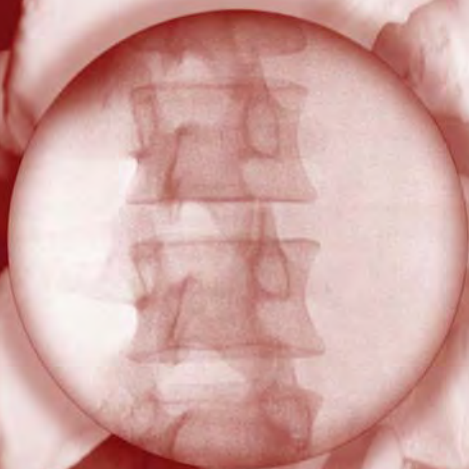


HANDBOOK OF C-ARM FLUOROSCOPY-GUIDED SPINAL INJECTIONS

**LINDA HONG WANG
ANNE MARIE MCKENZIE-BROWN
ALLEN H. HORD**



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Dedication

*To our spouses, without whose love, support, and patience
this handbook would not have been possible.*

*To our children, anything is possible if you put your mind
and heart to it.*

*To our parents, who taught us to believe in ourselves, to aim
past the limits, to never give up, and to make each day count.*

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To former and current pain fellows, with particular thanks to Dr. Talal Khan and Dr. Brannon Frank, for special assistance in the fluoroscopy images and computer editing. Your pursuit of knowledge was instrumental in our academic growth as well.

To our pain colleagues, Drs. Patricia Baumann and Michael Byas-Smith, for supporting us in this project.

And perhaps last, but certainly not least, to our patients, who give us their trust and, occasionally, restore our faith in ourselves.

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Preface



C-arm fluoroscopy-guided spinal injections have been performed widely for diagnosis and management of spine and para-spinal-related pain disorders. So often, residents and pain fellows do not receive formal training in radiography and the related anatomy of the vertebral column. The purposes of this handbook are to (a) illustrate spinal injections in a step-by-step fashion, (b) present fluoroscopy imaging and related spinal anatomy, and (c) describe manipulation of C-arm fluoroscopy to get ideal images for spinal injections.

The concept of this book started off as a compilation of notes and lectures that were put together for the educational benefit of our pain fellows as well as those residents who rotate on the pain service. The residents spend 2 months on the service and often have a difficult time orienting themselves to the C-arm and the resulting fluoroscopic images. While there are now quite a few books on the market that show the final needle position for spinal injections, we felt that there was a need for a book describing a more basic, step-by-step approach to spinal injections. As a pain fellow, Dr. Linda Wang started collecting images and teaching tools to help her better understand the reasoning behind the fluoroscopic images that were used for spinal injections. As a faculty member, Dr. Wang spent a tremendous amount of time studying the relationships between the skeletal model, the matching fluoroscopic image, and the desired needle placement in the cervical, lumbar, and sacral spinal regions. There is often a skeleton hanging prominently in the procedure room that is used as a reference when we perform fluoroscopically guided injections. Dr. Wang sought to recreate those images in her chapters that effectively demonstrate the relationships between the angle of the x-ray beam and the spinal column. In the chapters describing the fluoroscopic imaging of the cervical, lumbar, and sacral spine, Dr. Wang describes in detail how the trainee would go about obtaining the views needed to approach the spine at each level. Dr. McKenzie-Brown has long had an interest in the cervical spine and procedures performed around the cervical spine as well as in lumbar discography. The neck houses critical vascular structures that affect the way in which injections around the cervical spine are performed. The chapters that she wrote pertaining to cervical injections show a safe method for performing these injections under fluoroscopy. As our program became more interventional in the management of pain, Dr. McKenzie-Brown became more interested in radiation safety, and the basic tenets of radiation safety are succinctly described in Chapter 3. Finally, the sympathetic chapters are left as a category unto themselves. Until fairly recently, stellate and lumbar sympathetic injections were routinely performed without fluoroscopy. Dr. Wang takes us through step-by-step approaches to each of the sympathetic blocks with insights into how to ascertain the correct needle position at each level. Dr. Wang was encouraged by Dr. Allen H. Hord to enter the area of pain medicine. Dr. Hord served as a motivator and educator in the training of Dr. Wang and countless other physicians in the area of C-arm fluoroscopic techniques. His review of this handbook proved to be an invaluable asset.

