PART I

The Spinal Unit

"I've hurt my back, what should I do?" This message was recently emailed to me from a client who was away from home and away from her go-to low back pain remedies, hoping that I had some insight on pain relief. I can't tell you how many times in my career I have received a variation of this question in an email or a phone call. How I wish that there were an easy, single-sentence answer I could have given her, something that would have solved her problem quickly and easily, but alas, there wasn't. Every person's back problem is unique, so there is no one treatment that will fit everyone. Granted, the anatomy is the same—we all have roughly the same body structure—but how we have used and abused that structure is where the complications arise. The only "fixes" are time, patience, and hard work. The first section of this book will help you begin.

Anatomy is first. Without a clear understanding of how the body fits together and functions, it will be impossible to really understand how and why the exercises will help. The anatomy information is the foundation on which everything else is built. Your individual diagnosis, or pathology, is what determines the course of your exercise choices: You will use it to design a program to stabilize and strengthen your back.

In the first chapter, you learn about spinal anatomy—the basic information needed to understand what has happened in your spine based on your diagnosis. The second chapter introduces you to the concept of spinal stabilization and why it's so important to help you strengthen your low back. Finally, in chapter three you perform a self-assessment to provide a baseline of your condition, so you know exactly where you're starting; it will give you some perspective against which to measure your progress.

These chapters are going to be the first steps in your journey to learning how to manage your low back pain. Each chapter will provide you with the necessary information to understand the *why* behind the chosen exercises in the later chapters. My goal is to give you the tools and guidance to take control of your pain and to manage it through the exercises prescribed later. Once you understand the information about your particular condition, then you will be able to make better choices in your daily life to keep your back pain at bay. By reading these chapters, you're taking charge of your pain and choosing to not allow it to dominate your life.

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CHAPTER 1

Anatomy of the Spine

The human body is often likened to a machine. In fact, it is often called the perfect machine. Think about it. For what we ask this machine to do, it is as remarkably complex as it is resilient. However, like any machine, wear and tear can take its toll. Through not only athletic endeavors, but simply through daily activities, your body's joints are asked to perform thousands of similar movement repetitions. Whether you are a runner logging hard-pounding miles, or a tennis player breaking and charging on the court, or a golfer performing hundreds of swings in the same direction during each round (counting practice strokes), the effect it has on your ankles, knees, hip, shoulders, and especially spinal joints is enormous. The fact that these joints last as long as they do is remarkable.

But like most "machines," we too can break down over time. Dr. Ronald Hetzler, my Professor of Exercise Physiology, once remarked to our class that our bodies have a limited warranty of 70 years. While that is a bit simplistic, it's quite apropos. Our joints are made up of connective tissue, including tendons, ligaments, and cartilage, which do deteriorate—albeit very slowly—over time. Some people tend to break down more rapidly than others, due to their body's genetics or their activity level. We need to do everything we can to slow down this process and minimize the effects of Mother Nature.

The spine is the literal backbone of our machine, and is possibly the most complicated series of joints in the body. In this chapter we will delve into the spine, specifically the lumbar portion, discussing not only the musculature but also the other connective tissues that comprise this remarkable structure.

I understand that not everyone wants to dive deep into the anatomy, physiology, and kinesiology of the spine. "Just tell me what to do and let me do it" is something I hear way too often. But let me offer you something to think about. The exercises that I suggest later in this book are very important for building up your core strength and stability, and understanding the "why" behind each exercise is incredibly important as well. If you understand why you are doing the exercises, then you are more likely to actually do the exercises and perform them properly. I know I tend to drive my personal training staff a bit crazy with the "why." I am infamous for walking up behind them while they are training a client and whispering, "Why?" When they hear this, they know that I want them to justify why they chose that particular exercise for that particular client. Any exercise you do has to have a reason, otherwise you're just wasting time and money.

