Procedural sedation in children and adolescents is becoming increasingly employed to facilitate successful diagnostic imaging studies. Keeping the patient adequately sedated yet easily arousable can be of utmost importance during image-guided diskography. Dexmedetomidine provides an adequate level of sedation for diagnostic imaging studies. This sedation is unique in that the patients are sedated and sleepy but are easily aroused when stimulated and are able to follow commands appropriately. In addition, it preserves respiratory function even when administered in higher-than-recommended doses for sedation. This case series describes our clinical experience in using dexmedetomidine as the sole sedative agent to facilitate diskography in 4 adolescent patients, ranging in age from 15 to 18 years, who presented with chief complaints of back pain and degenerative diskitis. The clinical endpoints of sedation and analgesia were cooperative and still patients during needle placement in the intervertebral disks.

**Keywords:** Dexmedetomidine, diskography, monitored anesthesia care.

**Use of Dexmedetomidine for Monitored Anesthesia Care for Diskography in Adolescents**

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Diskography is a diagnostic modality used to determine whether the intervertebral disk is the cause of pain. It allows clinicians to determine whether diskogenic pain is the source of the patient’s back pain and to identify the spinal levels related to the pain. Computed tomography (CT) scans following the diskography procedure also allows for the morphologic evaluation of the disk to complement the magnetic resonance imaging (MRI) findings. Adolescents undergoing diskography require deep sedation to prevent motion during the procedure. There is a lack of literature on recommendations regarding the choice of anesthetic management technique for this procedure.

Because of its sedative and anxiolytic properties, dexmedetomidine has been shown to be a useful agent for pediatric procedural sedation. Pharmacologic mechanisms of the sedative or sleep-inducing actions of dexmedetomidine are different from most other common sedatives and anesthetics. Sedation with dexmedetomidine has properties that parallel natural non–rapid eye movement sleep without substantial respiratory depression. In addition, patients clinically sedated with dexmedetomidine are easily arousable, an effect not observed with other available sedatives. It thus appeared to us that dexmedetomidine possessed many of the characteristics of an ideal sedative for diskography in adolescents.

The effects of dexmedetomidine, including sedation, analgesia, and anxiolysis, are due to stimulation of postsynaptic \( \alpha_2 \)-adrenoreceptors. Stimulation of \( \alpha_2 \)-adrenoreceptors inhibits adenylate cyclase activity, reducing norepinephrine output at various sites in the central nervous system, in particular, the locus ceruleus. The locus ceruleus, along with many other sites in the brain, is known to have a role in the control of ventilation and sleep modulation. We describe our experience with using dexmedetomidine sedation during diskography for 4 adolescents with a history of back pain.

**Case Summaries**

After obtaining approval from the institutional review board of Cincinnati Children’s Hospital Medical Center, we retrospectively reviewed the medical charts of 4 adolescents who received sedation for diskography between March 2007 and March 2008. The patients’ demographic data are listed in the Table. The 4 patients ranged in age from 15 years to 18 years. There were 3 females and 1 male in the cohort. All presented with the chief complaint of back pain, with varying degrees of neurologic compromise, from no neurologic involvement to numbness and tingling in the lower extremities. Two of the patients (patients 3 and 4) also had a history of degenerative disk disease.

The anesthetic technique was consistent, and peri-procedure care was standard for the entire cohort. All patients fasted according to institutional policy, which is no solid foods for 8 hours preoperatively and no clear liquids for 2 hours before the scheduled procedure time. No patient received oral or intravenous (IV) premedi-
Demographic Data of Patients in Case Series

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Gender</th>
<th>Weight (kg)</th>
<th>Chief complaint</th>
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</thead>
<tbody>
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<td>16</td>
<td>M</td>
<td>65</td>
<td>Back pain, numbness of left lower extremity</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>F</td>
<td>57</td>
<td>Back pain, no neurologic compromise</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>F</td>
<td>56</td>
<td>Back pain, degenerative disk disease T11 through L2, surgery planned</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>F</td>
<td>47</td>
<td>Back pain, degenerative disk disease, numbness of right lower extremity</td>
</tr>
</tbody>
</table>

