Selective Cervical Nerve Root Blockade: Experience with a Safe and Reliable Technique Using an Anterolateral Approach for Needle Placement

BACKGROUND AND PURPOSE: Our aim was to evaluate the safety and clinical utility of a fluoroscopically guided anterolateral oblique approach technique for outpatient diagnostic and therapeutic selective cervical nerve root blockade (SCNRB).

MATERIALS AND METHODS: During a 13-year period (1994 through February 2007), 4612 patients underwent fluoroscopically guided diagnostic and/or therapeutic extraforaminal SCNRB by using an anterior oblique approach at affiliated outpatient imaging centers. Each procedure was performed by 1 of 6 procedural radiologists, all highly experienced in and actively performing spinal injections on a full-time basis in clinical practice. All of the proceduralists were thoroughly experienced with lumbar injections before endeavoring to perform SCNRBs. Nonionic contrast was injected in nearly all patients (except isolated patients with contrast allergy), and a minimum of 2 projection filming procedures were performed to document the accuracy of needle placement and contrast dispersion before the injection of therapeutic substances. All clinically significant complications beyond skin discoloration and temporary exacerbation of symptoms were recorded.

RESULTS: There were no serious neurologic complications, such as stroke, spinal cord insult, or permanent nerve root deficit. One life-threatening anaphylactic reaction occurred and was attributed to the injected materials and not the specific procedure itself. Another patient had a 3- to 4-minute grand mal seizure, from which he fully recovered within 30 minutes. There were no infections.

CONCLUSION: The technique we describe for fluoroscopically guided SCNRB is a useful and safe outpatient procedure when performed by skilled and experienced proceduralists.

Materials and Methods

In the years 1994 through February 2007, 4612 patients (aged 17–83 years) underwent outpatient percutaneous SCNRB at 1 of 8 outpatient imaging centers in the Minneapolis-St Paul metropolitan area (Center for Diagnostic Imaging, St Louis Park, Minn). Each procedure was performed by 1 of 6 highly experienced procedural radiologists, engaged in the full-time practice of spine injection.

Procedures were performed to either investigate and diagnose the origins of cervical radiculopathy or therapeutically intervene in such pain or both. All patients were referred for injection by clinicians having no financial relationship whatsoever with either the imaging/diagnostic centers or the radiologists performing the procedure. Specialties referring patients for SCNRB included orthopedic spine surgery (most frequently), neurosurgery, neurology, physiatry, anesthesia-pain management, internal medicine, and family practice. The C6 and C7 roots were the most frequently studied levels. C5, C4, and C8 were blocked with considerably lower frequency.

Procedures were performed in a dedicated special-procedures suite equipped with a highly specialized table with multidirectional tabletop movement capability, including head-up and head-down tilt, elevation change, side movement, side roll, and high-resolution multidirectional C-arm fluoroscopy with magnification and filming capability. After giving informed consent, the patient was placed supine on the table with the neck extended and chin deviated approximately 30° away from the side where the injection was to be performed (Fig 1). To prevent the patient from moving suddenly, we then placed 1¼-inch paper adhesive tape across the forehead and secured it to the tabletop on both sides. Initially, fluoroscopy was used to determine the optimal fluoroscopic axis for the needle approach and to mark the skin at the site for needle placement, by using the butt
end of a ballpoint pen to place a circular dent in the skin. The target for final needle-tip placement was the lower lateral inferior aspect of the nerve root canal peripheral to the neural foramen at the desired cervical spinal segment. Thereafter, the skin was thoroughly sterilized with iodine solution, which was allowed to dry for approximately 2 minutes, after which it was rinsed with alcohol and a fenestrated plastic adhesive sterile drape was applied.

