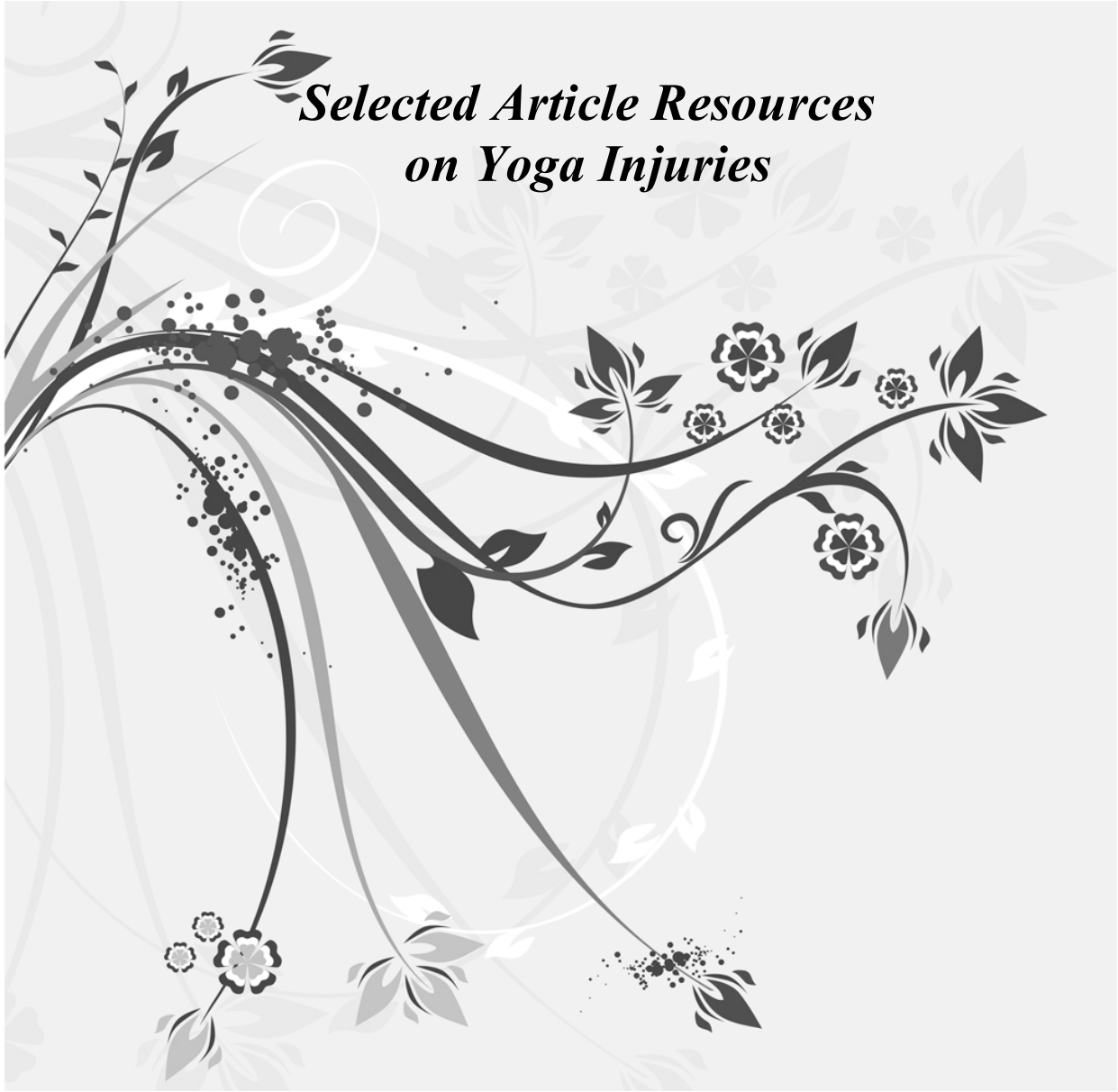
Selected Article Resources on Yoga Injuries



Intuitive Alignment: Tadasana Hips

As teachers, we adjust our students to help them understand alignment, but are we creating dependency? Here's how to help your students help themselves in Tadasana, the building block for all yoga poses.
By Roger Cole

If you adjust a student in Tadasana (Mountain Pose), she will be aligned for a moment, but if you teach her how to *feel* Tadasana, she will be aligned for a lifetime. Tadasana is the root of all yoga postures, so improving it can revitalize a student's entire practice. Although it's simple in concept—just stand up straight—it's often a challenge for beginners because they can't see themselves in the pose. As teachers, we instinctively act as an extra set of eyes for our students, observing them from various angles and suggesting, through word, touch, or example, that they move one body part this way, another that way, until they line up better. This works for some students, but for others it can be an exercise in frustration—it can be hard for them to reproduce your corrections accurately on their own. What they really need is to learn what Tadasana alignment feels like from the inside so they can create it from scratch whenever they want. In this column, we'll focus on ways you can teach your students to feel a crucial element of Tadasana alignment: accurate placement of the pelvis and hip joints. In next month's column, we'll expand on this technique and apply it to teaching alignment of the whole body in Sirsasana (Headstand). Before we launch into specifics, let's acknowledge that there is more than one path up the mountain. One excellent way to teach Tadasana that will <u>not</u> be covered here is to have your student stand with her back against a wall, make various adjustments, then maintain these adjustments as she steps away from the wall and re-establishes the pose. This can be very effective, but once your student is away from the wall she no longer gets ongoing sensory feedback from it about her body position. The techniques below are intended to teach your student how to get that kind of feedback from her internal sense organs. Once she has learned to listen to these sensations in Tadasana, she will be able to do the same in many other poses.

Before you can teach a student how to align her hips in Tadasana, she must position her feet and legs properly. Make sure she starts by:

pointing her feet straight ahead
distributing her weight equally between her inner and outer feet
extending (straightening) her knees completely
lifting her kneecaps and pointing them straight ahead.

With her feet and legs in place, you can teach her the four elements of positioning her pelvis and hips in Tadasana:

equalize hip height
neutralize pelvic tilt
neutralize front-to-back placement (whole pelvis not too far forward, not too far back)
point pelvis straight ahead (don't bring one hip forward of the other).
Equalize hip height: Unless your student has an anatomical abnormality in her feet, legs or pelvis (such as a difference in bone length between her left and right legs), her hip joints will be at the same height as one another when her pelvis is centered between her feet. If her body is symmetrical left and right, her feet will bear equal weight when her pelvis is centered. So, in most cases, even though your student cannot see her own pelvis in Tadasana, you can teach her to equalize the height of her hips simply by instructing her to shift her pelvis left and right until she feels exactly the same amount of weight on her two feet. Students who have structural anomalies may require more complicated instructions that are beyond the scope of this column.

Neutralize pelvic tilt: To help your student place her pelvis in a neutral (non-tilted) position, first have her place her fingers on her left and right pelvic rims (iliac crests) and trace forward along both rims until she locates the foremost point (the anterior superior iliac spine, or ASIS) on each side.. Next, while she keeps her fingers on the fronts of these spines, have her bring her attention to the position of her pubic symphysis (the junction of the two pubic bones at the midline of the front of the pelvis, often incorrectly referred to by yoga teachers as "the pubic bone"). Have her tilt her pelvis backward (moving her ASISs backward and her pubic symphysis forward) or forward (ASIS forward, pubic symphysis backward) until the ASIS and the symphysis lie in the same vertical plane. In other words, the pubic symphysis should be neither in front of nor behind her two anterior superior iliac spines. For most students, this will create a neutral pelvic tilt. When she achieves it, your student will have a moderate inward curve in her lower back.

Neutralize front-to-back placement of the pelvis: The instructions in this paragraph involve whole-pelvis movements, rather than tilt. They will help you teach your student to feel for herself how far forward or backward to place her pelvis relative to her feet. When she finds the right spot, her pelvis will balance naturally atop her legs. For some people, the optimal balance point is where the hip joints line up exactly above the ankle joints; for others, the ideal hip position may be a little forward of this.

The technique described here will only work if your student's pelvis is in the neutral (non-tilted) position (see previous section). Note that as she experiments with different fore and aft positions of her pelvis it will probably tilt a little out of neutral. She will need to correct this to finalize the pose.

To teach front-to-back hip placement, you will first show your student how to use palpation (feeling with her fingers) to identify the position she wants, then have her graduate to using internal sensations alone to guide her self-adjustments. We'll explore ways to teach this from both the front and the back of the pelvis.

Here's how to do it from the front. First, starting in Tadasana, have your student lift one foot, flexing her hip until her thigh is parallel to the floor and her knee points straight ahead. Have her trace one fingertip up the midline of the front of her lifted thigh until she reaches the crease at the junction between the front of her thigh and her pelvis (her front groin). Here, she will find the tendon of her contracted rectus femoris muscle or the nearby sartorius muscle under her finger. (Note that the tendon will bulge out, interrupting the crease at this point.) Instructing her to keep her fingertip on this spot, have her lower her foot back to Tadasana and find the same "front hip crease" spot on the other side with the corresponding fingertip of her other hand.