Each of the spinal injections in this handbook is simply written. The preferred patient's position as well as C-arm fluoroscopy position, preferred fluoroscopic images, and related anatomic structures on the spine are described. The steps taken to get to the final placement of the needle tip are also described. Not only are the correct needle placements illustrated from different views of the spine, but possible incorrect needle placements are shown as well. We endeavored to provide a handbook that will become a useful teaching aid for residents and fellows striving to improve their skills in the performance of spinal injections for pain management.

The Authors



Linda Hong Wang, M.D., Ph.D., graduated from Capital University of Medical Sciences (Beijing Second Medical College) in Beijing, China. She then came to the United States and studied basic science in pain medicine at the University of Illinois in Chicago. After she received her Ph.D., she continued her training in anesthesia at the Mayo Clinic in Rochester, Minnesota. She completed her anesthesiology residency at Emory University School of Medicine, following which she spent 12 additional months there in her pain fellowship. She is currently working in Emory's Department of Anesthesiology in Atlanta, Georgia.

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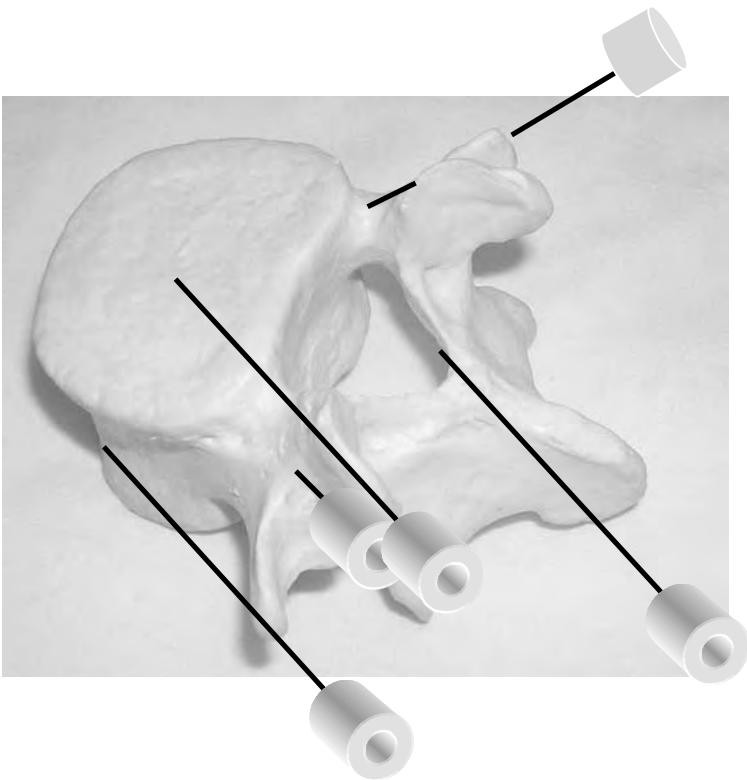
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Chapter

1

An Introduction to Spinal Injections



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In 1994, the International Association for the Study of Pain (IASP) defined pain as “*an unpleasant sensory and emotional experience associated with actual or potential damage or described in terms of such damage.*” Spinal pain is still a leading cause of disability in the industrialized world. Spinal injections are common procedures for both the diagnosis and treatment of pain related to the spine. This book utilizes a step-by-step approach to illustrate routinely performed fluoroscopically guided spinal injections and procedures at the cervical, thoracic, and lumbosacral regions. This is done in an attempt not only to introduce trainees to the basic interventional techniques but also to assist instructors in their pursuit of demonstrating the techniques of spinal injections in a clear and simple manner.

All of the commonly performed spinal injections involve placing the needle in or around the vertebral column. Mastery of the technique of spinal injections involves learning where along the spine to place the needle. Figure 1.1 and Figure 1.2 demonstrate the wide variety of spinal injections that are commonly performed in pain practices. Figure 1.1 represents the axial view, while Figure 1.2 shows the oblique view of the spinal column.

