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Percutaneous radiofrequency lumbar facet rhizotomy guided by computed tomography fluoroscopy

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Abstract
X-ray fluoroscopy-guided percutaneous radiofrequency facet rhizotomy is used to treat chronic low back pain. The traditional fluoroscopic approach to the medial branch of the posterior rami, however, is associated with a small incidence of complications. We describe a new method for radiofrequency lumbar facet rhizotomy in which computed tomography (CT) fluoroscopy is used to guide needle placement. Three patients with chronic intractable low back pain underwent CT fluoroscopy-guided percutaneous facet rhizotomy. After the safest and shortest route to the target site was determined on the CT image, the needle was advanced along the predetermined route under real-time CT fluoroscopy. When the needle tip was located at the target site, electrical stimulation was applied to verify proper electrode placement. After confirming the clinical effect and lack of complications under test block with a local anesthetic, denervation was performed using radiofrequency current. Pain scores of all patients were reduced after the procedure without any complications such as paralysis or neuritic pain. None of the patients complained of severe discomfort during the procedure. CT fluoroscopy-guided percutaneous lumbar facet rhizotomy appears to be safe, fast, and effective for patients with lumbar facet pain.

Key words Computed tomography · Fluoroscopy · Radiofrequency facet rhizotomy

Introduction

Percutaneous radiofrequency rhizotomy of the medial branch of the posterior rami is used to treat chronic low back pain [1–3]. X-ray fluoroscopy-guided percutaneous rhizotomy has been used for spinal pain management for many years. Kornick et al. [2], however, reported that fluoroscopically-guided percutaneous radiofrequency denervation of lumbar facets is associated with an overall 1.0% incidence of complications, such as localized pain and neuritic pain lasting for a few weeks.

Recently, minimally invasive, real-time imaging-guided percutaneous techniques under computed tomography (CT) fluoroscopy were added to the list of treatment options available for neurectomy [4,5]. Imaging-guided techniques with CT fluoroscopy increase the efficacy and safety of several nerve block operations. In this case report, we describe a new method for radiofrequency lumbar facet rhizotomy in which CT fluoroscopy is used to guide needle placement.

Methods

CT fluoroscopy-guided percutaneous facet rhizotomy was performed with the patient lying on a CT table in a prone or lateral position. A marking device made of X-ray opaque wires was attached to the patient's lower back. A scout view of the lumbar spine was used to determine the optimal level for rhizotomy. CT scans (Hispeed Advantage SG; GE Medical Systems, Milwaukee, WI, USA) were obtained at the optimal level of the spine and the safest and shortest route to the target site was determined on the CT image (Fig. 1). The junctions of the superomedial aspect of the transverse processes with the superior articulating processes were used to identify the medial branches of the T12-L4 dorsal rami. The insertion point was marked by referring to the marking device. Following sterilization and subcutaneous anesthesia with 0.5% lidocaine, a 22-gauge 97-mm insulated needle (Hakko, Tokyo, Japan) was inserted at the marked point. The insertion angle of the needle was adjusted using a red guiding laser in the CT gantry conforming to the scanning slice. The needle was advanced following the predetermined route under real-time CT fluoroscopy. When the needle tip was

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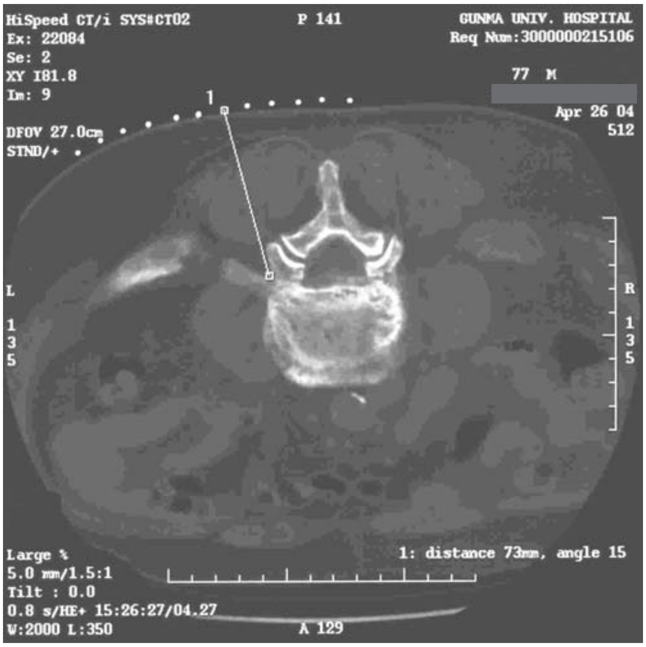

Fig. 1. The safest and shortest route to the target site was determined on the CT image

Fig. 2. The needle tip was located at the medial branch target site of the dorsal rami

located at the target site (Fig. 2), low-voltage sensory stimulation was applied (up to 1 V at 50 Hz; RFG-3CF, Radionics, Burlington, MA, USA) to ensure that the electrical stimulation reproduced pain in the diseased area. Motor stimulation (up to 1 V at 2 Hz) was then applied to verify proper electrode placement and to exclude placement near the ventral ramus. Contractions of the multifidus muscle were observed with electrical stimulation of between 0.3 and 0.5 V when the electrode was properly placed. Thereafter, the effect of nerve block was simulated by a test dose injection (2% mepivacaine, 0.2 ml). After confirming loss of sensation in the diseased area and lack of side effects, denervation was performed by applying radiofrequency current to each target site using the RFG-3CF lesion generator. The condition for electrocoagulation was 90°C for 120 s.