Once she has her fingers in place, ask your student to press firmly inward (toward the back of her body), indenting the flesh enough to notice how springy it feels. Then have her deliberately shift her hips well forward of the Tadasana position (see photo, middle panel, but exaggerate the movement more) and notice what happens. The flesh will harden under her fingers as the rectus femoris and sartorius muscles stretch. Next, have her shift her hips backward so the front hip creases deepen (see photo, bottom panel). The flesh will soften under her fingers as the muscles slacken. Have her repeat the forward and backward shifting of her pelvis, reducing the range each time, until she can feel how slight movements produce subtle differences in the firmness of the muscles. Instruct her to find the position where the flesh under her fingers feels exactly half way between hard and soft. If she has not lost her neutral pelvic tilt, this halfway point will be the Tadasana position of the pelvis.

The next step is to teach your student to do the same thing without using her fingers. To do this, she will need to notice the internal sensations of stretching and relaxation that accompany the adjustments. She can follow the instructions below with her fingers in the same place as before at first (as a transitional step), then repeat the actions with her arms at her sides in classic Tadasana position. Have her shift her hips forward as before and notice the sensations of stretch that arise at the rectus femoris and sartorius. Then have her shift her hips backward and feel that the stretch disappears. As before, have her shift her hips alternately forward and backward, reducing the range with each repetition, and noticing how the forward movement creates a feeling of stretch and the backward movement creates a feeling of laxity. Instruct her to find the position where the muscles feel exactly half way between stretched and soft. This will be the Tadasana position.

It's very useful to teach your student to make similar adjustments from the posterior (rear) side of her body as well. In Tadasana, ask her to put her fingertips on her sitting bones (ischial tuberosities), slide them about one-half inch toward the floor, then press into the flesh immediately below the sitting bones. She will be pushing on the tendons of her hamstring muscles. With her fingers in place, have her tip her pelvis and trunk a few degrees forward at the hip joints as if starting to go into Uttanasana. She will feel her hamstrings contract, making them bulge slightly under her fingertips. Next, have her return to the upright position and shift her pelvis well forward of Tadasana. She will feel her hamstrings relax and recede under her fingertips. As she did when she was palpating her front hip creases, have her alternately shift her hips forward and back, making the movements more and more subtle until she finds the point of neutrality (hamstrings neither bulging nor receding, neither hard nor totally soft under her fingers). Once she can feel this bal-

ance with her fingers, help her make the transition to feeling it from the inside by noticing the internal sensations that arise just below her sitting bones as she moves her pelvis forward and backward in ever-diminishing oscillations.

Once your student has learned to feel the internal sensations from both the front (hip creases) and back (hamstring origins) that signal neutral front-to-back alignment of her pelvis, have her neutralize both areas at the same time while practicing Tadasana. With practice, this will enable her to recreate the optimal position of her pelvis whenever she wishes without the help of a teacher or a wall.

Point the pelvis straight ahead: Preventing the pelvis from turning to one side or the other is one of the most difficult aspects of Tadasana alignment to feel from the inside. To teach it, you'll have your student use a combination of palpation and internal sensation at first, then internal sensation alone, as you did with front-to-back placement.

First have your student identify the location of her ASIS and her greater trochanter on one side. The greater trochanter is the large knob of bone that protrudes from the outside of the upper thighbone (femur). While standing, your student can feel it just beneath the skin on the side of her thigh, a little below the level of her hip joints. Have her trace a line on her skin from the ASIS to the greater trochanter, and locate the midpoint of that line. Then, have her press the tip of her index finger firmly into the skin about one half to one inch in front of that midpoint. Ask her to press the same spot on the other side of her body at the same time. Her fingertips should end up a couple of inches to the outside of and slightly higher than the "front hip crease" points she pressed to feel front-to-back alignment (described above). Anatomically, she should be pressing on the anterior (front) part of her left and right gluteus medius muscles.

Once she has her fingers in place and pressing inward, ask your student to compare the "springiness" of the flesh and the internal sensations she feels on one side vs. the other as she alternately turns her pelvis left and right. Have her to notice how, as she turns to the left, the muscle under her left finger grows firm and there is an internal sensation of contraction, while on the right the muscle softens and the sensation of contraction disappears (and vice-versa when she turns the other way). Teach her to find the point where both her finger sensations and her internal sensations feel exactly balanced between the left and right sides. Finally, have her repeat the exercise with her arms at her sides in Tadasana position, using only her internal sensations, not palpation, to judge the point where the sensations are the same on the two sides. With practice, she should be able to align her pelvis so it points quite precisely straight ahead using internal sensations alone to judge her position.

All this subtle up-down, front-back, left-right adjustment of the pelvis is a lot for a student to process. It's a good idea to divide your instruction on the various aspects of Tadasana hip alignment into several separate lessons. Ultimately, the techniques described here will empower your student to find her own Tadasana. When she does, she will have a deeper understanding of

alignment she can apply to every yoga posture.

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July 2004

Positioning the Heels in Backbend

In Sivananda, I learned to keep my heels together and squeeze the buttocks in backbends to protect my lower back. In an Iyengar class I learned never to squeeze the buttocks in backbends. Which is correct?

By Roger Cole

—Bianca Wiedemann, Germany

Roger Cole's reply:

Squeezing the buttocks and keeping the heels together makes backbends harder, not easier, on the lower back. Here's why: An essential part of backbending is extension of the hip joints (the position in which the top rim of the pelvis is tilted backward relative to the thighs and the sit bones are forward). If the pelvis doesn't tilt back, you force your lower back to do too much of the backbending action, and it hurts.

Squeezing the buttocks and joining the heels engages muscles that outwardly rotate and separate (or abduct) the thighs. Some of these muscles prevent the pelvis from tilting fully back into the backbending position. In addition, rotating the thighs out and separating them brings the top, outer part of the thigh bones (the greater trochanters) behind the pelvis, where they also block a backbending movement. If the pelvis doesn't do its share of the backbend, the lower back takes too much of the bend.

A part of the buttocks (the lower part of the gluteus maximus) should contract in backbends, however. Its job is to help extend the hip joint while avoiding external rotation. To learn to distinguish helpful from unhelpful actions, try this exercise. Stand upright in Tadasana (Mountain Pose). Put all your weight on one foot. Without leaning the torso forward, lift the other leg straight behind you, keeping the knee straight.

Turn your head and look back at your lifted foot. Notice that the toes are turned part way out, the heel in. This is because the gluteus maximus muscle that lifts the leg extends the hip joint and externally rotates it. So at this point, you are contracting both muscle fibers that are helpful for backbends (those that extend) and muscle fibers that are unhelpful (those that externally rotate).

Feel the buttock of the lifted leg with one hand. Notice that most of it is contracted. Now, keeping the leg lifted, squeeze your two buttocks together. Notice that the upper part of the buttock contracts more, and the lifted foot turns out more. Now you are contracting still more unhelpful muscles that cause external rotation.

Return to standing upright on two feet in Tadasana. Turn both feet in, with big toes touching and heels separated about 6 inches (15 cm). Again lift one foot straight back as before, but this time, strictly maintain the internal rotation of the thigh, so the toes still point in and the heel stays out.

Now feel with your hand which part of the buttock is contracting.

You will find that the lower buttock where it joins the thigh is firm, but the upper buttock (the place that contracted when you squeezed the buttocks together before) is now soft. This is the correct action for backbending, because it selectively contracts those muscle fibers that extend the hip joint while avoiding those fibers that externally rotate it.

Note that people who backbend very easily at the hip joint may be able to do some backbends without contracting any part of the gluteus maximus at all, even the part that extends the hip joint. However, everyone must contract those gluteus fibers at least somewhat in poses like Setu Bandha Sarvangasana (Bridge Pose), Urdhva Dhanurasana (Upward Bow Pose), and other postures that require lifting the pelvis off the floor from a supine position.

Roger Cole, Ph.D., is a certified Iyengar Yoga teacher and a research scientist specializing in the physiology of relaxation, sleep, and biological rhythms. He trains yoga teachers and students in the anatomy, physiology, and practice of asana and pranayama. He is based at North County Yoga Center in Solana Beach, California, and teaches workshops worldwide.

Forget Six-Pack Abs
Healthy abdominal muscles are strong, not hard.

By Fernando Pagés Ruiz

Have you ever stood at the mirror, sucked in your stomach and thought, "I wish I could look like this all the time?" If you grew up in the United States, your answer is probably yes. Madison Avenue has sold us the notion that taut abdominals are the quintessence of health and beauty. Rock-hard bellies are used to promote everything from underwear to cereal.
But if you yearn for the rippled look of "six-pack" abs, consider what you may sacrifice to obtain it: That look might cost you flexibility and freedom of movement. Overdoing abs exercises can lead to a flattening of the lumbar curve, creating a weakened spinal structure. "We're even beginning to see hunchback conditions because of excessive abdominal crunches," claims biomechanics and kinesiology specialist Michael Yessis, Ph.D., author of *Kinesiology of Exercise* (Masters Press, 1992).

Society's obsession with flat tummies has psychological consequences too. "We want to control our feelings, so we make our bellies hard, trying to 'keep it together,'" says yoga teacher and physical therapist Judith Lasater, Ph.D., author of *Living Your Yoga* (Rodmell Press, 2000). Soft bellies appear vulnerable; abs of steel don't. But the traditional military posture of attention—chest out, belly in—not only makes soldiers appear hard and invulnerable, it also foils their independence. Soldiers are supposed to follow orders, not intuition. Yogis may be warriors too, but we want to shed armoring. Tension interferes when trying to access the deeper wisdom that rests in the belly. As yogis, we require a supple abdomen in which we can sense the stillness of our being.