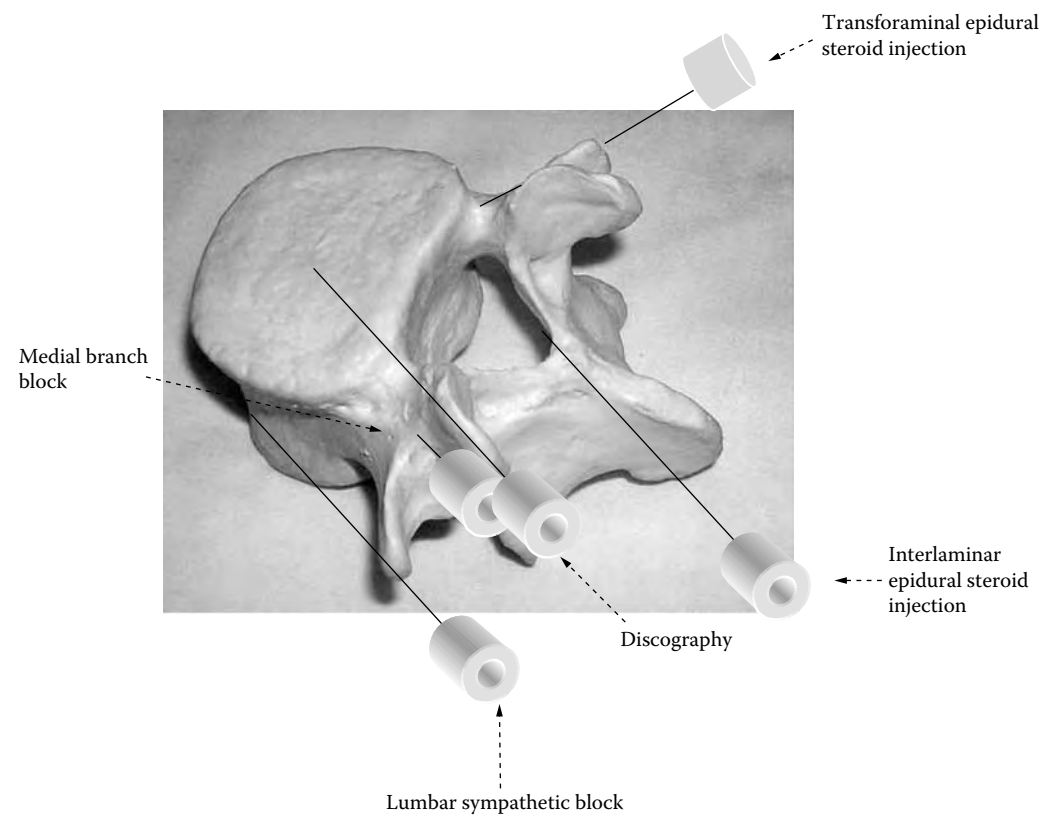
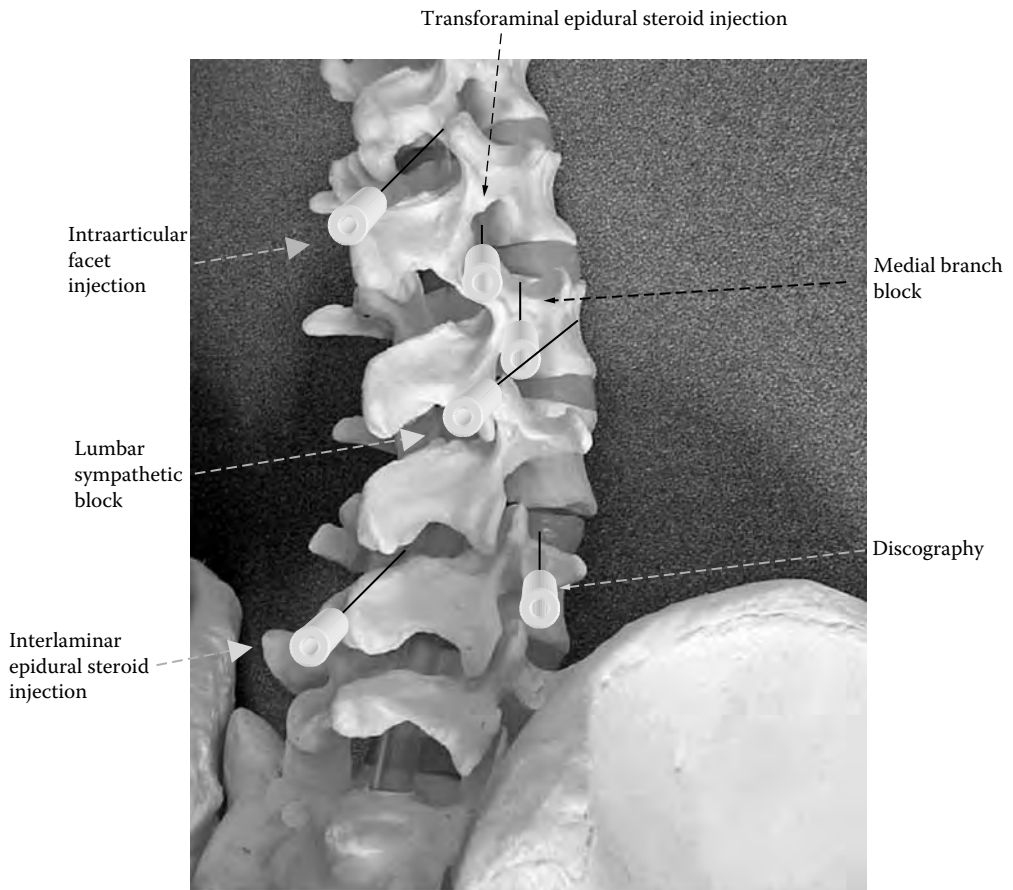