Table. Demographic Data of Patients in Case Series

cation. All patients were brought to the interventional radiology suite, where they were monitored with the American Society of Anesthesiologists (ASA) standard physiologic variables (electrocardiogram, arterial oxygen saturation, capnography, temperature, and arterial blood pressure) recorded at 5-minute intervals on the anesthetic record. Baseline vital signs for all 4 adolescents were within the following ranges: heart rate, 54 to 88/min; systolic BP, 101 to 128 mm Hg; diastolic BP, 60 to 76 mm Hg; respiratory rate, 18 to 24/min; and oxygen saturation measured by pulse oximetry (SpO₂), 98% to 100%.

An IV catheter was inserted in the interventional radiology suite after the subject inhaled 70% nitrous oxide in oxygen for about 2 to 3 minutes via a circuit attached to an anesthesia machine (Draeger Fabius, Draeger Medical, Telford, Pennsylvania). Once IV access was established, all patients were asked to position themselves in the prone position on the diagnostic imaging table. All patients remained breathing spontaneously with supplemental oxygen at 2 L/min via a Salter-style nasal cannula (Salter Labs, Arvin, California) that allowed continuous monitoring of end-tidal carbon dioxide (ETCO₂).

After successful venous cannulation and patient self-positioning, all patients received an IV loading dose of dexmedetomidine (2 μg.kg⁻¹), which was given over 10 minutes. Upon completion of the loading dose, a dexmedetomidine infusion was started at 2 μg.kg⁻¹.h⁻¹. After successful placement of the second spinal needle, the dexmedetomidine infusion was decreased to 1 μg.kg⁻¹.h⁻¹. Vital signs were stable (< 10% change from baseline) in all patients following the bolus dose. All patients received an antibiotic before the start of the procedure to minimize the risk of iatrogenic diskitis. Once the loading dose was complete and the primary infusion had begun, the skin was prepared and draped by the interventional radiologist in a sterile fashion using povidone-iodine (Betadine) gel as the preparation solution.

Fluoroscopic images of the lumbosacral region were obtained before placement of the needle for diskography. The vertebral levels to be tested during the diskography study were based on the patient’s clinical symptoms and MRI findings. “Control levels” were also used above and below the level suspected to be the source of pain. These levels were predetermined to be morphologically normal and unlikely to be the cause of the patient’s complaints, yet were immediately adjacent to the suspected insulting level. The needle tract at each level was infiltrated with approximately 3 to 4 mL of plain 1% lidocaine. If patients moved or reacted during spinal needle insertion or injection of the lidocaine, they were deemed to be inadequately sedated, and they received another bolus of dexmedetomidine (1 μg.kg⁻¹) over 10 minutes. Pain assessments were not necessary related to the lidocaine injections, as the patients were already sedated, and these were merely superficial tracts created as paths for the spinal needles to pass through. Two of the 4 patients in this cohort required the additional bolus of dexmedetomidine (1 μg.kg⁻¹) with local injection at the first needle site. Spinal needles (22 gauge) were directed 1 at a time toward the targeted intervertebral disk from a parasagittal approach. An interventional radiologist placed the tips of the needles in the center of the intervertebral disk for accurate assessment of the disk. Needle placement was confirmed with anterior-posterior and lateral fluoroscopic imaging (Figure 1). Once the first spinal needle was in place, the dexmedetomidine infusion was decreased to 1 μg.kg⁻¹.h⁻¹. After successful placement of the second spinal needle, the dexmedetomidine infusion was stopped. Patients had a total of 3 spinal needles placed.

All patients remained adequately sedated through the time required to place the final needle, and there was no need to deviate from the anticipated sedation model. All patients were easily aroused at the completion of the procedure in a few minutes. All patients were oriented to time and place and were asked a series of baseline parameter questions before disk provocation. These questions included name, age, grade and school they attended, and current date. Once the patient was able to answer these questions appropriately, he or she was considered alert enough to proceed with needle injection. None of the patients in the cohort was too sedated or unable to become oriented appropriately before needle provocation.