Healthy Bellies
"We're a culture afraid of the belly," laments Lasater. In our societal obsession with abdominal minimalism, we often lose sight of the true nature of this crucial part of the body. Abdominal muscles assist breathing, align the pelvis, flex and rotate the trunk, keep the torso erect, support the lumbar spine, and hold in the organs of digestion. The crunch-obsessed fitness buffs are *partly* right, though: Strong, toned muscles at the core of your body support good health. But that does not mean we should cultivate a permanent navel cramp, hold our breath, and stand like soldiers on parade. Take a look at the Buddha, perhaps the world's best-known yogi. In many paintings and statues, he doesn't have "abs of steel." Yogis know that chronically tight abdominals aren't any healthier than chronically tight hamstrings or back muscles. Yoga can help you develop the perfect balance of abdominal strength, suppleness, relaxation, and awareness.

Of course, different yoga teachers approach abdominal exercise in different ways. Some approach the belly primarily through sensory exploration, helping us become sensitive to all the layers of muscles and organs; others use standing poses, employing the arms and legs to

strengthen the abdominals in their function as stabilizers for the limbs. Still others stress motion, emphasizing that the value of abdominal muscles lies in their ability to move and change shape. But all of the yoga teachers I spoke to highlighted four themes in common: (1) Movement springs from the body's center of gravity just below the navel; (2) asanas train this core to act as a stable base and fluid source of movement; (3) abdominal muscles should be toned but not tense; (4) the first step in abdominal fitness requires learning to sense this core, becoming familiar with it from the inside.

Tummy Topography

A basic knowledge of the belly's anatomy can help us approach core work with a more accurate mental map. So let's peel away the layers and see what lies under the skin.

Abdominal skin differs from much of the skin covering the rest of the body. It has a subcutaneous tissue that loves to hoard fat. It can store up to several inches. Those fat-free torsos you see in advertisements are possible for less than 10 percent of the population. You have to have really thin skin to show muscle, explains Richard Cotton, spokesperson for the American Council on Exercise, and this takes more than diligent exercise; it takes the right genetics.

You have to be young too. Once fat cells accumulate around your torso, they don't disappear. You can starve them; they'll shrink. But they will always be there, endeavoring to fill up. Too much belly fat—we all know—is unhealthy. But working too hard to eliminate fat can also cause serious problems. Women can suffer estrogen depletion, bone weakness, and fractures. "A few millimeters of fat over those muscles don't matter," Cotton says. Most adults, including distance runners and people of optimal health, carry a slight spare tire around their middles.

Instead of obsessing about fat, we'd do better to focus deeper. Right under the skin, a sturdy wall of four paired muscles stretches over our internal organs. On the surface, the straplike rectus abdominus extends along the front, from pubic bone to sternum. On either side, a thin but powerful muscle, called the external oblique, courses diagonally from the ribs to the rectus, forming a "V" when viewed from the front. Running perpendicular to the external obliques, the internal obliques lie just below. These two pairs of muscles work in concert, rotating the trunk and flexing it diagonally. The innermost layer of abdominal muscle, the transversus, runs horizontally, wrapping the torso like a corset. You flex this muscle to pull in your belly. The sinewy, three-ply sheath formed by the transversus and the obliques provides a strong, expandable support; it protects the viscera and provides compression that aids elimination and a housing flexible enough for diaphragmatic breathing.

You can exercise all of these muscles with yoga. For example, when you raise your legs and torso in Navasana, you're contracting the rectus abdominus, drawing your sternum toward the pubic bone. Holding postures like Navasana helps invigorate this muscle isometrically, toning your abdomen without compromising flexibility. You engage the upper portion of the rectus when you flex your torso forward while keeping your legs stable, as in Paschimottanasana (Seated Forward Bend). Conversely, you engage the lower portion of this muscle by raising your legs while maintaining a stable torso, as in Urdhva Prasarita Padasana (Upward Extended Foot Pose, a.k.a. Leg Raises; see below). To keep the rectus not just strong but flexible as well, it's important to combine contraction exercises with complementary stretching postures like Setu Bandha Sarvangasana (Bridge Pose) or Urdhva Dhanurasana (Upward Bow Pose). A strong, re-

sponsive rectus will protect your lower back and allow you to sit up with ease. But don't overdo it. Overworking this muscle can not only compromise your backbends, it can actually bunch up your torso and flatten the natural curve of your lumbar spine.

Rotational exercises like Jathara Parivartanasana (Revolved Abdomen Pose) engage the internal and external obliques, key muscles for developing a firm abdominal wall. These muscles also stabilize the spine while rotating the trunk and pelvis. For example, when you kick a ball, the obliques rotate your pelvis. When you throw a ball, the obliques pull your shoulder around. In asana practice you can exercise the obliques by either holding the shoulders steady while rotating the trunk, as in Jathara Parivartanasana, or rotating the shoulders while keeping the legs steady, as in Parivrtta Trikonasana (Revolved Triangle Pose). These muscles also stabilize your vertebrae to maintain spinal alignment when you lift a heavy weight. When toned well, the diagonal muscle fibers of the internal and external obliques form a powerful, interlacing network that draws in the abdomen. As you engage the obliques in asana practice, imagine yourself cinching up the strings of a corset, drawing from the sides to flatten the front.

The transversus abdominus also plays an important role in maintaining a toned abdominal wall. You engage this muscle when coughing, sneezing, or exhaling forcibly. Unlike the other three abdominal muscles, the transversus doesn't move your spine. Perhaps the most effective means of exercising it entails working with the breath. Pranayama practices involving forceful exhalations, like Kapalabhati and Bhastrika (called by a variety of English names, including Breath of Fire, Skull Shining, and Bellows Breath) provide an excellent workout for the deep transversus. To feel this muscle contract, stand with your feet shoulder-width apart, bend your knees slightly, and place your fingers on your sides, just below the rib cage. Now cough and feel the muscles under your fingers contracting forcefully. To contract this muscle even further, try this: Rest your hands on your thighs. Take a full breath, then exhale completely while contracting your abdomen to expel the last bit of air from your lungs. Then, without drawing in any new air, begin counting aloud: One, two...etc. You will experience your transversus cinching around your waist tightly, like a belt. Before the lack of oxygen becomes uncomfortable, relax your abdominals and allow the air to draw in slowly. This important classic yoga exercise is called Uddiyana Bandha (Upward Abdominal Lock). As you begin to grasp it, you can try further traditional exercises like Agni Sara Dhauti (Cleansing through Fire) and Nauli (Abdominal Churning), which are used to massage the abdominal organs.

Breathing Room

People who work with the breath—singers and woodwind musicians, for instance—know it's connected to the belly. Your diaphragm lies at the base of your lungs, directly over your liver and stomach. When your diaphragm contracts, it moves these organs out of its way, pushing your belly out slightly. If you breathe primarily by using the muscles of your rib cage, without taking advantage of the diaphragm's power, you're limiting your breath to accessory muscle groups too weak and inefficient to fill your lungs completely. But if your abdominal muscles don't release, your diaphragm can't descend fully. That's why yogis balance abdominal strength with flexibility.

Keep in mind that deep, diaphragmatic breathing does not entail pushing your belly out deliberately. Full belly breathing just requires a naturally alternating engagement and release. To assure deep diaphragmatic breathing, first engage the abdomen in a complete exhalation, then allow

your lungs to fill up naturally, relaxing the abdomen but not pushing it outward.
This fluid interplay of abdominal muscles and lungs provides an excellent focus for a meditation that you can use to complete your abdominal work. Lying on your back in Savasana (Corpse Pose), breathe slowly and deliberately, sensing the strength of your inner core as your obliques and deep transversus muscles compress to expel the air from your lungs completely. Then enjoy the flow of oxygen that fills your chest as these muscles release, creating space for prana to stream into your heart like water flowing into a basin. After a few minutes, allow your breath to resume its natural pattern. Observe it without criticism or effort. Imagine your abdominal cavity as the fluid container of your deepest wisdom and feel the energy at your navel radiating throughout your body.

Your Sacred Center

Our center of gravity lies just below the navel, a spot many yoga teachers call the "power center." The source of our vitality, the abdomen is a sacred space in our bodies, so we would do well to shift from criticizing how it looks to respecting how it feels. Ana Forrest, owner and primary teacher at Forrest Yoga Circle in Los Angeles, says she's observed that as people begin to sense and move from their lower torso, over time they experience a surge in creativity and sexuality.