FIGURE 1.1
Axial view of needle placements for spinal injections.

**FIGURE 1.2**

Oblique view of needle placements for spinal injections.

We will guide readers in a step-by-step fashion through injections commonly performed around the cervical spine, including intra-articular cervical facet and medial branch injections, radio-frequency ablations, and cervical transforaminal and interlaminar epidural steroid injections.

Chronic pain is among the most common forms of low back pain that we encounter in our practice. We will help readers to understand the details of commonly performed lumbar spinal injections, such as lumbar medial branch block and transforaminal epidural steroid injection.

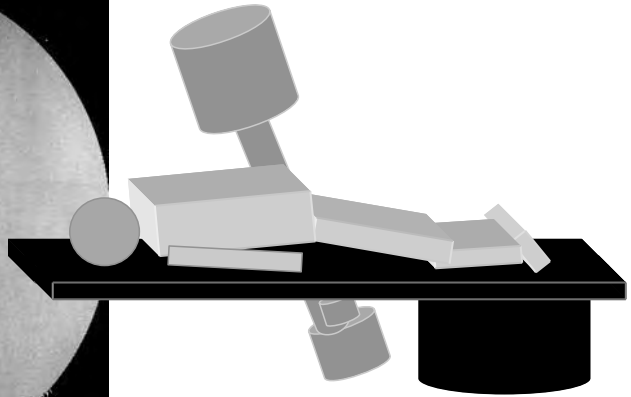
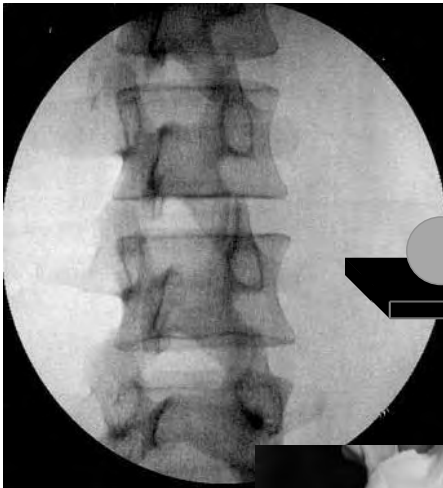
The more commonly performed procedures in the sacral region that we will discuss include sacroiliac and caudal injections.

We will also describe commonly performed sympathetic blocks including stellate ganglion blocks, lumbar sympathetic blocks, and performance of the superior hypogastric plexus block.

Chapter

2

Basic Radiographic Background of the Vertebral Column



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It is essential to be familiar with fluoroscopic images and related anatomy of the human vertebral column in order to perform spinal injections. In this chapter we will go over basic fluoroscopic images of human bones, including human vertebrae.

C-Arm Fluoroscopy and Images

A C-arm fluoroscope consists of an x-ray tube, a C-arm arch, an image intensifier, a control panel with a footswitch, and a computerized image display system (Figure 2.1). In C-arm fluoroscopy, a fluoroscopic beam, usually coming from below, penetrates the spine, sending an image to the intensifier. The image is then displayed on a TV screen for review (Figure 2.2). The C-arm can be rotated in different directions in order to view an object from different angles (Figure 2.3). The control panel allows us to adjust how images are generated and displayed by pressing function keys. The footswitch, also part of the control panel, offers more flexibility. The image system not only displays fluoroscopic photos but also stores fluoroscopic images for review and comparison.