So, for those of you who want to truly understand why you are doing these exercises, then please read on. For those who are more impatient, skip forward to the chapters on your specific pathology or injury and the corresponding exercises. But remember that these chapters are waiting for you when you are ready. Okay, let's begin.

Spinal Anatomy

First, let's discuss the importance of your spine. What does it do and why do you need it? The spine is critical for efficient movement of the body. It helps to integrate movements between the torso, pelvis, and shoulder girdle. Without a healthy, free-moving spine, the body is very limited as to what it can do. Throwing a ball or swinging a bat performed with arms only—without the use of the entire body—would be powerless. Believe it or not, most movements you do involve the entire body. Whether it is running for a bus, picking up a child, putting the laundry in the dryer, or unloading the dishwasher, you are using your entire body. A healthy, functioning spine is critical for all of these movements.

Another important feature of the spine is protection for our spinal column and nervous system. The bones of the spine enclose our spinal column, providing its own suit of armor and protecting it from damage. This also gives structure to our nervous system; our nerve endings exit the spine to each muscle and organ in the body. This structure creates a network mainframe from which all the wires (nerves) branch outward.

The Bones

The spine is made up of five distinct sections (see figure 1.1). Starting at the top and moving downward, we have the cervical spine comprised of seven bones, the thoracic spine comprised of twelve bones, the lumbar spine comprised of five bones, the sacrum made up of five fused bones, and finally the coccyx comprised of three to five small bones. Each section has a specific structure designed for its function, and each region has a curve unto itself. The cervical region curves inward (lordosis), the thoracic region curves outward (kyphosis), the lumbar curves back inward (lordosis), and the sacrum curves outward. These curves allow the spine to withstand stress and absorb forces.

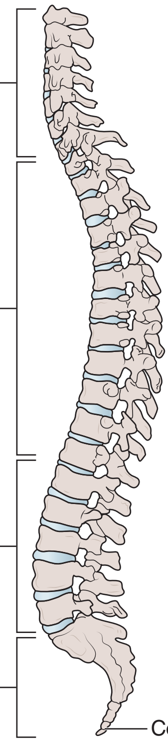

FIGURE 1.1 Five sections of the spine: cervical, thoracic, lumbar, sacrum, and coccyx.

Cervical Spine

The cervical region (the neck) is made up of the smallest vertebra and is designed for the largest range of motion. Move your head and neck around and you will see what I mean. Rotating it, tilting it forward and back, and side to side, you will see that you can move the neck in many different directions. Unlike some animals with eyes on the sides of their heads, we have our eyes on one side only. This gives us great depth perception but limits our field of vision. The ability to turn our necks and see up to 270 degrees around our bodies aided our ancestors in protection from enemies and predators as well as in hunting and scouting. It's this flexibility that gives us great advantages in vision but also creates an area of inherent weakness; a lot of injuries in the cervical region are due to arthritis, muscle strains, and fractures. These vertebrae are relatively small compared to their counterparts further down the spine, which is evident when looking at the "body," or front portion, of the vertebra. This is the round portion in the front of the vertebra that bears the weight of everything above it. Because it is near the top of the spinal column, it doesn't have as much weight to support as the areas below it. You can also see it in the articular surfaces, the posterior sections where the bones glide on each other and allow for muscle attachment, which are smaller and appear more delicate. Their shape and size allows the cervical region of the spine to have the greatest amount of movement.

Thoracic Spine

The vertebrae of the thoracic spine comprise the upper back. The vertebrae change as they travel down your spine. The front portion (body) of the vertebra get larger as they are required to support increasing weight. The spinous process (the part of the bone sticking out on the back) eventually begins to point at a downward angle rather than straight out. This, combined with the direction of the articular (mating) surfaces, allows for flexion, side-to-side movement, and limited extension, but the important thing to note is that it also allows a greater amount of rotation. In fact, most of the rotation that occurs in the trunk comes from the thoracic spine and not from the lumbar region (the waist).

Lumbar Spine

Traveling further down the spine, we come to the lumbar region. We cover this area in great detail because the low back is one of the most often injured areas of the body.

