EDITORIAL

Image-Guided Injection Therapy in the Lumbar Spine

Jürgen Krämer, Maria Blettner, Gael P. Hammer

Degenerative changes in the lumbar spine can cause back pain with or without radiation into the lower limb. The most common sufferers are middle-aged persons between the ages of 30 and 50, but the number of patients under age 30 is steadily rising.

The affected persons typically have pain that can be treated initially with physical therapy and medications. When these measures no longer suffice, injection therapy can provide additional help. Published guidelines now recommend periradicular injection therapy for radicular lumbar syndromes. This low-risk, minimally invasive form of treatment should always be preferred over a surgical procedure unless major weakness is present (7, 14–16). Computerized tomography (CT) or conventional X-ray fluoroscopy is often used to provide imaging guidance for the placement of the injecting needle into the lumbar spine. Both of these techniques result in the delivery of a certain amount of ionizing radiation to the patient. The lumbar spine and the abdominal and pelvic organs lie unprotected in the path of the X-ray beam generated by the CT scanner or fluoroscope.

Health care is an important area where measures should be taken to protect against radiation injury, because, on average, about 50% of an individual's annual dose of ionizing radiation is derived from medical procedures (1, 2). The potentially problematic use of ionizing radiation in medicine is currently under discussion in a number of countries, not only in Germany (3, 11, 12), particularly in light of the increasing use of computerized tomography (17). The purpose of this article is to raise awareness of the problem of ionizing radiation in image-guided injection therapy.

The indications for injection therapy

The clinically important anatomical sites in the lumbar motion segment are the anterolateral epidural space, the foramino-articular region, and the intervertebral joint capsules. The vicious circle of pain, faulty posture, and more pain can be broken by desensitization of nerve roots and nociceptors through repeated local injections of analgesic and anti-inflammatory medications at the site of origin of the pain (7, 9, 10). A prerequisite for success is the precise diagnosis of the primary disorder by means of a segmental examination employing the techniques of neurology and manual medicine.

If a presumptive site of origin of the pain has been found, a reasonable next step is to attempt to lessen the pain through the local infiltration (test injection) of a

local anesthetic. Therapy can be provided thereafter with repeated infiltrations, in which steroids may be added. The possible types of infiltration include the following:

- Infiltration of affected nerve roots within the spinal canal with a perineural-epidural injection
- Spinal nerve analgesia at the intervertebral foramen
- So-called facet infiltration at the intervertebral joints.

These infiltration sites can only be reached by needles measuring 8 to 12 cm in length. The lumbar spine, below the level of termination of the spinal cord, is a relatively safe area for injection therapy in comparison to the rest of the spine. The use of only small amounts of added anti-inflammatory substances, usually cortisone, and of no more than a low concentration of local anesthetic lowers the risk still further. Nonetheless, extreme care should always be exercised in order to help the patient rapidly and in targeted fashion. The main target structure of injection therapy is the compressed, inflamed, edematous nerve root. The safest and most effective type of injection is perineural-epidural injection, which is performed with very small amounts of local anesthetic and anti-inflammatory drug that are applied directly to the site of compression through the thinnest needle available (29 gauge).

The technique is demanding, however, and should first be practiced on cadavers in specialized injection courses and in other tutorial settings (3, 7, 9). As long as the physician is still on the steep part of the "learning curve," it is entirely reasonable to check the needle position obtained through palpatory anatomical orientation against a computer-tomographic or fluoroscopic image.