A mixture of iohexol contrast agent (Omnipaque 350, GE Healthcare, Mississauga, Ontario, Canada) and ce-fazolin was injected using fluoroscopy at each vertebral level, 1 level at a time, with the control levels being injected first (Figure 2). During injection, the patients were asked about the pain (ie, the location of pain, similarity to typical pain, and level of pain). Each level was individually injected, assessed, and rated on a pain scale by the patient according to procedure protocol. Institutional protocol for diskography was standardized in that the printed protocol dictated the order of the level of injection and assessment, and used a standard diskography protocol.
record as well as a standardized pain assessment scale. Patients were asked to rate their average daily level of back pain on a scale of 0 (no pain) to 10 (unbearable pain) during the preoperative assessment. Patients were then reassessed again at each individual disk level during the procedure, during spinal needle injection, using the same pain scale. A score of 6 and above was deemed clinically significant for pain reproduction (pain concordance) and considered positive. With each injection, the patients were blinded as to which level was being injected at that time. One of the 4 patients reported pain concordance during injection of the suspected level. All patients received an IV dose of ondansetron at the end of the procedure.

After injection and assessment of all levels was completed, the patients were transferred to the imaging department, where limited CT scans of the injected levels were obtained. The CT images were evaluated for the appearance of the intervertebral disk, including extent of tear, if present, and correlation with pain and MRI findings.

**Figure 1.** Fluoroscopic Images Demonstrating Proper Intradiskal Needle Placement During Diskography
Left, oblique view; right, lateral view.

**Figure 2.** Radiographic and CT Images Demonstrating Contrast Media Injected Into Nucleus Pulposus of Intervertebral Disk
Contrast material is in nucleus pulposus at L3-4 and demonstrates normal appearance of nucleus on conventional radiographs (A, B) and lateral reconstructed computed tomography (CT) images (C).
All patients tolerated the procedure and dexmedetomidine sedation well. None of the patients complained of pain secondary to the procedure. All of the patients remained motionless for successful multiple needle placements, maintained spontaneous breathing, and had stable vital signs throughout the procedure. We observed, relative to preprocedure baseline values, a mean decrease in systolic blood pressure of 4.8%, a mean decrease in diastolic blood pressure of 5.1%, and a mean decrease in heart rate of 7.3%. All patients maintained oxygen saturation equal to or greater than 98% throughout the entire procedure. The presence of ETCO₂ was monitored during the procedure, but accurate CO₂ values were not reported. No patient required pharmacologic intervention because of hemodynamic changes. Data for the entire cohort, relating to dexmedetomidine loading dose, infusion rates and adjustments, and the time period required for the patient to be alert enough to answer questions appropriately before disk provocation, are presented in Figure 3.

All patients were discharged the day of the procedure after they met postanesthesia discharge criteria according to institutional policy. The standard discharge criteria included level of consciousness (awake or easy arousal with verbal commands), core temperature of at least 36°C, ability to swallow (taking oral fluids), adequacy of muscle strength (strong and close to baseline movements of extremities and head), and status consistent with the patient’s preoperative baseline level of function. No severe complications were identified on follow-up communications with the orthopedic surgeons who requested the diskography.

**Discussion**

Although diskography remains an invasive procedure, its use is still generally considered an invaluable adjunct as a preoperative investigation to evaluate the intervertebral disk as a pain source, and prevails as the only dynamic test for this form of investigation.16 Provocative diskography can provide unique information about the pain source and the morphology of the disk. Although the goal is to be able to successfully recreate the patient’s typical pain, the procedure itself is not overly painful. There may be some soreness associated with the tracts through which the spinal needles are passed, but there should be no lasting pain. Any pain recreated with disk injection will be fleeting because the disk is only temporarily enlarged, negating the possibility of a continuous source of pressure or pain. Diskography may also provide information for selecting appropriate treatment of the painful annular tear.17 An annular tear is an outstretching of the pressurized nucleus propulsus due to a breakdown of the annulus fibrosus. If the breakdown or tear is severe enough, the nucleus propulsus may continue to escape from the center of the vertebral disk to a point at which it will begin to apply to vertebral nerves, causing great pain.