The lumbar spine contains the largest vertebrae in the spine, which makes sense because it carries the most weight and contributes greatly to the strength and stability of the entire body. Stability is incredibly important in this region. While the lumbar spine has great flexion, extension, and side-to-side movement, it does not allow for much rotation. In fact, each lumbar spinal segment rotates only one or two degrees. So, from your waist you only rotate 5 to 10 degrees total. That's not very much. The thoracic spine does the lion's share of trunk rotation. This thoracic rotation along with hip rotation makes you appear to be twisting at the waist, but the motion is really happening above and below your lumbar area. So, when you swing that golf club or tennis racket, you should focus on turning through the hips and shoulders and not at the waist. Forcing too much rotation from the lumbar spine will ultimately result in injury and pain.

Low Back Pain: Did You Know?

Here are a few facts about low back pain:

- Low back pain is the leading cause of disability worldwide.[1]
- Low back pain accounts for 264 million days of missed work annually.[2]
- It is estimated that nearly 80 percent of all people will suffer from low back pain at some time in their lives.[3]
- The cost of low back pain to our health care system is over $50 billion annually. If you factor in missed work and lost wages, that number climbs to over $100 billion dollars.[4]

Sacrum

The sacrum is located below your lumbar spine and is made up of five fused vertebrae. It is concave (kyphosis) in nature and serves as a connection between the spine and the pelvis (hip bones). The point at which the sacrum meets the pelvis is called your sacroiliac joint (SI joint) and it is an area where we occasionally see dysfunction. While the sacrum is seated between the two bones of the pelvis much like a keystone in an archway, sometimes the fit isn't as snug as it should be. Through use and abuse you may stretch out your sacroiliac (SI) ligaments leading to greater movement than desired. That, combined with too little or too much movement, can cause instability in the SI joints which in turn can produce dysfunction and pain. This could manifest itself as sciatic nerve pain in which feelings of numbness, tingling, or radiating pain down the leg can range from irritating to downright debilitating. This indicates muscular imbalance, whether it is an imbalance of one muscle being too tight and its corresponding muscle being too loose, or one muscle being too strong and its corresponding partner being too weak. Either scenario can cause the joint to get (and remain) out of alignment leading to faulty movement patterns which, if not addressed, can create lasting problems. For example, the piriformis muscle attaches from the hip to the sacrum. If one side gets too tight and the other is stretched beyond its normal length, the sacrum itself tilts to one side. If we view the entire spine as a chain, this shift in the sacrum can cause a shift all the way up the spine.

Coccyx

The coccyx is made up of three to five bones at the very bottom of your spine. Until we injure it, not much is mentioned about the coccyx (or tailbone). Injury is usually caused by a trauma, such as a fall or being struck by something. Unfortunately, a broken coccyx can lead to long-lasting pain and should be treated by a physician or physical therapist.

Intervertebral Disc

We cannot go any further without talking about another very important structure of our spinal column, the intervertebral disc. The disc is an amazing structure that can certainly be a pain.

The intervertebral disc is comprised of two areas (see figure 1.2). Like a jelly donut, with pastry on the outside and jelly on the inside, your disc also has external and internal portions. The outer portion is called the annulus fibrosis and is made up of fibrocartilage, which is really tough connective tissue. It has to be; think of how much motion your spine experiences on a daily basis, and multiply that by your age. Consider all the sporting events you've participated in and all the moving, twisting, and bending movements that you take for granted. The tough annulus fibrosis is

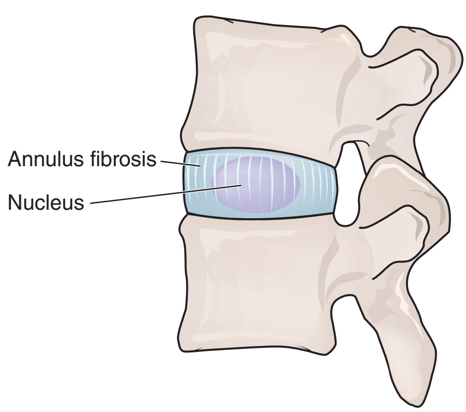

FIGURE 1.2 Intervertebral disc.