Throughout the world's healing and mystical traditions, the belly is seen as an important center of energy and consciousness. Tantra yoga sometimes represents the navel as the home of *rajas,* or solar energy. In Tantric practice, the yogi stirs up rajas in the belly by using the breath, helping to create a divine body endowed with paranormal powers. You've probably noticed that many of India's great spiritual adepts sport prodigious bellies. These tremendous tummies are thought to be full of prana. Hence, Indian artists often depict their deities with a paunch.
In China, the gentle art of tai chi emphasizes the lower abdomen as a reservoir for energy. Tai chi teacher Kenneth Cohen, author of *The Way of Qigong* (Ballantine Books, 1997), explains that it's possible to strengthen the abdominals by learning how to compact qi (prana) into the belly. "From the Chinese viewpoint, the belly is considered the dan tian or 'field of the elixir,' where you plant the seeds of long life and wisdom," Cohen explains.
If you're skeptical of all this esoteric anatomy, consider the work of Michael Gershon, M.D. "You have more nerve cells in the gut than you do in the combined remainder of the peripheral nervous system," Gershon claims. Gershon, who chairs the department of anatomy and cell biology at Columbia University's College of Physicians and Surgeons at Columbia Presbyterian Medical Center, says he's quite sure that our thoughts and emotions are influenced by the gut.
Gershon came to this unorthodox conclusion through meticulous research on serotonin, an important brain chemical that also functions in the bowel. Operating independently from the brain, a huge nervous system that Gershon has dubbed the "second brain" works silently in the abdomen. Gershon explains that this gut brain, properly known as the enteric nervous system, doesn't "think" in the cognitive sense—but it constantly affects our thinking. "If there isn't smoothness and bliss going up to the brain in the head from the one in the gut, the brain in the head can't function," Gershon says.
So the next time you're critically eyeing your stomach, you might consider instead saying a reverent Namaste to your power center and home of your gut instincts. And you can also help culti-

vate the belly bliss Gershon recommends by employing an integrated approach to abdominal work, combining somatic and energetic awareness with asana and pranayama.

A recovering six-pack-abs junkie, Contributing Editor Fernando Pagés Ruiz writes health and fitness articles from his home in Lincoln, Nebraska. He can be reached at fpages3@aol.com.

Yoga Journal
March/April 2001

Yoga With a Herniated Disk

I am a 31-year-old male with a herniated disk in my upper back at T3-4 and in my lower back at S5. Which asanas would create space at these levels and re-nourish the disks?

By Roger Cole

—*Randy Jellen, Lisle, Illinois*

Roger Cole's reply:

First of all, your yoga program should be tailored to your individual needs by an experienced teacher; some postures that are wonderful for one person may bad for another. That said, most of the postures you practice should probably be modified with props—your teacher can show you how to use blankets, blocks, bolsters, straps, and other props to put gentle traction on your spine.

Here is some general advice for protecting your back after disk injury:

- While your back pain persists, do not bend forward past 90 degrees with straight knees.
- Avoid all seated forward bends.
- Avoid rounding your back.
- If a pose causes any pain, tingling, or numbness, stop immediately.

Bear these cautions in mind as you practice this list of asanas that many people with disk problems find helpful. They may be practiced in the order presented, but it is not essential. You can start out with just one or two postures, then gradually add more over several days or weeks. You can consult B.K.S. Iyengar's book *Yoga: The Path to Holistic Health* (London: Dorling Kindersley, 2001) for photos and detailed descriptions of many of the poses.

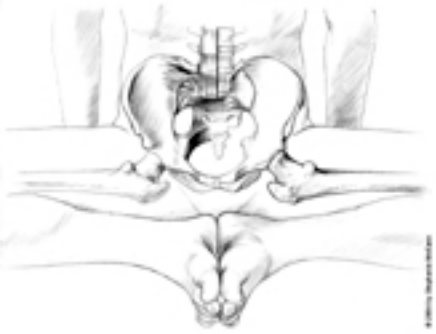
- Savasana (Corpse Pose)—legs elevated, knees bent, calves supported on chair seat
- Tadasana (Mountain Pose)
- Marichyasana III (Marichi's Pose)—stand sideways at wall with foot nearest wall supported on stool or chair seat; twist gently toward wall
- Bharadvajasana (Bharadvaja's Twist)—seated in a chair
- Virabhadrasana II (Warrior II Pose)—stand with back against ledge or counter top, press hands down on ledge for support
- Utthita Parsvakonasana (Side Angle Pose)—take bottom hand to block for support
- Utthita Trikonasana (Triangle Pose)—stand with back against ledge or counter top, slide bottom hand along ledge to support and lengthen spine, use top hand on ledge behind top hip to

improve alignment

- Ardha Urdhva Mukha Svanasana (Half Upward-Facing Dog Pose)—with hands on back of chair, not on floor or seat of chair
- Supta Padangusthasana (Reclining Big Toe Pose)—with belt around foot, with bent knees at first
- Balasana (Child's Pose)—with trunk supported on a bolster or three long folded blankets
- Savasana (Corpse Pose)—legs elevated, knees bent, calves supported on chair seat

Roger Cole, Ph.D., is a certified Iyengar Yoga teacher and a research scientist specializing in the physiology of relaxation, sleep, and biological rhythms. He trains yoga teachers and students in the anatomy, physiology, and practice of asana and pranayama. He is based at North County Yoga Center in Solana Beach, California, and teaches workshops worldwide.

Practice Tips for the Sacroiliac Joints:



Learn the three major ways to help your students prevent or treat SI problems.

By Roger Cole

After learning all the ways that asanas can stress the sacroiliac area in Protect the Sacroiliac Joints in Forward Bends, Twists, and Wide-Legged Poses, you may be thinking, "Maybe I'll just advise my students to give up yoga, go home and sit on the couch watching reruns of *Sex and the City* until their SI joints fuse . . . and I'll ask them to save me a seat." Luckily, you can do better than that (and not just by picking a better TV show).

To help your students prevent sacroiliac joint (SI) problems, or avoid making existing ones worse, follow these three suggestions: *put it in place*, *stabilize it* and *move it with care*.

I. Put it in place

If your student does not have an existing SI problem, or if she has had SI problems but her joints are currently in good alignment (pain-free), you can skip to suggestion 2, "Stabilize it." If your student's SI joint is currently out of place, advise her to try to get it back into place before practicing asanas. This is easier said than done, and it doesn't mean she can't ever practice if her SI joint is a little out of place, but it's much better to practice with the SI joints where they belong.

One way to get a misaligned SI joint into place is to have a qualified health professional, such as a physical therapist, chiropractor, or osteopath, physically manipulate it. As a yoga teacher, you don't have license to do this yourself, so don't try unless you have additional qualifications. Also, despite their training and licensing, most health professionals really don't understand how

to manipulate the SI joints effectively, so advise your student to be careful to choose a caregiver who has a track record of helping with this specific problem.

A second way your student might get her wayward SI joint back into place is by practicing specialized asanas to put it there. There is not room in this article to go into the details, but here is a general framework for understanding these poses. There are lots to choose from, and each health professional or yoga teacher seems to have her favorite. Despite the wide variety, postures that help realign the SI fall into just four simple categories.

Backbends, like Supta Virasana (Reclining Hero Pose), may help by directly pushing the top of the sacrum backward into place.

Modified twists can sometimes help by rotating one side of the sacrum backward and the other forward; however, these poses tend to be complicated and tricky to perform, and the wrong twist can easily make matters worse, so your student needs to learn them from a specialist.

One-sided pelvic tilts, such as reclining and drawing one bent knee toward the armpit on the same side, may help by focusing the adjustment specifically on the joint that is out of place, so that the ilium shifts in the right direction relative to the sacrum.

Exercises that pull the ilium bones apart, such as certain variations of Padmasana (Lotus Pose), or specialized poses that use props or muscle actions to apply lateral pressure to the upper thighbones, may help by opening the top part of the SI joint space. This seems to give the upper sacrum room to slide back into place without grating its rough auricular surface across the auricular surface of the ilium.

Many of the most successful SI-adjusting exercises combine elements from more than one category, and some add another factor: muscular resistance. For example, practicing Salabhasana (Locust Pose) variations with just one leg lifted combines backward bending with one-sided pelvic tilting and works muscles against the resistance of gravity. Combining a Padmasana action with a backbend (as in some forms of Matsyasana, or Fish Pose) can often create both the space and the movement needed to put the sacrum back where it belongs.

There are a few crucial things to tell your student about adjusting her SI joint, whether she does it herself or has someone else do it. First, tell her that a good SI adjustment should feel good, both during the adjustment and afterward. If the adjustment feels at all painful, or even neutral, it is probably not helpful and may even be harmful. Second, tell her that the appropriate adjustment or pose for her SI may be one-sided. An asymmetrical adjustment or posture that helps the SI when practiced on one side may well make it worse when practiced on the other. Advise her to only practice the posture on the side that feels relieved by it. Third, tell her that not all adjustments are appropriate for her. A posture or manipulation that works wonders for her friend may do nothing at all for her. Advise her to find just one or a few postures or adjustments that work

well and to abandon those that don't work. Fourth, tell her that immediately after she gets her SI adjusted into place, she is best off leaving it alone overnight (or longer) before practicing any asanas. When she does practice, she should begin with stabilization.

II. Stabilize it

Certain yoga postures and practices can help stabilize the sacroiliac region by strengthening the muscles that cross the joint or holding the pelvic bones in place.

Backbends against the resistance of gravity, such as Salabhasana, Setu Bandha Sarvangasana (Bridge Pose), and Urdhva Dhanurasana (Upward Bow Pose) all strengthen the erector spinae muscles that run vertically from the sacrum or ilium up the back. They also strengthen the gluteus maximus (buttock) muscles. Note that practicing one-legged variations of these poses (like Eka Pada Setu Bandha Sarvangasana, Bridge Pose with one leg lifted) doubles the strength demands on one side of the body and puts asymmetrical stress on the SI joints. This means that these poses can be especially effective strengthening exercises, making them therapeutic for people who have an existing SI imbalance; however, the asymmetry also has the potential to worsen an existing imbalance.