A 25-gauge spinal needle (with a sharp point) was then carefully advanced through the skin (no local anesthesia), using a slight caudal-to-cephalad approach in most cases, depending upon body habitus, along the axis of fluoroscopy but without live fluoroscopy (which has only rarely been used) toward the target anatomy. Intermittent fluoroscopy, by using the low-dose mode for 0.25–1.0 seconds on average, was then used to check the needle position and alignment until the target anatomy was reached. The needle was then advanced until either the cervical spine was contacted or radicular pain was provoked (Fig 2A, -B). If radicular pain was provoked during needle placement, the needle was carefully withdrawn a few millimeters, redirected by using bevel rotation, and advanced until the bony spine was contacted. Thereafter, a test injection of 1–2 mL of full-strength contrast (Iohexol [Omnipaque], GE Healthcare, Princeton, NJ) (240 mg/mL) was performed (after connecting the contrast syringe with a 24-inch connecting tubing to the needle) during live fluoroscopic observation to assess needle position relative to the desired target anatomy (Fig 2C, -D). In each case, the needle tip was placed against bone, deep to the nerve, in the posteroinferior lateral aspect of the neural foramen to ensure depth control and stable positioning of the needle. If the needle position was judged satisfactory, proximal and distal nerve root opacification was observed (Figs 2C, -D, 3–5).

Anteroposterior (AP) and oblique films were then obtained by using most often the 6-inch intensifier mode, and therapeutic injection was made taking extreme care to not move the needle during the exchange of the contrast-filled connecting tubing and the syringe containing therapeutic substances. If less than optimal nerve root filling and/or vascular opacification was observed (Fig 6), fine-needle manipulations were performed to reposition the needle tip, followed by repeat contrast injections until optimal needle position and nerve root opacification (without vascular filling) was obtained. Fluoroscopic spot films in the AP and oblique projection were then obtained in every case to document contrast dispersal. After satisfactory/optional needle positioning, contrast injection, and filming, patients were questioned about their experience (if this was a familiar sensation in location and character) during injection. After filming and brief questioning of the patient, we injected a therapeutic mixture of lidocaine, 2%, mixed with either betamethasone acetate suspension (Celestone Soluspan; Schering, Kenilworth, NJ) or generic/formulated sodium...
phosphate (40 mg/mL) or methylprednisolone sodium phosphate or acetate (Depo-Medrol; Pharmacia, Kalamazoo, Mich) in a 1:1–3:1 mixture in a total volume of 1.0–1.6 mL. Care was taken to inject no more than 1.6 mL and ideally tailor the volume and mix of therapeutic injectant on the basis of the prior contrast dispersal pattern, the amount of contrast injected, and the purpose of the procedure that was being performed, primarily diagnostic versus therapeutic. After injection of therapeutic substances, the needle was removed and light pressure was applied to the injection site for approximately 30–60 seconds.

Patients were then removed from the fluoroscopy suite and taken to a waiting room where they could be continuously observed and monitored for therapeutic response during the next 20–45 minutes. Patients were asked to rate their response to injection 20–30 minutes postprocedure and describe a percentage estimate regarding the degree of pain relief obtained (0%–100%). After obtaining their response to injection, we checked their status, after which they were discharged, provided that there were no complications or negative side effects requiring further observation. All patients were required to either bring an alternative driver with them or be transported. In the most recent 3 years, since we have had a certified ambulatory surgical center (ASC) available to us within 1 of our centers, approximately 5% of SCNRBs have been performed with light conscious sedation, most often in patients demanding sedation because of a negative prior experience elsewhere. Other procedures electively performed in the ASC included patients considered to be at higher than usual risk due to various medical circumstances. Each patient was carefully observed and questioned about any problems before discharge. Patients were instructed to call us first during the next week in the event of any questions, swelling, local redness, increased pain, fever, or problem that they experienced that might relate to the procedure.

Results
There were no permanent nerve root, spinal cord, brain stem, or cerebellar/cerebral infarcts/insults in the series. There were also no infectious complications. A 45-year-old male patient had a grand mal seizure lasting 3–4 minutes within 10 seconds of therapeutic injection of 1.5 mL of a mixture of 2 parts lidocaine 2% and 1 part generic formulated betamethasone along a C6 nerve root. He recovered completely within 30 minutes without requiring any additional medications beyond nasal oxygen and IV saline. One female patient had a life-threatening generalized anaphylactic reaction (from which she recovered fully) to injected materials (generic betamethasone acetate) minutes after completion of the SCNRB. We are still uncertain whether her reaction was to the contrast or the formulated steroid solution, which we completely stopped using after that event. Approximately 5% of patients (usually those who did not respond to the injection with pain relief) described exacerbation of clinical pain for up to 10 days postprocedure, though all of these patients’ pain ultimately returned to preprocedure levels. Minor and temporary skin discoloration up to 3 cm around the site of injection was encountered in a small number of patients (no exact count). In each patient, this resolved within 14 days.