there to manage compressive forces, in other words, shock absorption. It is really good at its job—until it gets damaged. The annulus fibrosis is made up of seven to eighteen layers of fibrocartilage that are alternately arranged: One layer may be horizontal, the next diagonal, the next vertical, and so on, giving the disc strength and resiliency. If all the layers went in the same direction, the disc would be strong in handling certain forces but weak in others. Much like a tire on your car, each layer of steel belts embedded in the tire allow for it to move and flex as it goes around a turn, but at the same time be very strong. Similarly, the disc has to be able to withstand not only compressive forces for which it was designed, but also resist, support, and limit flexion and rotation. These layers of the annulus fibrosis allow it to distribute weight (forces) onto the vertebrae as well as protect the vertebral end plate which nourishes our discs.

The center of the disc is called the nucleus—the jelly in the donut so to speak. It is a gel-like structure comprised primarily of water that provides shock absorption. As forces are applied to your disc (donut), your nucleus moves depending on the nature and direction of the force. When a compressive force is applied to the disc, flattening out the jelly donut, the nucleus is evenly pushed out 360 degrees. If the force is applied only to the back of the disc (as if you are arching your back), the nucleus moves forward; if force is applied to the front of the disc (as if you are bending forward) then the nucleus is pushed backward. This becomes very important when we discuss disc herniations and bulges, because it is the nucleus that pushes its way through the annular fibers and causes trouble.

Muscles

We have talked about the bones, which are the framework for the spine, and now we must also discuss the muscles that align the spine. Think of these as the support mechanism that keeps the spine aligned, allowing it to move safely and return to its proper original position. Your body is comprised of two groups of muscles: mobilizers and stabilizers. The mobilizers are "mirror muscles"—the ones that you see in the mirror when you flex your muscles. These produce a lot of torque, meaning they are your power-generating muscles. With a predominance of type II muscle fibers, they build tension rapidly and are designed for strength over endurance, but tend to fatigue quickly and work better with higher amounts of resistance. Stabilizers, on the other hand, are located much deeper in the body. These are muscles you generally cannot see from the outside. Let's look at each group more closely.

Stabilizers of the Spine

The stabilizers are small muscles located close to the joint they stabilize. They primarily consist of slow-twitch muscle fibers (except for a select few), and do not provide a lot of power, but are built for endurance. Responsible for posture, they are often referred to as your "postural muscles," meaning they keep the joints in

Fast-Twitch Versus Slow-Twitch Muscles

Fast-twitch muscles fire quickly and are able to produce a lot of power, but the cost of producing this amount of power is that they fatigue easily. These muscles run out of energy (oxygen) quickly, so they are not meant for endurance, but for strength. They are the larger muscles that you can see in the mirror. The sprinter, Usain Bolt, for instance, has very large lower body muscles; being the "fastest man alive," you would expect that, but you wouldn't expect him to run a marathon. His muscles are built for quick bursts of speed and power.

Slow-twitch muscles are the endurance fibers. They don't produce nearly as much strength and power but can contract for a longer period of time and for a greater number of repetitions. Postural and stabilizing muscles fall into this category. There are also intermediate fibers that, depending on whether you train primarily for endurance or for power, will take on the characteristics of those fast- or slow-twitch fibers.

proper alignment allowing the joints to move the way they were designed. These muscles work best with low resistance. If too much resistance is used, the larger mobilizing muscles will try to "out-muscle" the smaller stabilizers, bypassing the training of these incredibly important, often forgotten muscles.[6,7,8]

When talking about the low back, most people think about the muscles that you can see on either side of your spine. Place your hand on either side of your lumbar spine. On each side of it, you will first feel a little valley and then a large muscle, which is actually a collection of muscles called your erector spinae, the mobilizers of the spine. These are the muscles that feel so good when you receive a massage. They are often quite tight and can limit your range of motion.