Mula Bandha (the Root Lock, performed by contracting and lifting the area bounded by the tailbone, pubic bones, and sitting bones) strengthens the pelvic floor muscles (pubococcygeus, iliococcygeus, and coccygeus) that help keep the lower end of the sacrum from lifting and the lower pelvic bones from spreading apart.

Virabhadrasana III (Warrior III) powerfully strengthens a host of muscles that either cross or affect the SI joints, including the piriformis (which runs from the front of the sacrum to the outer upper thighbone), erector spinae, gluteus maximus, and gluteus medius (which runs from the outer ilium to the outer upper thighbone). However, this pose is an asymmetrical forward bend that can irritate the sacroiliac of the standing leg, so it is best reserved for students whose SI joints are already in place and stable.

Pranayama (Breathwork) includes certain actions that cinch the waist to a narrow shape without contracting the outer layers of the abdominal muscles. These actions help selectively contract the innermost abdominal muscle layer, the transversus abdominis. Strengthening this muscle helps stabilize the SI joints by holding the fronts of the ilium bones together horizontally.

III. Move it with care

Teach your students to avoid SI injury by moving with special care in the poses that put the most strain on the sacroiliac joints, especially seated forward bends, twists, and wide-legged poses. The most important instructions are to move the sacrum and the two ilium bones as a unit, keep the pubic bones together, and roll to one side before sitting.

Move the sacrum and the two ilium bones as a unit. In forward bends, instruct your students to "lift the sitting bones" or to "lift the sitting bones and tailbone together," not "lift the tailbone" alone, because lifting the tailbone faster than the sitting bones tilts the top of the sacrum forward relative to the ilium. Instructions to lift the sitting bones (and to "tilt the top of the pelvis forward") are intended to activate the iliocostalis muscles that run vertically from the back of the ilium to the rib cage. These muscles drive the pelvic tilt by moving the ilium bones forward, and these, in turn, push the sacrum ahead of them. This is less likely to cause SI trouble than actions that attempt to drag the ilium bones forward by pulling on them with the sacrum.

Teach your students that when the pelvis stops tilting forward in a forward bend, they should also stop moving the sacrum forward. They can continue bending the spine forward a little after the pelvis stops, but they should avoid bending it too far or pulling too hard, because this can draw the sacrum out from between the fronts of the ilium bones.

Protecting the SI goes hand-in-hand with protecting the disks of the lower back (lumbar) in forward bends. Both require that your student bend gently, rather than forcibly pulling her spine forward (or allowing someone else to push it). However, to protect her disks your student has to limit the amount of forward bend in her lumbar spine. In doing so, she runs the risk of inadvertently transferring the forward-bending force that would have gone into her lumbar directly into her sacroiliac joints. To avoid this, teach your student (1) to reduce the total amount of forward-pulling force in forward bends--advise her, in particular, not to pull too hard with the arms--and, (2) to bend cleanly at the hip joints, rather than letting the body bend half way between the lumbar spine and the hips.

Moving the sacrum and the two ilium bones as a unit is also important in twists. Instruct your students not to rotate the sacrum faster than the pelvis. Rather than insisting that they hold the pelvis rigidly in place, allow them to let it turn a little along with the twist. Teach them that when the pelvis stops turning, the remaining twist should come not from the SI joints but from rotation higher up on the spine and trunk (that is, from joint movement of the thoracic vertebrae and ribs, facilitated by release and stretch of surrounding muscles).

Keep the pubic bones together. In poses that spread the thighs apart, like Baddha Konasana (Bound Angle Pose), Upavistha Konasana (Wide-Angle Seated Forward Bend), Prasarita Padottanasana (Wide-Legged Forward Bend), and Virabhadrasana II (Warrior II Pose), teach your students to release the inner thigh (adductor) muscles while keeping the pubic bones together by stabilizing them with other muscles. Although students without SI problems may need to learn to relax the pelvic floor and spread the sitting bones in these poses, those with SI instability may benefit instead from instructions to contract the pelvic floor muscles, pulling the sitting bones and pubic bones toward one another. (Using the pelvic floor muscles to pull the tailbone toward the pubic bones can also help, especially if bending forward). Also instruct your students to narrow the waist in wide-legged poses. This selectively activates the transversus abdominis muscle, which helps hold the front of the pelvis together left to right.

For many students (especially more flexible ones and those with existing SI problems), all this muscular stabilization may not be enough in Baddha Konasana. It may also be necessary to place supporting blankets under each thigh to prevent the legs (and therefore the pelvis) from spreading too far. This is even more important in Supta Baddha Konasana (Reclining Bound Angle Pose), because the alignment and relaxed muscles of this pose make it especially hard on the SI joints.

Roll to one side before sitting. After Savasana (Corpse Pose) or other reclining poses, instruct your students to roll to one side. Tell those with SI instability to move the pelvis and spine as one unit. Sitting straight up from the supine position can force the psoas and iliacus muscles to put excess forward pull on the spine and pelvis. Rolling as a unit prevents excess twisting at the SI joints.

Following these suggestions can help you and your students maintain healthy SI joints as you increase your body's mobility and advance in your practice.

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Practical Ways to Protect the Disks

Learn specific ways to protect your students from disk injuries or help them avoid exacerbating existing injuries.

By Roger Cole

This article is a continuation of Protect the Disks in Forward Bends and Twists.

How can you protect your students from disk injuries or avoid exacerbating existing injuries? The specific asana suggestions that follow are intended only for healthy students. See the next section for advice on dealing with students who have disk injuries.
Never force the spine into a forward bend. This is the most important precaution a yoga teacher must observe to prevent disk injuries. It is especially important never to push on a student's back to bend it forward, particularly if her legs are straight (straight legs stretch the hamstrings, holding the pelvis fixed, and thereby focus the bend on the lower spine). If for some reason you must perform a hands-on adjustment, place your hands on the posterior-superior part of the ilium bones (on the upper, back side of the pelvis, alongside the top of the sacrum) and guide (don't push!) the student forward in a way that rotates the pelvis around the heads of the femurs. Also, teach students not to force their own spines into flexion by pulling strongly with their arms, contracting their abdominal muscles, bouncing, etc.

Loosen the hamstrings and hip rotator muscles. Stretching the hamstrings and hip rotators reduces risk of disk injury by freeing the pelvis to move independently of the legs. This allows the hip joints to flex more and the spine to flex less when bending forward or sitting upright. Maintaining a regular yoga practice is a great way to free the pelvis, and this is one reason it is so good for the back. But herein lies the rub: the very poses that loosen the hamstrings and hip rotators--forward bends--are also potentially the most dangerous for the disks. It all depends on

which postures you choose and how you teach them.

Reclining forward bends such as Supta Padangusthasana (Reclining Big Toe Pose) are easiest on the disks. They provide the safest way for tight students to stretch the hamstrings and hips. Standing forward bends, such as Uttanasana (Standing Forward Bend), although harder on the disks, provide the best trade-off between safety on the one hand and stretch, strengthening, precise alignment, and body awareness on the other. They are suitable for most healthy students, but may need to be modified for tight students. Seated forward bends, such as Paschimottanasana (Seated Forward Bend) are good for improving sitting posture and for stretching deeply, but they are hardest on the disks and so must be practiced with the greatest caution. They usually require modification for all but the most flexible students.

To make forward bends safer, the teacher must be careful to focus the action in the hip joints, not in the lower back. One good rule of thumb is the 90-degree rule: Do not start bending the spine forward until the pelvis appears to be at a 90-degree angle to the legs. If the student cannot achieve 90 degrees, ask him not to bend the spine forward at all, but only to work on the pelvic tilt. Support him with props if necessary to achieve this. For example, he could rest his hands on a block in Uttanasana, and elevate his pelvis on a stack of folded blankets in Dandasana (Staff Pose). Once the pelvis tilts past 90 degrees in relation to the legs, ask him to flex his spine only moderately.

How much flexion is OK? Here's another convenient rule: Find a photograph of a skilled yoga practitioner with very loose hamstrings practicing Uttanasana (Standing Forward Bend) such as this one. The practitioner should be folding fully forward at the hips, elongating the front of her body, and resting the ribs and forehead on her legs. Look carefully at the degree of rounding of her back. A healthy yoga student whose hamstrings are not as loose as those of the photo model should tilt the pelvis forward until it stops, then, keeping the front of the body as long as possible, round her back only as much as the model does in full Uttanasana.

Lengthen the spine. Actions that put traction on the spine pull the vertebrae apart, increasing space for the nerves and helping the disks soak up fluid. There are simple ways your students can learn to apply traction to their own spines in asanas. One is to press their hands down into the floor while sitting in Dandasana. The downward pressure of the hands lifts the spine away from the pelvis. This action can precede many different seated forward bends or twists. There are also numerous ways to apply traction with wall ropes. One is to sit facing the wall and grasp high wall ropes to pull the trunk diagonally up and forward in partial Paschimottanasana.

Sit well. When we stand, the lumbar spine normally curves inward in what appears to be a slight backbend (lordosis). This is the healthy neutral position for the disks and spinal nerves. Teach your student to maintain this curve (but not increase it) while sitting upright in poses like Baddha Konasana (Bound Angle pose) or Sukhasana (Easy Pose), and in twisting in poses like Bharadvajasana (Bharadvaja's Twist). If his lumbar spine flattens or flexes, elevate his pelvis on enough folded blankets or other props to re-establish the curve. Also, advise your students to maintain

the normal curve of the spine while sitting in daily life, and encourage them to take frequent breaks if they must sit for long periods. A good way to take a break is to stand and walk for a while, but the best way is probably to lie down. Reclining gentle backbends may be particularly good for many people. Most non-seated asanas are also helpful. Even seated poses, though not ideal, provide relief from prolonged chair sitting.