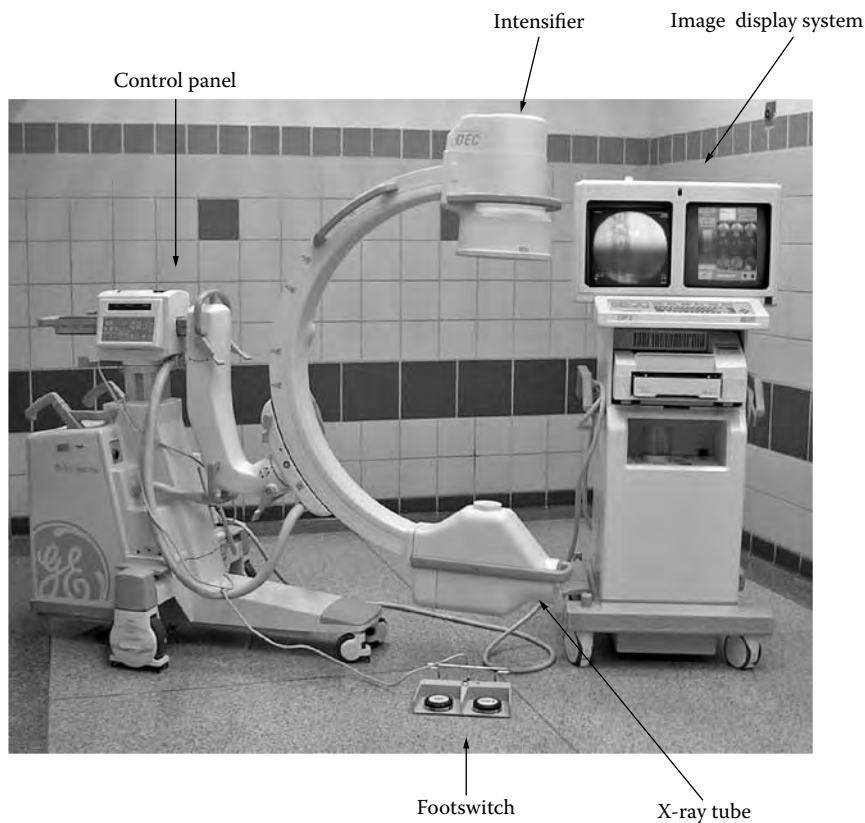


FIGURE 2.1
Photograph of a C-arm.