However, these are *not* the muscles we want to talk about right now.

Move your fingertips into that valley between the spine and the erectors (see figure 1.3*a*). You've now located the spinal stabilizers. Stand up and find that valley just off your spine again (see figure 1.3*b*). Lean forward slightly until you feel this space bulge up against your fingers (see figure 1.3*c*). That feeling is your spinal stabilizers firing. Did both sides fire at the same time? If they didn't that indicates that you may have some dysfunction in your spinal stabilizers. This forward-leaning motion will be reintroduced in the exercise section and I will explain how to get them firing together again.

Your spinal stabilizers are the most important muscles of the spine. These muscles are nearest to the spine; in fact, they lie right on it and hold it together through activity and movement. These muscles have multiple responsibilities, which is to both allow *and* restrict movement. They govern the amount of movement your spine is allowed, and at the same time, can assist the larger muscles in performing a particular range of motion.

The spine has a limited range of motion based on its given structure and biomechanics. The disc, for instance, can only move so far without causing

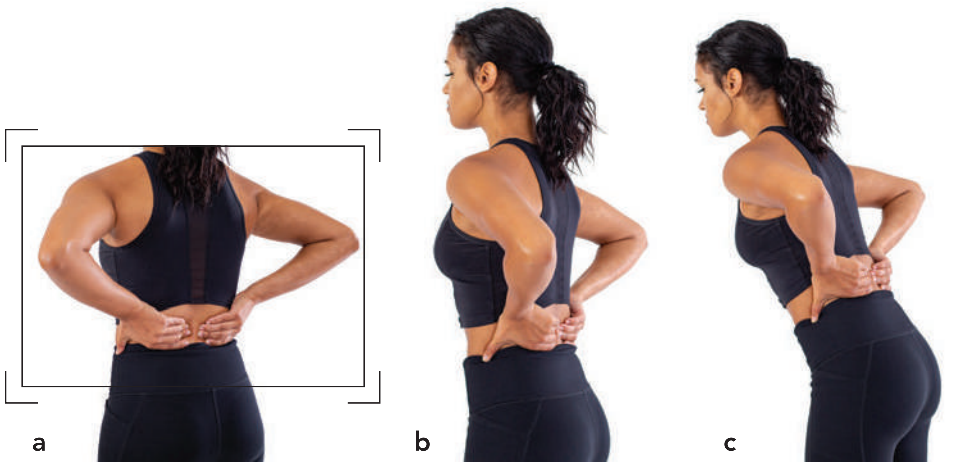

FIGURE 1.3 Finding and assessing your spinal stabilizers.

damage to itself. The bones, likewise, are restricted because too wide a range of motion can lead to damage and injury. The spinal stabilizers are responsible for limiting these motions. They are also responsible for returning the bones back to their original position. Like a spring on a door that slams shut after it's been opened, these muscles restore the spine to its proper position.

The spinal stabilizers are made up of four different muscles: interspinalis, intertransversarii, rotatores, and multifidus (see figure 1.4). They work together to create an interconnected web-like structure, connecting one vertebra to another while allowing some movement.