Discussion
The technique we describe evolved from considerable experimentation regarding how to perform SCNRB safely and reproducibly as requests for this procedure grew. There was a paucity of technique literature (especially radiologic) in 1993 when referrals for SCNRB began to increase. The anterolateral approach using a sharp pointed 25-gauge needle, which we described and was introduced by author S.R.P. in early 1993, was thereafter used by the first 2 investigators (S.R.P, K.P.S.) for several procedures each, and was agreed upon as the safest and most reliable technique, and has been used by all members of our local practice since. We have made only a few minor refinements in this technique since the original implementation, and this has become one of the more frequently per-
formed studies in our practice (Fig 7). Minor individual technical variations are exercised by each proceduralist to address special and unique circumstances encountered.

High-resolution C-arm fluoroscopy best facilitates SCNRB, though CT and/or CT fluoroscopy have been described and advocated by others. A series of 1036 cases (without any serious complications) of fluoroscopically guided SCNRB using a lateral approach support our opinions regarding fluoroscopy and the safety of this procedure. Careful positioning of the patient and determination of fluoroscopic axis before sterile preparation and needle introduction circumvent the need for live fluoroscopy of the proceduralist’s hands during needle manipulation and placement (Figs 1 and 2A, -B). We carefully advance the needle incrementally with 0.5- to 1-second fluoroscopy checks (hands removed from the field) until we either encounter the bony spine or the patient feels pain, after which a small amount of contrast is injected during magnified fluoroscopic observation (Fig 2). If we have accomplished optimal nerve sheath opacification (Figs 2C, -D, 3–6), after injecting up to a maximum of 1.5 mL of contrast at that site, we obtain images in AP and oblique projections. Thereafter, therapeutic injection is made through the needle after disconnecting the contrast syringe and connecting tubing. Often, additional needle manipulations are required after initial introduction until the desired nerve root is opacified and there is no observed vascular opacification. We do not inject steroid and anesthetic until we achieve optimal nerve root opacification and have ruled out any significant (especially arterial) filling with contrast. This can be challenging in cases of foraminal and/or central spinal canal (especially multilevel) stenosis, in which venous collaterals are often encountered. We have found that needle placement into the lower lateral aspect of the desired neural canal most often leads to a successful study. A typical procedure takes approximately 15 minutes from initial physician-patient contact in the procedural suite and less than 5 minutes from initial needle introduction to procedure completion. Fluoroscopy time rarely exceeds 1 minute for the entire procedure.

The applications of SCNRB as both a diagnostic and/or therapeutic procedure have increased substantially in recent years, as has literature pertinent to this subject. In our own practice, referrals for SCNRB have grown rather dramatically from 13 cases in 1994 (Fig 7). Diagnostic blockade is most often performed to evaluate whether clinical radicular pain is related to neural impingement observed on imaging studies and to identify which nerve or nerve roots may be involved in clinical pain generation. When diagnostic blockade is successful and thereafter provides substantial and lasting pain relief, the procedure may be repeated at a later date and may become a purely therapeutic endeavor. Different injection techniques and mixtures of anesthetic and steroid exist; however, all diagnostic injections include local anesthetic, and all therapeutic interventions involve the use of the anti-inflammatory steroids. In our practice, an initial diagnostic SCNRB would use 1.0–1.6 mL of a mixture of 1 part steroid and 2- to 3-parts lidocaine, whereas a repeat (therapeutic intent) injection for the purpose of pain management might use 1.3–1.6 mL of a mixture of 1 part steroid to 1–2 parts lidocaine.

The technique we describe emphasizes the use of high-resolution fluoroscopy, undiluted nonionic contrast media, and an anterolateral approach for needle placement. We do not perform needle placement and manipulation under live fluoroscopy; however, magnification fluoroscopy, live observation, and filming are always performed during contrast injection. Digital subtraction angiography is not routinely performed in our practice; however, it is available whenever we have a question about possible arterial opacification. We consider the use of undiluted contrast and live fluoroscopic observation during contrast injection to be crucial. We decline most (but not all) referred cases of SCNRB where there is a history of contrast allergy, especially patients with long-standing diabetes mellitus, generalized poor health and frailty, and advanced age with multilevel advanced degenerative spondylosis. Live observation of the contrast injection under magnified high-resolution fluoroscopy is the only way to confidently rule out arterial opacification.

