurography

	Patients with accidental intravascular infusion ($n = 88$)	Patients without accidental intravascular infusion ($n = 123$)	P value
Age (years)[a]	68 ± 18	66 ± 14	NS
Male gender (%)	38 (43.2)	66 (53.7)	NS
BMI (kg/m^2)[a]	23.3 ± 3.5	23.7 ± 3.5	NS
VAS scores (mm)[a]	61.3 ± 20.0	63.3 ± 21.5	NS
Duration of symptoms (days)[a]	106.6 ± 146.4	52.4 ± 56.4	0.001
Presence of back pain (%)	53 (60.2)	62 (50.4)	NS
Presence of persistent pain (%)	84 (95.5)	118 (95.9)	NS
Presence of sudden pain (%)	34 (38.6)	48 (39.0)	NS
Presence of radicular symptoms of the lumbar spine (%)	79 (89.8)	93 (75.6)	0.011
Presence of radicular symptoms of the sacral spine (%)	65 (73.9)	77 (62.6)	NS
Presence of diabetes (%)	9 (10.2)	11 (8.9)	NS
Steroid administration (%)	2 (2.3)	6 (4.9)	NS
Anticoagulant administration (%)	1 (1.1)	5 (4.1)	NS
Antiplatelet agent administration (%)	8 (9.1)	14 (11.4)	NS
PT-INR[a]	0.98 ± 0.6	0.98 ± 0.8	NS
Platelet count (/μL × 10^4)[a]	21.2 ± 6.1	21.4 ± 5.0	NS
History of surgery of the lumbar spine (%)	28 (31.8)	34 (27.6)	NS

NS not significant, *BMI* body mass index, *VAS* visual analog scale, *PT-INR* prothrombin time-international normalized ratio

[a] Mean ± SD

Table 2 Multivariate analysis of risk factors for accidental intravascular infusion after sacral epidurography

Variables	OR	95 % CI	*P* value
Duration of symptoms	1.006	1.002–1.010	0.005
Presence of radicular symptoms of the lumbar spine	2.511	1.097–5.748	0.029

OR odds ratio, *CI* confidence interval

Lumbosacral epidural injection of local anesthetics is effective in the treatment of chronic low back pain [6]. It is generally a safe procedure, with an incidence rate for minor complications of 9.6–15.6 % following lumbar or caudal epidural injections [7, 8]. However, serious complications, such as cardiorespiratory arrest, spinal cord infarction, and paraplegia have also been reported with lumbosacral epidural injections [9]. The frequency of local anesthetic-induced systemic toxicity in caudal block is higher than that with lumbar epidural block [9]. Recently, ultrasound-guided caudal block has become common practice [1, 2]. The advantages of ultrasound-guided caudal block are that it is easy to use and is radiation free [10]. Conversely, the disadvantage of ultrasound-guided caudal block is that it cannot provide us with information regarding the depth of needle insertion. Hence, inadvertent intravascular placement of the needle cannot be visualized [3]. Moreover, it was considered to continue the inflammatory process of back pain and radiculopathy in adults and to lead to localized growth of new blood vessels [4, 5]. We hypothesized that accidental intravascular injection during caudal block frequently occurred in patients with back pain and radiculopathy. The aim of this study was to assess the incidence and risk factors for accidental intravascular injection of contrast during caudal epidurography and to reveal the risk factors of intravascular injection during caudal block in adults.

Our main finding was that both radicular symptoms of the lumbar spine and duration of symptoms are significant and independent risk factors for accidental intravascular injection during caudal epidurography. Radicular symptoms of the lumbar spine, such as those caused by lateral lumbar disc herniation or lumbar spondylosis, result from radiculopathy at the intervertebral foramen [11]. Prolonged radiculopathy and concurrent chemical inflammation of the nerve roots around the intervertebral foramen lead to localized neovascularization [5], which increases the risk of accidental intravascular injection of drugs during epidurography in patients with long-standing radiculopathy of the lumbar nerve roots. These facts provide a possible explanation for our findings that the variables positively associated with the risk of accidental intravascular injection during caudal epidurography are duration of symptoms and the presence of radicular symptoms of the lumbar spine. Recently, direct connections between the epidural space and the venous circulation, which are presumably located in the vicinity of the nerve root, have been suggested [12, 13]. Accidental intravascular injection of contrast media during caudal epidurography in this study might have occurred around the venous plexus near the nerve roots in the caudal epidural space. To reveal the mechanisms by which lumbar symptoms affect intravascular injection, further investigations are needed to examine the anatomical and pathological differences at the venous plexus between patients with and without lumbar and sacral root symptoms. In particular, our results suggest that in patients with radicular symptoms of the lumbar spine, ultrasound-guided caudal anesthesia should include injection of the local anesthetic combined with adrenaline, as this would be beneficial in blocking adrenergic pressure of the local anesthetic.

Although the incidence of accidental intravascular injection during epidural anesthesia is reportedly 21.3 % at the caudal level [14], the incidence in our study seemed to be higher (41.7 %) when sacral epidurography was performed. This higher incidence might be explained by the fact that digital subtraction angiography could clearly detect even microscopic intravascular injection compared with traditional fluoroscopy, because the digital subtraction angiography technique allows better visualization of intravascular contrast after identifying transforaminal epidural flow of the contrast [15].

There are several limitations to this study. First, the number of patients who underwent caudal epidurography and were enrolled in our study was small. Second, this study investigated only patient factors, without assessing the technical skill of the physician performing the procedure. Individual technical skill levels for caudal epidurography would also affect our study results.

The incidence of accidental intravascular drug injection during caudal epidurography in this patient cohort was closely associated with the presence of radicular symptoms of the lumbar spine and the duration of symptoms. This finding suggests that the incidence of accidental intravascular drug injection during ultrasound-guided caudal anesthesia increases in patients with chronic radicular symptoms of the lumbar spine.

Conflict of interest There is no potential conflict of interest to disclose.

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