Although MRI is considered the primary screening imaging modality for the evaluation of low back pain, diskography is more sensitive in the detection of internal disk disruption, including the detection of disk degeneration and annular fissures. Abnormal structures and disks may be identified on MRI, but they may not be the source of a patient’s symptoms. Furthermore, these abnormal findings often are found in otherwise asymptomatic and healthy individuals. When reviewing MRI reports, it is important to bear in mind that morphologically abnormal-appearing disks may not be eliciting any pain and a minimally disrupted disk may be the source of great pain.

Pain provocation is the most useful and important aspect of diskography.18 Pain can often be elicited by injecting contrast material into a morphologically normal nucleus propulsus. The primary goals of diskography are first, to determine whether diskogenic pain is a source of the patient’s back pain and second, to identify the disk level or levels causing the pain before treatment. Whether pain can be elicited by diskography is not important. The critical question to answer is whether the pain produced by the diskography at a given disk level matches the patient’s typical pain (concordant) or is different from the patient’s pain (nonconcordant). The ideal sedation agent in this study should provide an adequate level of sedation to allow needle insertion and should allow for the patient to be arousable quickly once the procedure is done. It is important that patients are alert and oriented enough to be able to distinguish if injection with a contrast medium replicates their previously reported symptoms.

When we were asked to provide anesthesia services for diskography in these adolescents, dexmedetomidine was our drug of choice because patients clinically sedated with dexmedetomidine are easily arousable, an effect not observed with other available sedatives. Dexmedetomidine also produces analgesia and sedative effects in addition
to preserving respiratory function, even when administered in higher-than-recommended doses for sedation. Patients having a diskogram must be sedated in the prone position for the procedure. The advantage of dexmedetomidine over other sedatives is that it provides sedation without substantial respiratory depression. A recent large-scale, retrospective report of dexmedetomidine sedation for MRI demonstrated that a loading dose of 3 μg.kg⁻¹ over 10 minutes followed by a dexmedetomidine infusion at 2 μg.kg⁻¹.h⁻¹ resulted in successful sedation in 97.6% of 747 children presenting for MRI. We were able to follow this model to provide adequate levels of sedation for diskography, despite employing a slightly smaller loading dose.

Dexmedetomidine is contraindicated in patients with known or suspected hypersensitivity to dexmedetomidine. It is extremely important to use it with caution in patients with heart block, severe ventricular dysfunction, and hypovolemia. Despite the high affinity of dexmedetomidine for the α₂- vs α₁-adrenergic receptor (1,620:1), severe cardiovascular effects, such as bradycardia, sinus arrest, and hypotension, have been reported. Case reports highlight the potential for bradycardia, most commonly when dexmedetomidine is administered with other medications that have negative chronotropic effects. We did not observe any hemodynamic changes of sufficient magnitude (> 10% change from baseline) to require interrupting the procedure in the 4 patients.

Patients receiving a diskogram must be able to cooperate when asked questions at the end of the procedure. Such cooperation is not always easily achieved with traditional sedatives such as fentanyl, midazolam, and propofol. In addition, these agents have well-known respiratory depressant effects. For this procedure an arousable state of sedation is desired to obtain verbal responses from patients on reproducibility of pain. Dexmedetomidine as a sole sedative agent effectively provided ideal sedation to all 4 patients while maintaining stable hemodynamics, without any adverse effects.

In summary, we present preliminary clinical experience with the use of dexmedetomidine for analgesia and sedation during diskography in adolescents. Using dexmedetomidine provided an adequate level of sedation and analgesia for performance of diskography.

REFERENCES


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