Strengthen and stretch trunk muscles. Strong erector spinae muscles are essential to maintaining the lumbar curve, especially while sitting, but if they are too tight, they can compress the disks. Standing poses are ideal for stretching these muscles because they also strengthen them in the stretched position. One of the best actions for achieving this kind of strength is to elongate the front of the body while coming up out of Uttanasana.

Physical therapists recommend strengthening the abdominal muscles to keep the back healthy. They often recommend partial sit-ups with the knees bent, because full sit-ups, or sit-ups combined with straight-leg lifts, as in the yoga pose Paripurna Navasana (Full Boat pose), can be hard on the back. Also, if the abdominals get too tight they can cause excessive flexion in the lumbar and disk compression. Therefore, any abdominal strengthening program should be counterbalanced with a backbending routine to stretch these muscles.

Maintain a well-rounded practice. Disks do not live by forward bends alone. They also need backbends, side bends, and twists. A well-rounded yoga practice is best for preventing disk injuries.

Dealing with Existing Disk Injuries

To teach yoga to a student who already has a disk problem, you need specialized knowledge that is beyond the scope of this article. However, here are a few general suggestions:

- *Ask the student's doctor* for recommendations, contraindications, and permission to practice.
- *Get help* from a qualified yoga teacher who is experienced with disk problems.
- *Work in private lessons* instead of group classes until the symptoms are under control and the student knows how to modify her own postures for safety.
- *Do less*. If the student has a recent disk injury or an acute flare-up of symptoms, work only on finding comfortable resting positions. Anything else is likely to make matters much worse. For older, less active injuries, be content to teach just a few poses per session.

- *Watch out for forward bends and all seated poses, especially seated twists.* These can instantly trigger symptoms in students with disk injuries. Do not teach them unless a qualified teacher has recommended them and shown you how to adapt them to disk problems. Ask your student to maintain a lumbar lordosis (a natural backbend in the lower spine) at all times; do not round the spine at all, unless specifically advised otherwise.

Practicing yoga is great for your disks if you do it right, but potentially harmful if you do it wrong. It's easy to learn how to protect and nourish the disks in yoga. With a little knowledge, you can help your students avoid injury and keep their backs healthy for a lifetime.

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Protect the Sacroiliac Joints in Forward Bends, Twists, and Wide-Legged Poses

For some specialists, SI pain is a mysterious phenomenon. Learn some theories about its origin as well as practical ways to help your students prevent or treat SI problems.
By Roger Cole

If you ask a room full of beginning yoga students where their sacroiliac joints are, most will reply with a blank look that says, "I don't have a clue." This is a healthy response--if they don't know where it is, it probably doesn't hurt. If you ask a room full of more advanced yoga students--or teachers--the same question, many will immediately start rubbing a bony bump on their lower back, a couple of inches below the belt line and two or three inches to the side of the midline. That's a pathological response; they rub that spot because it aches. And if you ask a room full of orthopedic surgeons what's going on with these students and teachers, some will say the ache is coming from a sacroiliac injury, while others will pooh-pooh that idea and insist that the pain is from an injured disk or other spinal problem. What's going on here?

The probable answer is that in most people (such as beginning yoga students and orthopedic surgeons), the sacroiliac joints don't move much, if at all. Because of this, beginning students never notice them, and some doctors don't believe that anything short of a train wreck could push them far enough out of place to cause trouble. In more advanced yoga students and teachers, on the other hand, it appears that these joints often move quite a bit, and they frequently get hurt in the process.

While there is no conclusive, scientific proof that this answer is correct, there is ample medical evidence from the non-yoga world that the sacroiliac joints can indeed move and can be a source of back pain. Regardless of the cause of the all-too-familiar "SI joint" ache in asana practice, yoga teachers have discovered some very effective ways to prevent or relieve it. Let's start from the beginning and explore this SI phenomenon step-by-step so that you can learn to prevent or treat the problem in yourself or your students.

Where Does it Hurt?

First, let's make sure we're all talking about the same thing. If you've been around the yoga community long enough, you have heard many yoga students complain of what they call "sacroiliac pain" or "SI pain." If you question them carefully, you'll find that this pain usually follows a very specific pattern (described below) that sets it apart from other types of back pain. However, you will also find some students who think they have SI pain when their symptoms don't fit the pattern, and other students whose symptoms fit the SI pattern but who don't call their problem by that name.

In this article, we'll assume that pain that fits the specific pattern below originates in the sacroiliac joints or their surrounding ligaments, even though we acknowledge that some reputable people believe the pain originates elsewhere. It's very important not to confuse what we are calling SI pain with other types of back pain, because, in most cases, the explanations and suggestions in this article simply don't apply to students with other types of pain.

The cardinal symptom of SI pain is an ache on or around the posterior superior iliac spine (PSIS), on one side of the body only. The PSIS is the rear-most point of bone on the pelvis. In most students you can palpate it by pressing your fingers into the back of the pelvis above the main mass of the buttock, about two or three inches to the side of the center line of the upper sacrum. If you find it, you will feel a distinct, bony prominence beneath your fingers. If your student tells you that that spot, or the depression just to the inside of it, is achy or tender, while the corresponding spot on the other side of her body is not tender, then she probably has the classic SI problem associated with yoga. (Note that, although your student feels SI pain on or very near the PSIS, this bone actually lies a short distance away from the sacroiliac joint. We'll look at the anatomy of the joint later.)

If your student does not have pain localized over either PSIS, then she probably does not have an SI problem. For example, some students will report pain localized only on the midline of the sacrum or lumbar spine. Others will report only pain that is clearly above, below or far to the outside of the PSIS. None of these pain patterns is the classic sacroiliac pattern. If your student tells you she has pain over *both* PSIS bones, her problem is probably either (1) not of sacroiliac origin at all (in which case most of the suggestions in this article probably won't help), or (2) a complicated problem that may involve one or both SI joints along with other structures (in which case the suggestions in this article may or may not help).

When you find a student with classic, one-sided SI pain, she may tell you that the ache she feels over her PSIS also seems to radiate forward over her pelvic rim, possibly as far as her front groin or upper-inner thigh. She may also report pain that runs down the outside of the hip and leg. It is important to distinguish outer hip and leg pain caused by SI problems from sciatica. Sciatica is pain that follows the course of the sciatic nerve, and it is usually caused by a lumbar disk problem (see Protect the Disks in Forward Bends and Twists). Unlike sacroiliac pain, sciatic pain feels like it passes deep through in the fleshy part of the buttock and travels down the *back* of the thigh (on the outer side). SI pain emanates from above the buttock and travels only down the *side* of the thigh, not along the back of it. Also, if your student's pain radiates all the way to her foot, she would feel sciatica between her first and second toes, whereas she would feel SI pain only on the outer edge of her foot or heel.

Most students with SI problems will tell you that long periods of sitting and most types of forward bends aggravate their pain, but this is also true for students with sciatica and other back problems. And, as with other back problems, backbends can either relieve SI symptoms or make them worse. But unlike students with other back problems, those with SI pain are often particularly aggravated by wide-legged (abducted) poses, such as Baddha Konasana (Bound Angle

Pose), Upavistha Konasana (Wide-Angle Seated Forward Bend), Prasarita Padottanasana (Wide-Legged Forward Bend), Utthita Trikonasana (Extended Triangle Pose), Virabhadrasana II (Warrior II Pose), and Utthita Parsvakonasana (Extended Side Angle Pose). They also have trouble with twists, such as Marichyasana III (Pose Dedicated to the Sage Marichi III), and side-bends, such as Parivrtta Janu Sirsasana (Revolved Head-to-Knee Pose). For many, the worst pose is a combination of twisting, abduction, and forward bending, namely Janu Sirsasana (Head-to-Knee Pose).

Let's look at the anatomy of the sacroiliac joint to see how it can get injured and what we can do to prevent or relieve trouble there.

Sacroiliac Joint Anatomy 101

A joint is where two bones come together. The sacroiliac joint is where the sacrum bone and the ilium bone join one another.

The sacrum is located at the base of your spine. It is composed of five vertebrae that have fused together during development to form a single bone roughly the size of your hand. When you view the sacrum from the front, it looks like a triangle with its point facing down. When you view it from the side, you see that it curves, concave in front, convex behind, and that it tilts, so its top end is well forward of its bottom end. Protruding from the bottom end of the sacrum is the tailbone (coccyx).

Each half of the pelvis is composed of three bones, the ilium, the ischium and the pubic bone, that have fused together during development. The topmost bone (the one that forms the pelvic rim) is the ilium. The sacrum is wedged between the left and right ilium bones. On the upper part of the sacrum, on each side, there is a rough, rather flat surface that abuts a corresponding rough, flat surface on the ilium. These surfaces are called *auricular surfaces.* The places where the auricular surfaces of the sacrum and ilium come together are the sacroiliac joints.