All of the serious neurologic complications of SCNRB described occurred either during or immediately following the
procedure,\textsuperscript{13–26} and there exist differing theories regarding the pathogenesis of such events. Obviously, direct injection of steroid and/or anesthetic into the spinal cord, a cervical nerve root, or the vertebral or a spinal radicular artery has the potential for permanent and devastating insult. We are uncertain about the seizure etiology in our patient, who fortunately recovered completely. An unintended intra-arterial injection of steroid and anesthetic must be considered; however, we experienced a similar complication in a patient after lumbar injection with the same generic betamethasone mixture. We terminated the use of this mixture after having a number of serious complications and have had no seizures or anaphylactic reactions in more than 20,000 spinal injection procedures since discontinuing the use of that mixture. Such complications can be avoided by a highly skilled and experienced proceduralist using an optimal technique before therapeutic injection (provided that the medicinal substances are safe).\textsuperscript{9} The separation of anesthetic (first) and steroid solution (second) injections is advocated as a safety measure to decrease/eliminate the risk of stroke.\textsuperscript{21–23,27} We have always injected a single mixed solution of anesthetic (first) and steroid solution (second) injections is performed under CT control. AJNR Am J Neuroradiol 1998;19:349–52 2. Murtagh R. The art and science of nerve root and facet blocks. Neuroimaging Clin N Am 2000;10:465–77 3. Sipman CW, Lipetz JS, Jackson HB, et al. Therapeutic selective nerve root block in the nonsurgical treatment of atrophic cervical spondylotic radicular pain: a retrospective analysis with independent clinical review. Arch Phys Med Rehabil 2000;81:741–46 4. Wagner AL, Murtagh FR. Selective nerve root blocks. Tech Vasc Interv Radiol 2002;5:194–206 5. Stekel K, Pfirrmann CW, Schmid M, et al. Cervical nerve root blocks: indications and role of MR imaging. Radiology 2004;233:87–92 6. Anderberg L, Annertz M, Brandt I, et al. Selective diagnostic cervical nerve root block–correlation with clinical symptoms and MRI-pathology. Acta Neurochir (Wien) 2004;146:559–63; Epub 2004 Apr 26 7. Wagner AL. CT fluoroscopic-guided cervical nerve root blocks. AJNR Am J Neuroradiol 2005;26:43–44 8. Sasso RC, Macadeq K, Nordmann D, et al. Selective nerve root injection can predict surgical outcome for lumbar and cervical radiculopathy: comparison to magnetic resonance imaging. J Spinal Disord Tech 2005;18:471–78 9. Ma D, Gilula LA, Riew KD. Percutaneous foraminal steroid injection: a possible mechanism for spinal cord injury. AJNR Am J Neuroradiol 2002;23:871–77 10. Larkin TM, Carragee E, Cohen S. A novel technique for delivery of epidural steroids at diagnosing the level of nerve root pathology. J Spinal Disord Tech 2005;18:471–78 11. Friedman R. Safer injection of cervical nerve roots. J Spinal Disord Tech 2003;16:539 12. D’Amato M, Aprill C. Letter to the editor. J Spinal Disord Tech 2003;18:206 13. Bosowers PJ, Kotinkin EJ, Simon MA, et al. A cervical anterior spinal artery syndrome after diagnostic blockade of the right C6-cervical nerve root. Pain 2001;91:397–99 14. Houten JK, Errico TJ. Paraplegia after lumbar neuralgia nerve root block: report of 3 cases. Spine J 2002;2:70–75 15. Baker R, Dreyfus P, Mercer S, et al. Cervical transforminal injection of corticosteroids into a radicular artery: a possible mechanism for spinal cord injury. Pain 2002;103:211–15 16. McMillan MR, Crompton C. Cortical blindness and neurologic injury com-

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Conclusion

The technique we describe has stood the tests of numbers and time. In skilled and experienced hands, SCNRB is a safe and valuable procedure for both diagnosis and treatment of cervical radicular pain.
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