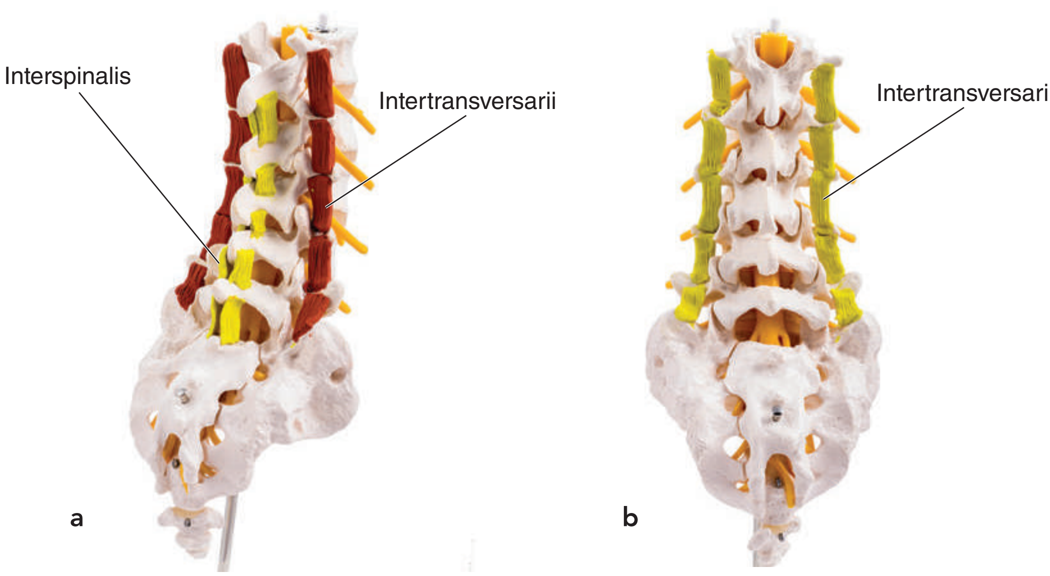

FIGURE 1.4 Spinal stabilizers: *(a)* interspinalis, *(b)* intertransversarii.