The sacrum bears the weight of the spine. The SI joints distribute this weight so that half goes to each hip and, from there, to each leg. As gravity wedges the triangular sacrum firmly down between the inclined auricular surfaces of the ilium bones, it tends to force the ilium bones apart, but strong ligaments prevent them from moving. This wedging action and the resistance of the ligaments combine to form a stable joint.

Some of the ligaments that stabilize the SI joints cross directly over the line where the sacrum and ilium meet. Those on the front are called the ventral sacroiliac ligaments, and those on the back are the dorsal sacroiliac ligaments. Other strong ligaments (the interosseous ligaments) fill the space just above the SI joints, holding the ilium bones firmly against the sides of the upper sacrum. The normal, tilted position of the sacrum places its top end forward of the SI joints and its bottom end behind them. This setup means the weight of the spine tends to rotate the sacrum around the axis formed by the SI joints, pushing the top end down and lifting the bottom end up.

The sacrotuberous and sacrospinous ligaments are ideally located to oppose this rotation by anchoring the lower end of the sacrum to the lower part of the pelvis (the ischium bones).

The auricular surfaces of the sacrum and ilium are lined by cartilage. The joint space is completely surrounded by connective tissue and is filled with a lubricating fluid called synovial fluid. Like other synovial joints, the SI joints can move; however, their range of motion is very limited. For example, trained chiropractors, physical therapists and other professionals learn to feel the PSIS tilting back slightly relative to the sacrum when a standing person lifts one knee toward the chest as if marching. This rocking action is thought to aid in walking. However, according to one anatomy text,

The sacroiliac synovial joint rather regularly shows pathologic changes in adults, and in many males more than 30 years of age, and in most males after the age of 50, the joint becomes ankylosed (fused, with the disappearance of the joint cavity); this occurs less frequently in females.[1]

In other words, with age, the sacrum and the two ilium bones often merge into a single bone. This might explain why some orthopedic surgeons do not believe in SI joint injury. Perhaps they have operated on adults, seen with their own eyes that the sacrum is completely fused to the two ilium bones, and concluded that even the slightest dislocation of this joint is impossible. This may well be true in people whose joints have fused, but that leaves out the rest of us, more women than men, who, through heredity or lifestyle (including yoga), have retained mobility in our SI joints.

Feeling Out of Place

Many health professionals who have worked with yogis believe that the cause of their sacroiliac pain is excessive movement of the joint, leading to misalignment, ligament strain, and, possibly, eventual deterioration of cartilage and bone on the auricular surfaces. There are a number of theories about the details of the pathology. To understand one hypothesis about what SI misalignment means, imagine a piece of china that has broken in two. The broken edge of each piece has a rough surface, but, because they match one another exactly, you can fit the two pieces back together precisely. The bumps on one surface fit into the depressions on the other, and vice versa. When you glue the two pieces back together, all you see is a tiny hairline where the break was. But if you misalign the two pieces in any direction, the bumps on one will clash with the bumps on the other, and the crack between them will remain wide.

Similarly, the auricular surfaces of the sacrum and ilium have bumps and depressions that fit together beautifully when you align them properly but clash with one another if you shift the bones out of place in any direction. In this hypothesis, the pressure of bump on bump is the source of SI pain. If it continues over a long period of time it may eventually cause the cartilage and then the bone to deteriorate, causing more pain.

Since strong ligaments hold together the SI joint, the only way to move it out of place with yoga

is to overstretch those ligaments. So another hypothesis is that the source of SI pain is sprained or torn ligaments, rather than injury to the joint surfaces themselves. Of course, the two hypotheses are not mutually exclusive; on the contrary, it seems likely that an extreme stretch could simultaneously damage ligaments and move the joint out of alignment.

Why Me?

Why would the SI joint move excessively in more experienced yoga practitioners and teachers, but not in most beginners or other people? Obviously more advanced yogis perform more extreme stretches and repeat them over a longer period of time. But self-selection may also be a factor: a lot of people choose to start and stick with yoga because they are already naturally flexible. So, for pre-existing biological reasons (such as genetic or hormonal differences), many dedicated practitioners may have come to yoga with looser ligaments and muscles than other people, putting them at increased risk of SI instability. Similarly, the high proportion of women in yoga could contribute to the high proportion of SI problems. Women are more susceptible to sacroiliac trouble than men for several reasons. For starters, the width and structure of the female pelvis makes the SI joint less stable in women. Next, women (on average) have more flexible ligaments than men. Finally, women who have been through childbirth sometimes have SI damage because a hormone of pregnancy (relaxin) dramatically loosens ligaments all over the body and the process of childbirth puts enormous strain on the SI joints.

But clearly, we can't blame it all on heredity, hormones, and hard labor. Yoga postures do contribute to sacroiliac problems. What causes the trouble, and what can we do about it?

Getting ahead of Yourself

No one knows for sure, but it appears that in yoga, the most common SI problem occurs when the top of the sacrum tilts too far forward on one side of the body relative to the ilium. This may happen, for example, in asymmetrical forward bends like Janu Sirsasana. Your student's bent leg holds one side of her pelvis back while she uses her arms to pull her spine toward her other leg. The spine pulls the top of her sacrum forward on both sides, but the top of the pelvis (the ilium) stays farther back on the bent leg side, so the top of the sacrum separates from the ilium and moves in front of it on that side.

Something similar can happen when students practice two-leg forward bends, like Paschimottanasana (Seated Forward Bend), unevenly. For example, if your student's right hamstring muscles are tighter than her left ones, when she bends forward in Paschimottanasana her right sitting bone will stop lifting before her left. This will cause her right ilium to stop tilting forward before her left. As her spine bends farther forward, it will drag the top of her sacrum along with it. This will pull the right side of her sacrum forward of her ilium, which is tilted to its maximal point, unseating her SI joint on that side and overstretching the surrounding ligaments. Meanwhile, her left ilium will keep moving forward along with the left side of her sacrum, so she won’t put undue stress on her left SI joint.

Even if she practices Paschimottanasana perfectly symmetrically, your student's forward bending action will still stretch her SI ligaments (including the sacrotuberous and sacrospinous ligaments, which normally resist the forward tilt of the sacrum by stopping the lower end from lifting up). This will loosen both of her SI joints, making them more vulnerable to displacement in other poses. If she has loose pubococcygeus muscles (the muscles that run between pubic bone and tail bone), this may make the problem worse by making it easier for the tail bone end of the sacrum to lift up.

Once your student tilts one side (or both sides) of her sacrum too far forward, it tends to get stuck there. The sacrum is narrower in the back than in the front, so as it moves forward, the ilium bones move closer to one another. To slide her sacrum back into place, your student has to force her ilium bones apart against the resistance of the ventral, dorsal, and interosseous sacroiliac ligaments. This is especially hard because it also requires that she slide the bumpy joint surfaces of her sacrum and ilium over one another. This may be why backbending postures sometimes hurt when the SI joint is out of place (she presses bump on bump), but also why backends sometimes relieve SI pain (it feels good if she succeeds in getting the sacrum back where it belongs).

So backbends can be good or bad for the SI joints, while forward bends usually spell trouble. Postures that spread the thighs wide apart (into abduction), like Baddha Konasana, Upavistha Konasana, and Virabhadrasana II are also big time troublemakers. These poses all pull on the adductor (inner thigh) muscles, drawing the pubic bones away from one another. This action apparently pulls apart a critical portion of the SI joints (perhaps it opens the front of the joints more than the back, or opens the lower part of the joints more than the upper part). As the joints unlock, it is easier for the sacrum to slip forward out of place. Loose pelvic floor muscles may aggravate this problem because they allow the left and right halves of the lower pelvis to move away from one another more easily than tight muscles do.

If the above reasoning is correct, then combining abduction with forward bending should be especially hard on the SI joints. The evidence seems to bear this out: people with SI problems often find it puts their SI joint "out" if they bend forward in spread-leg poses like Baddha Konasana, Upavistha Konasana, or Prasarita Padottanasana.

Twists and side-bending postures can also cause trouble for people with unstable SI joints. Twists (like Marichyasana III) can pull one side the sacrum forward of the other. Side bends (like Utthita Trikonasana, Utthita Parsvakonasana, and Parivrtta Janu Sirsasana) may create a gap in the joint on one side and jam it on the other. While side bending alone is unlikely put the joint out of place, the gapping it causes can further loosen an already overstretched interosseous ligament, and the jamming it causes can further irritate misaligned auricular surfaces by pressing them harder against one another.

To round out the picture, imbalances in hip flexor muscles may also contribute to SI problems. The two psoas muscles connect the front of the lumbar spine to the upper inner thighbones. If

one of them is tighter than the other, it might pull one side of the spine too far forward, pulling that side of the sacrum along with it. The two iliacus muscles connect the front of the ilium bones to the upper inner thighbones. A tight iliacus on one side could cause a different kind of SI problem by pulling the ilium too far forward relative to the sacrum.

[1]Hollinshead, WH. Textbook of Anatomy. Second Edition. New York: Harper and Row, 1967, p. 378.

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Protect the Disks in Forward Bends and Twists

What causes disk trouble? What is sciatica? How can you protect your students from a disk injury, or help an injured student heal? Read on for answers to all of these questions as well as specific asana suggestions.

By Roger Cole

Practicing asanas is one of the best things your students can do to maintain healthy backs. However, there are a few mistakes in practice that can seriously injure their backs. One of these is the improper practice of forward bends and twists, which can damage the disks near the base of the spine. Every yoga teacher should know how to prevent this.