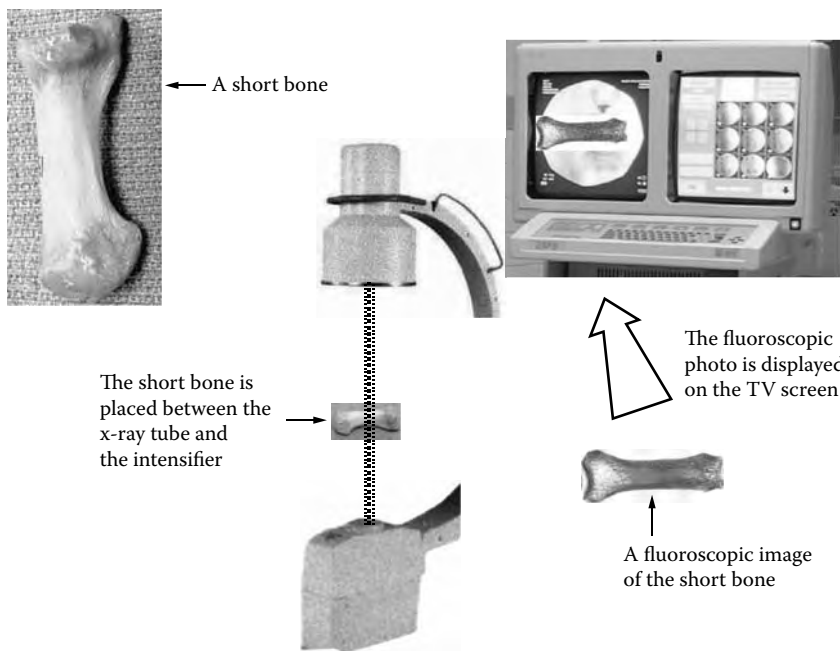


FIGURE 2.2

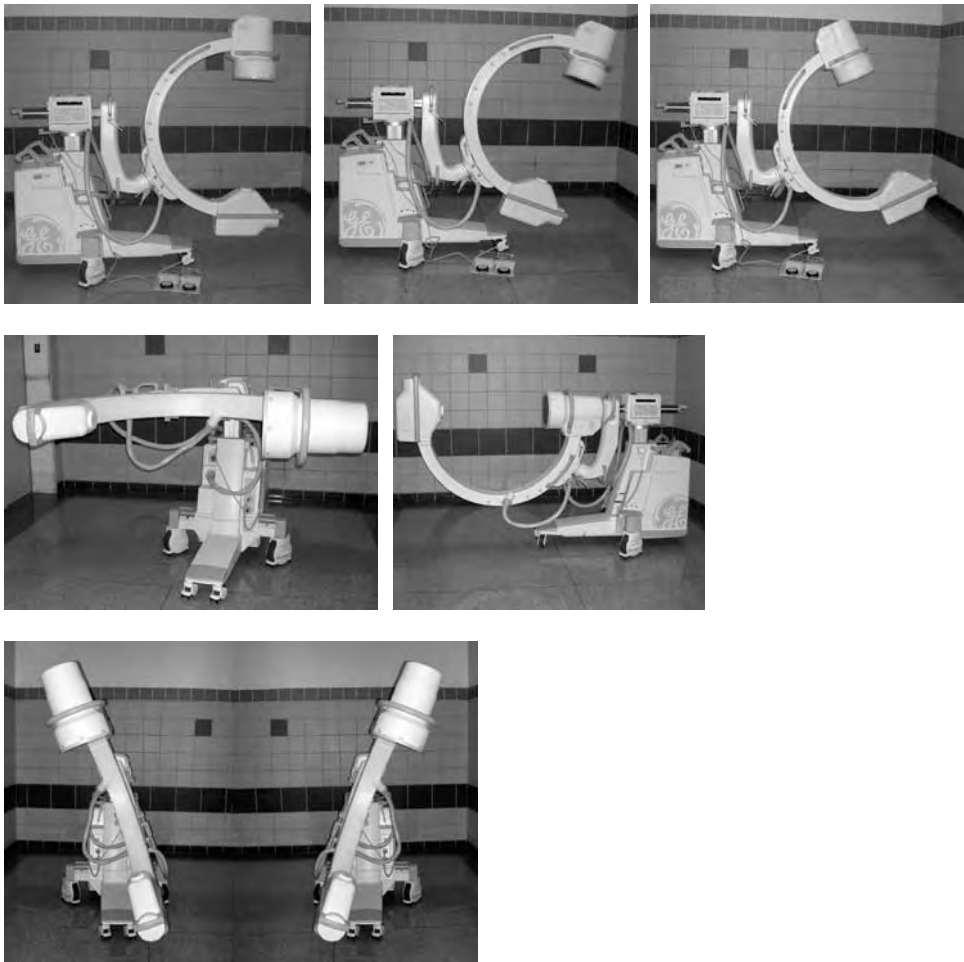


FIGURE 2.3
C-arm rotations.

A photograph (Figure 2.4) and a fluoroscopic image (Figure 2.5) are both two-dimensional pictures. However, each has striking differences. Because our goal is to inject appropriate medications in or around the target areas of the spine, it is essential to understand the fluoroscopic images of the spine and the relationship between needle placement and the target area.



FIGURE 2.4
Regular picture of the spine, anterior view.

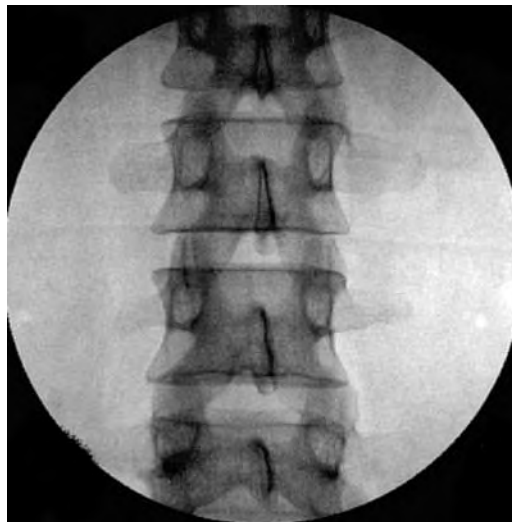


FIGURE 2.5
Fluoroscopic photo of the lumbar spine.