Case report

Three patients with chronic intractable low back pain underwent CT fluoroscopy-guided percutaneous facet rhizotomy using the technique described above (Table 1). All patients had local paraspinal tenderness and pain on hyperextension and no findings of obvious neurologic defect. Because their pain symptoms had not improved satisfactorily using standard pain clinic therapy such as trigger point injection and epidural block, percutaneous facet rhizotomy was planned and performed. Cases 2 and 3 underwent the procedure twice, each with an interval of several months. Pain scores for all patients were reduced at 24 h after the procedure with no complications such as paralysis or neuritic pain the next day. None of the patients complained of severe discomfort during the procedure. The CT fluoroscopy used in our cases radiated 0.176 mGy·s^{-1} (at 10 mA and 120 kV per 3-mm slice).

Discussion

Percutaneous radiofrequency lumbar facet denervation was introduced as a treatment for chronic low back pain by Shealy in 1974 [1,3]. Kornick et al. [2], however, reported that X-ray fluoroscopy-guided percutaneous radiofrequency denervation of lumbar facets is associated with an overall 1.0% incidence of complications. The complications discussed in their report included neuritic lower limb pain, which might be the result of injury to an L3 or L4 ventral ramus. The ventral rami lie anterior to the target point for radiofrequency neurotomy, and are at risk for radiofrequency-mediated thermal injury if the electrode slips ventrally over the transverse process. In our technique, by monitoring the location of the needle tip in a real-time manner, the surgeon can easily avoid injuring the ventral ramus of the spinal nerve. Also, by applying a weak electrical current, proper needle placement adjacent to the

Table 1. Demographic and characteristic data of the patients

Case	Age (year)/ sex	Diagnosis	Sites of block	VAS (cm) pre	VAS (cm) post	Duration of fluoroscopy (s)
1	73/F	Deforming lumbar spondylosis	r-L2, 1-L2, 4	8	3	91
2	77/M	Lumbar spinal canal stenosis	(1) l-L4	8	3	32
			(2) l-L4, 5	6	3	48
3	48/M	Lumbar spondylosis	(1) l-L4, 5	9	5	75
			(2) l-L2, 3	8	5	78

r, right; l, left; 1, first block for the patient; 2, second block for the patient; VAS, visual analogue scale of pain intensity; pre, pretreatment; post, posttreatment (24h after the treatment)

medial branch of the dorsal rami is confirmed prior to electrocoagulation. Some physicians might consider the 1.0% incidence of complications, which include temporary paresthesia, to be negligible. However efforts to minimize complications should be continued in medical practice. Although, we could not compare the risks and benefits of the CT-guided technique and the classical X-ray fluoroscopy-guided technique in this report, further study will clarify which is most beneficial for patients.

The amount of radiation energy exposure may be a concern in CT guiding procedures; however, Gusmao et al. [5] reported that the amount of radiation energy exposure to patients and staff is smaller in the CT-guiding technique than in the conventional X-ray fluoroscopy-guiding technique in percutaneous trigeminal nerve radiofreqency rhizotomy. This is because CT guiding allow physicians to execute quick and accurate needle advancement. Teeuwisse et al. reported that the amount of radiation in CT fluoroscopy was acceptable [6]. The CT equipment used in our case radiated $0.176\,mGy{\cdot}s^{-1}$ (at 10mA and 120kV per 3-mm slice). The radiation energy was set such that the extent of the facet joint, transverse process, and muscle structures were visualized clearly. Fluoroscopy duration per person was approximately 1min in all cases. This duration was shorter than the exposure duration in normal CT scanning for abdominal examination. By reducing insertion time, exposure to radiation energy can be reduced further. Although previous CT images had lower resolution quality because of relatively long scanning times, modern high-speed CT equipment gives high-resolution images instantaneously.

We performed this procedure in the CT room in the Department of Radiology. By using a pre installed CT device, new investment was not required to start this technique. Prior to needle puncture, the skin of the patients was disinfected carefully and covered by a large sterilized cloth. Also, operators paid special attention to complete the procedure without touching the unsterilized parts. Although the space available within the CT gantry is not great, by using a short needle (97mm), operators could manipulate the needle without problem. No infections were reported in our cases. Recently, demand for CT-guided intervention has increased, and many institutions are planning to install a CT device in their operating theater. In the near future, CT-guided operative techniques including nerve blocks will be more common.

In addition to the safety benefits of this procedure, our technique produces minimal discomfort, especially in patients with chronic pain syndrome. Our technique with CT fluoroscopy allows physicians to advance the needle quickly and accurately. Further experience with CT fluoroscopy-guided neural blocks might establish the superiority of CT to X-ray fluoroscopy in many pain-clinic procedures that are currently routinely performed under X-ray fluoroscopy. In conclusion, CT fluoroscopy-guided percutaneous lumbar facet rhizotomy appears to be safe, fast, and effective for patients with lumbar facet pain.

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