Radiation exposure in image-guided injections

Galanski and colleagues (4) reported the results of a nationwide questionnaire in Germany (1999) regarding radiation exposure during CT scanning (*table*). Typical CT scans of the lumbar spine were performed in a region measuring approximately 6 cm in length. The region of interest was longer than this when scans were performed for certain specific indications, e.g., disc herniation or degenerative skeletal changes associated with low back pain and sciatica. Scans performed for the latter indications require higher spatial resolution and therefore higher doses of radiation. In the treatment of nerve root compression with injection therapy (7), it can be assumed that 5 to 10 spinal injections will be performed under CT

Institut für Wirbelsäulenforschung an der Ruhr-Universität Bochum: Prof. Dr. med. Krämer

Institut für Biometrie, Epidemiologie und Informatik, Johannes-Gutenberg-Universität Mainz: Prof. Dr. rer. nat. Blettner, Dr. Hammer

TABLE

Typical effective doses in spinal CT scans (from Ref. 4)

Type of scan	Mean effective dose (mSv)
Cervical spine	2.5
Thorax	6.4
Abdomen and pelvis	13.0
Lumbar spine	3.4

guidance, and that this treatment may need to be repeated once every two years. That would correspond to an effective individual annual dose of 6.5 mSv (for 5 injections). Recent studies have shown that the use of low-dose protocols can reduce the effective dose per CT scan to as little as 0.22 to 0.43 mSv (10). Nonetheless, even so, repeated series of injections performed over the years will be associated with an increasing cumulative exposure to ionizing radiation.

The radiation exposure from intraprocedural fluoroscopy is a function of the length of time that the imaging apparatus is turned on, and also of the experience of the treating physician. Depending on the circumstances, the radiation exposure may be comparable to, or several times higher than, that associated with plain AP and lateral lumbosacral spine films (0.7 mSv).

The current biological and epidemiological data on radiation-related risks are regularly updated by a number of different working groups and institutions (5, 6). The models that have been published in the framework of such reports enable a quantitative estimation of an individual's increased risk of cancer due to radiation exposure. For the specific topic of interest of this article, however, no reliable data are as yet available. The increased number of solid tumors among persons aged 18 to 65 who are exposed annually to 10 mGy of radiation is estimated to be 2600 per 100 000 men (95% confidence interval [CI]: 1,250–5,410) and 4030 per 100 000 women (95% CI: 2,079–7,840) (5).

The implications of injection therapy

Image guidance usually implies the use of fluoroscopy or CT. Both of these techniques employ ionizing radiation. Image-guided injection therapy is relatively unproblematic in terms of radiation exposure if it is only performed once, as the radiation dose it delivers is comparable to that of a plain skeletal X-ray performed to diagnose a fracture, or that of a routine preoperative chest X-ray. In patients with spinal degenerative disease and nerve root compression, however, the treatment is rarely finished after a single infiltration. Multiple injections are necessary to bring about decreased swelling and desensitization of the root (7, 9). Furthermore, in patients with spinal degenerative disease, the symptoms can be expected to recur repeatedly over a long period of time, so that these patients will ultimately be exposed to a fairly high overall amount of radiation.

The younger the patient is when the initial image-guided treatment employing ionizing radiation is performed, the more likely it is that he or she will receive a high cumulative dose of radiation over the course of a lifetime, because disc disease will probably recur and require treatment on multiple occasions (7). Thus, the routine use of radiological techniques employing ionizing radiation for image guidance in spinal injection procedures is a problematic matter. If an image-guided series of spinal injections is nonetheless planned, the patient must be informed about the cumulative effect of radiation, and in particular of the elevated risk of leukemia and carcinoma (2, 3, 8, 9), especially in view of the fact that the injection series may need to be repeated one or more times in the future. MR-guided spinal injection procedures would have the advantage of being free of ionizing radiation, but these are not yet technically feasible, because the thin, amagnetic needles required that would be necessary for such procedures are not yet available. This is aside from possible considerations of cost.

The indications for radiological image guidance

Image guidance with fluoroscopy or computerized tomography is indicated for verification of the correct position of the needle while the physician performing the procedure is still on the steep part of his or her "learning curve," or when the orienting landmarks are difficult to palpate because of the patient's spinal deformities or obesity. Image guidance should also be used whenever a neurotoxic medication is to be injected in the vicinity of the spinal canal. This consideration applies mainly to intradiscal injections for chemonucleolysis and to joint capsule denervations with 96% alcohol or the like.