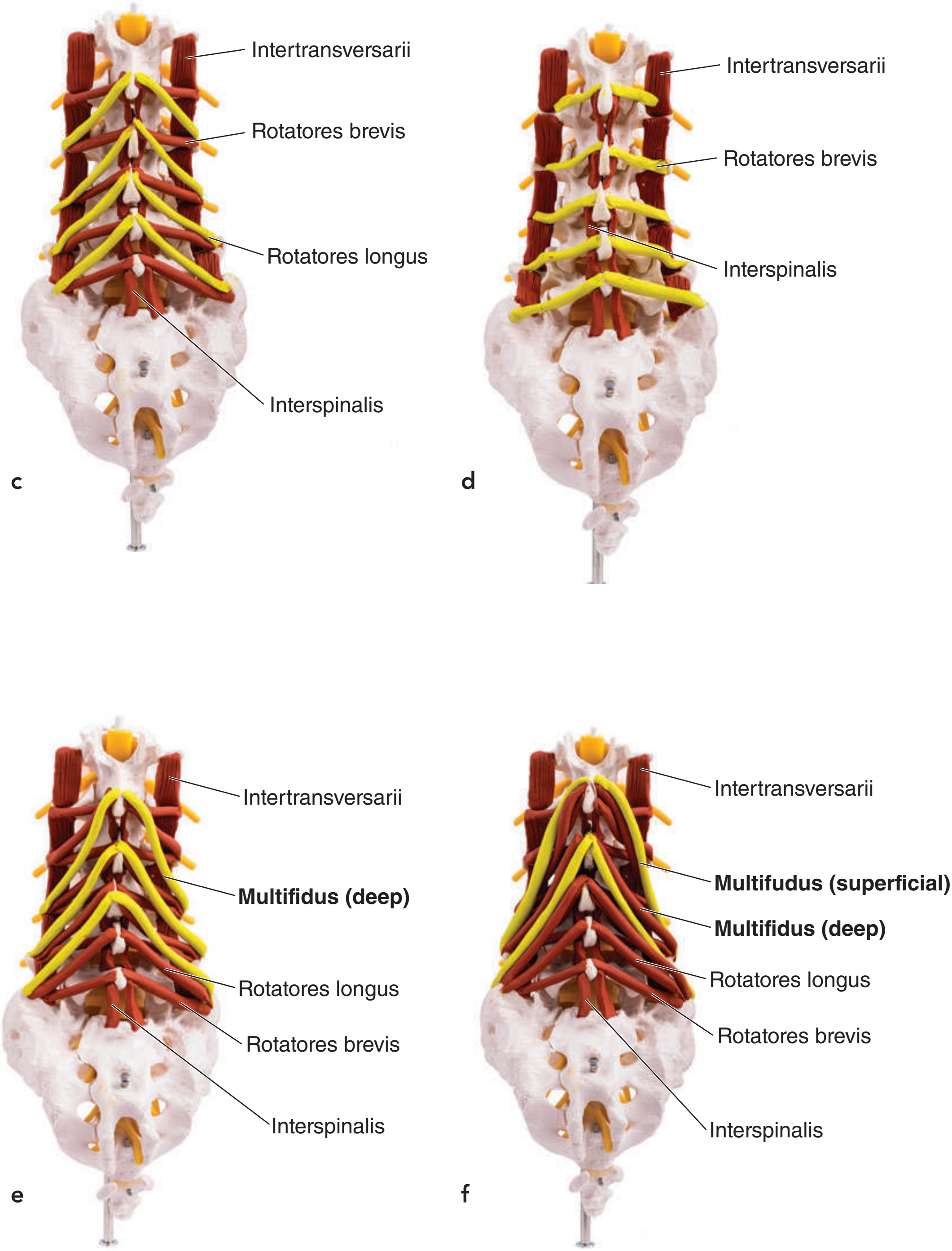

FIGURE 1.4 Spinal stabilizers: *(c)* rotatores longus, *(d)* rotatores brevis, *(e)* deep multifidus, and *(f)* superficial multifidus.
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Interspinalis

The deepest layer of the spinal stabilizers is the interspinalis (see figure 1.4*a*). This muscle connects from the superior (top vertebra) spinous process to the adjacent spinous process below and is seen primarily in the cervical and lumbar regions of the spine. When the interspinalis fires, it helps to extend and stabilize the spine.

Intertransversarii

The intertransversarii runs in pairs on both sides of your spine from the superior transverse process to the one below, and is found primarily in the cervical and lumbar region (see figure 1.4*b*). When both sides contract, it stabilizes the spine and assists in extending it. If only one side fires, it assists with side bending (lateral flexion).

Rotatores

The rotatores are made up of two sections called the longus and brevis, meaning long and short (see figure 1.4 *c* and *d*). This muscle travels from the spinous process of the superior vertebra (e.g., L1) to the transverse process of the next two vertebrae (L2 and L3). It looks like a wide A. This muscle is most prominent in the thoracic spine, though some literature shows it also in the lumbar spine. Its job is to support the spine and assist in extension and rotation.

Multifidus

The multifidus gets the most attention. People often mention this muscle when they are referring to all the spinal stabilizers. It's easy to see why; the multifidus has the largest surface area of the spinal stabilizers, which means it is easiest to see and easiest for researchers to study. This muscle, like the rotatores, starts at the spinous process of one vertebra (L1) and goes down two, three, and four levels (L3, L4, and L5). This muscle is present from the second cervical vertebra (C2) all the way down the spine. It is a primary stabilizer but also assists in spinal extension, lateral flexion, and rotation.

All of the spinal stabilizer muscles, and the multifidus specifically, support your posture and have a large number of slow-twitch muscle fibers. However, the multifidus has the added distinction of consisting of quite a large amount of fast-twitch fibers.[5] Figure 1.4*e* shows the deep multifidi spanning two levels which are assumed to have more slow-twitch muscle fibers and less fast-twitch muscle fibers. Figure 1.4*f* spans three levels which is a more superficial portion and presumed to have more fast twitch muscle fibers. The slower twitch muscles help you to maintain posture for long periods of time and allow you to maintain and return to correct spinal position throughout everyday activities. Without them, the spine would be quite fragile and at greater risk of injury. The fast-twitch fibers are automatic fibers that are responsible for being able to set and reset the spine quickly without any thought. Think of it as a safety