A fluoroscopic image of a cylinder from the side, for example (Figure 2.6), is a rectangular-shaped image regardless of the angle of the beam. We cannot view the cylinder from the ends. The TV screen of C-arm fluoroscopy is only able to display one image at a time. By reviewing a series of images of this object (Figure 2.7), we are able to mentally construct a three-dimensional picture of this cylinder.

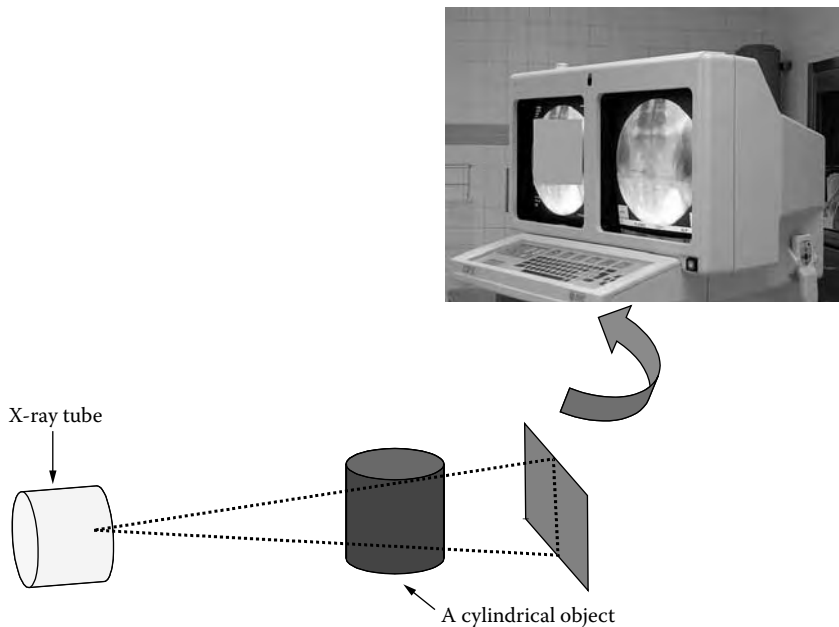


FIGURE 2.6
Fluoroscopy does not show a 3-D picture.

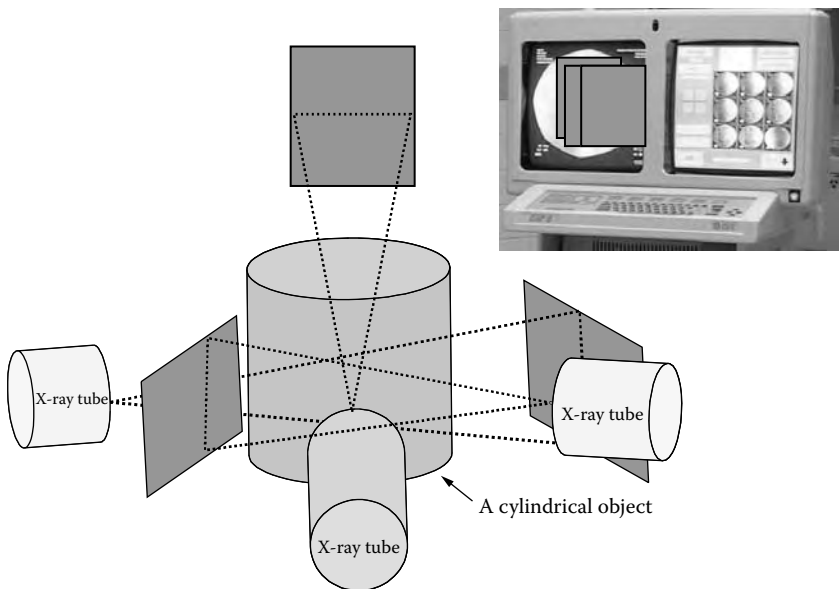


FIGURE 2.7
Creating 3-D images mentally.

If the fluoroscopic beam goes through a cube (Figure 2.8), the TV screen displays a square. However, we are unable to identify the properties of this cube.