The success of spinal injection therapy with or without image guidance is judged from the patient's own report. If the conservative measures that were previously used did not lead to any improvement, and if the patient describes clear-cut and persistent relief of pain after one or more spinal injections, then the goal of treatment has been achieved. The effectiveness of periradicular therapy unaided by image-guidance techniques has been documented in a randomized, controlled study (13).

Conflict of interest statement

The authors declare that they have no conflict of interest as defined by the International Committee of Medical Journal Editors.

Manuscript submitted on 4 January 2006 and accepted in revised form on 7 February 2008.

Translated from the original German by Ethan Taub, M.D.

REFERENCES

1. Bundesamt für Strahlenschutz. Umweltradioaktivität und Strahlenbelastung (annual report 2004). Bonn: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2005.
2. Nestle U, Berlich G: Strahlenschutz in der Orthopädie. *Orthopädie* 2006; 35: 571–82.
3. Strohmeier M: Stellungnahme der IGOST. *Orthopädie und Rheuma* 2004; 6: 33.

4. Galanski M, Nagel HD, Stamm G: CT-Expositionspraxis in der Bundesrepublik Deutschland. Ergebnisse einer bundesweiten Umfrage 1999. Frankfurt: Deutsche Röntgengesellschaft; Zentralverband Elektrotechnik und Elektroindustrie e.V. 2000.
5. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation: Health risks from exposure to low levels of ionizing radiation BEIR VII-Phase 2. Washington, D.C.: The National Academies Press 2006.
6. UNSCEAR or United Nations Scientific Committee on the effects of atomic radiation: Sources and effects of ionizing radiation – report to the general assembly, with scientific annexes. New York: United Nations 2000.
7. Krämer J: Bandscheibenbedingte Erkrankungen. 5th edition. Stuttgart: Thieme 2006.
8. Ratzel R: Umfang der Aufklärung bei Facetteninfiltration. Orthopädiemitteilungen 2005; 6: 448.
9. Theodoridis T, Krämer J: Injektionstherapie an der Wirbelsäule. Stuttgart: Thieme 2006.
10. Schmid G, Schmitz A, Borchardt D, Ewen K, von Rothenburg T, Koester O, Jergas M: Effective dose of CT- and fluoroscopy guided perineural/epidural injections of the lumbar spine: a comparative study. Cardio Vascular and Interventional Radiology 2006; 29: 84–95.
11. Annis ES, Butler PF, Applegate KE et al.: American College of Radiology. White paper on radiation dose. Medicine Journal of American College of Radiology 2007; 4: 272–84.
12. Wiesel S, Schoene M, Nelson C: Shocking rise in medical radiation exposure. Back Letter 2007; 22: 75.
13. Krämer J, Bickert U, Owczarek V, Traupe M: Lumbar epidural perineural injection: a new technique. European Spine Journal 1997; 6: 357–61.
14. Leitlinien der Orthopädie: DGOOC, BVO (ed.) 2nd edition. Köln: Deutscher Ärzteverlag 2002.
15. Arzneimittelkommission der Deutschen Ärzteschaft, Kreuzschmerzen. 3th edition. Köln; Deutscher Ärzteverlag 2006.
16. European Guidelines for the management of low back pain. Europ Spine Journal 2006; 15: 275–80.
17. Brenner DJ, Hall EJ: Computer tomography – An increasing source of radiation exposure. N Eng J Med 2007; 29: 2277–84.

Prof. Dr. med. Jürgen Krämer
 Institut für Wirbelsäulenforschung
 an der Ruhr-Universität Bochum
 Viktoriastr. 66–70
 44787 Bochum
 Germany

Dtsch Arztebl Int 2008; 105(34–35): 596–8
 DOI: 10.3238/arztebl.2008.0596