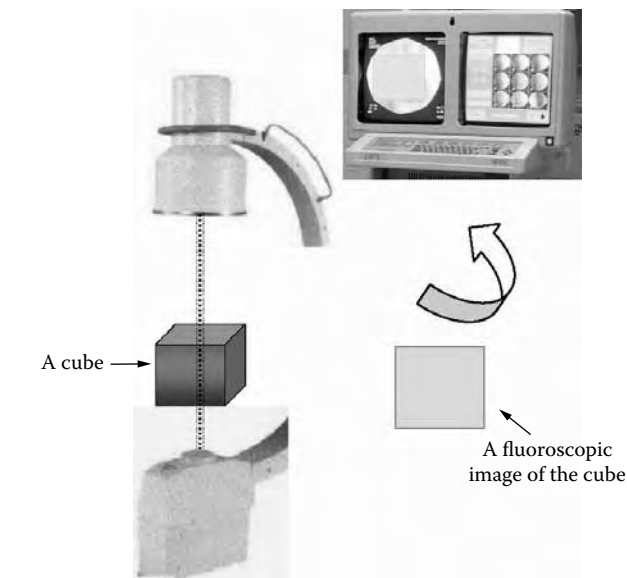


FIGURE 2.8

If a cylinder is placed on top of the cube, a fluoroscopic picture is merely a square with a circle in the middle (Figure 2.9). We are unable to judge the exact relationship between the cylinder and the cube.

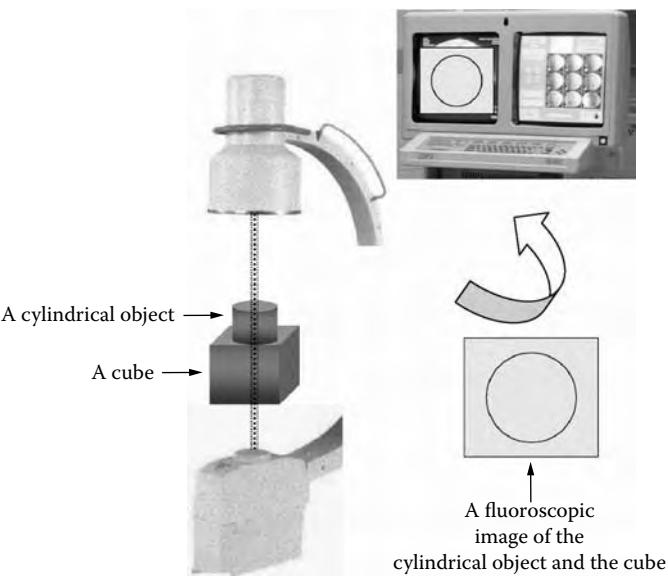


FIGURE 2.9

A fluoroscopic picture of these objects (Figure 2.10) is complicated. We cannot describe their exact relationships without adding another picture of these objects from a different view.

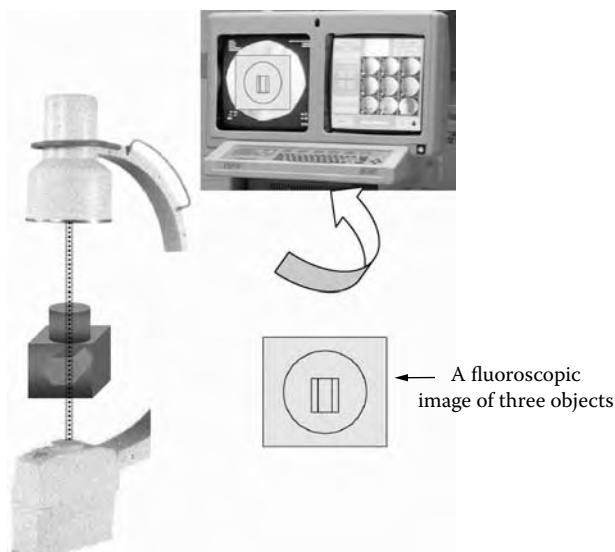


FIGURE 2.10

The basic steps of a fluoroscopy-guided spinal injection include the following (see Chapter 4 for details):

1. Identifying a target point in the area of the spine or the pelvis
2. Obtaining fluoroscopic images
3. Inserting a needle
4. Verifying correct needle placement by using the fluoroscopic images
5. Injecting the appropriate medication into the target area

It is important to review the anatomy of the vertebral column and the anatomy of the pelvic girdle.

Axial Skeleton

There are 206 separate bones that form the adult human skeletal system — the framework of the entire human body. The adult skeletal system is divided into the axial skeleton and the appendicular skeleton. The axial skeleton has a total of 80 bones that lie on or near the central axis of the human body, including the skull, vertebral column, ribs, and sternum. The vertebral column (Figure 2.11) consists of 26 vertebrae and includes 7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae, 1 sacrum, and 1 coccyx.