Luckily, most back injuries are not disk injuries, but disk injuries are serious because they are so debilitating and long lasting. Many of the things you teach your students to help them avoid disk injuries will also protect them from other types of back injuries, especially torn muscles, tendons, and ligaments caused by excessive bending of the lower spine. A student with a disk injury may have severe pain and muscle spasms in his back, but other back injuries can cause the same symptoms. The symptom that sets disk problems apart is radiating pain, that is, pain that feels like it's coming from a location distant from the injury. The most common type of radiating pain from a disk problem is called sciatica, because it follows the course of the sciatic nerve. This nerve, and its branches, runs through the buttock, down the outer back thigh and outer calf, and ends at the top of the foot between the first and second toes.

A student with a minor disk problem may only feel a dull ache deep in the fleshy part of the buttock, and it might occur only during forward bending or prolonged sitting. (Although the buttock is the most common location, the pain sometimes feels as if it is coming from deep in the hip, and it may be accompanied by muscle spasms there.) A student with a severe disk problem is likely to feel sharp, "electric" pain, tingling sensations, or numbness all the way from the buttock down the thigh and calf to the foot, even during simple movements. In serious cases, nerve damage can also cause weakness in leg muscles, such as the hamstrings or the shin muscles that flex the foot upward at the ankle joint.

All these symptoms are caused by pressure on the roots of spinal nerves where they exit the vertebral column. The pressure may come from a bulging disk, a herniated disk, or a narrow disk space.

It's easy to see how these problems occur once you understand the basic structure of the spine. The spinal column is made of bony vertebrae separated by flexible disks. The vertebrae surround and protect the spinal cord. At regular intervals along its length, the spinal cord sends out long

nerve fibers to various parts of the body. These nerves exit the spine between adjacent vertebrae. The part of the nerve near the spinal cord and vertebrae is called the nerve root. Adjacent vertebrae are matched in shape so that, when the disks separate them properly, they form holes (foraminae) through which the nerve roots pass freely. As the nerves exit these holes, they pass very close to the disks.

An intervertebral disk is composed of a tough, fibrous ring (the annulus fibrosus) wrapped around a jelly-like center (the nucleus pulposus). The whole disk is attached firmly to the main, cylindrical part (the bodies) the vertebrae above and below, so the nucleus is completely enclosed. (Note that the attachment is so strong that the disks cannot slide, so the term "slipped disk" is a misnomer.) When the spine bends, the bodies the adjacent vertebrae pinch closer together on one side and draw farther apart on the other side. This squeezes the disk that lies between them on one side and widens the disk space on the other, pushing the disk's soft nucleus toward the open side. This is usually not a problem; in fact, it's necessary for normal, healthy movement of the spine.

However, forcing the bend can push the nucleus pulposus so hard against the annulus fibrosus that the annulus stretches or tears. If it stretches, the disk wall bulges out, and may press on the adjacent nerve (especially in forward bends; see below). If it tears, some of the nucleus can leak out (herniate) and press very strongly on the nerve. Another, often-related disk problem is simple deterioration over time. As disks lose their plumpness, the vertebrae draw closer together. This narrows the foraminae through which the nerves pass, thereby squeezing the nerves.

The five mobile vertebrae of the lower back are called the lumbar vertebrae, and they are numbered, from top to bottom, L1 through L5. Below L5 lies the sacrum, a large bone composed of five vertebrae fused together with no disks between them (nerves exit the sacrum through holes in the bone). Although the sacrum is a single bone, the top vertebra of the sacrum is still called S1. So the disk between lumbar vertebra 5 (L5) and sacral vertebra 1 (S1) is called the L5-S1 disk. The next disk up, between lumbar vertebrae 4 and 5, is called the L4-5 disk, and so on.

Nerve fibers that exit the spine below vertebrae L3, L4, L5, S1, and S2 combine to form the sciatic nerve. This means that many of the fibers that contribute to the sciatic nerve pass directly over the L3-4, L4-5, and L5-S1 disks. If these disks are injured in a way that presses on the overlying nerve roots, it can cause sensations (pain, tingling, numbness) that the brain thinks are coming from the sciatic nerve. This is why students with sciatica often feel more symptoms in the buttock or leg than in the back. Some don’t even realize they have a back injury.

Of all the disks in the entire spine, the L5-S1 disk is subject to more mechanical stress than any other, so it is injured most often. The L4-5 disk is subject to the second-largest amount of mechanical stress, so it is injured the next most often. The reason these disks take such a beating is that they lie at the "bottom of the totem pole," the base of the vertebral column. This increases mechanical stress in two ways.

First, it makes them bear more weight than other disks. The compressive force of this weight flattens and spreads the nucleus pulposus, pressing outward on the annulus fibrosus on all sides. This pressure not only stretches the annulus, it also tends to slowly squeeze fluids out of the disks, narrowing the space between vertebrae.

Second, and probably more important, the entire vertebral column acts as a long lever that exerts its greatest leverage on the lowest lumbar disks. How much leverage? Imagine a pair of pliers with handles as long as your spine. Now imagine putting your finger between the jaws and having a friend squeeze the handles together. When we hold the sacrum fixed and bend the spine, we exert similar leverage on the L5-S1 disk, and nearly as much on the L4-5 disk.

Although this leverage effect occurs in backbends and side bends, it is most likely to cause injury in forward bends, especially when they are combined with a slight twist. In backbends, the nucleus pulposus shifts forward, but the disk wall cannot bulge forward because it runs up against a broad, strong ligament (the anterior longitudinal ligament) that runs vertically along the front of the vertebrae and disks for the entire length of the spine. In side bends, the bone structure of the spine itself makes it difficult (but not impossible) to bend the spine too far.

In forward bends, however, the lumbar bone structure offers no significant resistance, so the nucleus pulposus shifts freely backward, where it presses the disk wall against the narrow, relatively weak posterior longitudinal ligament. This ligament runs vertically up the back of the vertebral bodies and disks. Although it helps prevent the disk from bulging straight backward, it does allow it to bulge (or herniate) diagonally backward and to one side. This aims the protruding disk wall or herniated nucleus exactly at the point where the spinal nerve crosses the disk. We amplify this diagonal action if we twist slightly while bending forward. Twisting not only directs the bulge of the disk toward the nerve, it also adds its own compressive force to the nucleus and its own extra stretch to the disk wall. Therefore, forward bends in general, and twisted forward bends in particular, pose the greatest risk to the lumbar disks and nerves.

Among the forward bends, it is the seated ones that are most likely to cause trouble. In reclining forward bends (for example, Supta Padangusthasana, or Reclining Big Toe Pose), gravity does not compress the disks. In standing forward bends (for example, Uttanasana, or Standing Forward Bend), if the sacrum is tilted far enough forward to allow the spine to hang down, then gravity actually elongates the spine, widening the disk spaces. Only in seated forward bends does gravity compress the disks.

The erector spinae muscles that run vertically up the back exacerbate this compression, especially in seated poses. Although these muscles tend to bend the spine backward, and therefore help prevent excessive flexion, they also pull the vertebrae closer to one another, which puts additional pressure on the disks. When reclining, the erector spinae muscles are relaxed. In standing forward bends, they may be relaxed or moderately active. But in sitting forward bends, unless the hamstrings are very loose, the erector spinae muscles must contract very strongly to tilt the pelvis forward. This adds a very strong compressive force to the disks. Combined with the force of

gravity and the effects of leverage, this puts enormous pressure on the lower lumbar disks in seated forward bends.

Although seated forward bends are the worst, simply sitting upright is also hard on the lumbar disks. Whenever we sit, the top of the pelvis tends to tilt backward, bringing the sacrum along with it. This causes slight to moderate flexion of the lumbar spine, so the disks' nuclei push backward somewhat. The erector spinae muscles contract to prevent the pelvis from tilting farther back and to keep the spine from slumping. This limits flexion, but adds more vertical pressure. Meanwhile, gravity compresses the disks more strongly when the spine is upright than when it is tilted forward. So sitting upright puts more downward pressure but less backward pressure on the disks than bending forward does.

We tend to sit upright for long periods of time, so the effect on the disks is cumulative. The disks gradually lose fluids, and the spine becomes measurably shorter. As any person who suffers from sciatica can tell you, prolonged sitting (for example, in an office chair, in a car, or on a meditation cushion) can really make symptoms worse. Although not so prolonged, seated twists can also be hard on the disks because they combine the effects of upright sitting with the effects of twisting. Rounding the lower back in twists makes them much worse.

Whether sitting upright or bending forward, the position of the pelvis is crucial. The pelvis holds the sacrum in place. If the top of the pelvis tilts backward while sitting, or if it fails to tilt forward in a forward bend, it forces flexion at the L5-S1 and L4-5 joints. Tight hamstrings or hip rotator muscles are usually to blame for holding the pelvis back. For this reason, students who are inflexible in these areas are more prone to disk injury than those who are flexible there.

With a basic knowledge of the anatomy of the spine, it's much easier to learn how to teach students healthy habits that will protect their disks. To get specific advice, asana instructions, and cautions for teaching students with existing injuries, continue to Practical Ways to Protect the Disks.

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Working on Standing Forward Bend

I am working on standing forward bend. I can place my hand flat on the floor, but I cannot get my head and legs to meet. It feels as if my legs hyperextend.

By Roger Cole

Roger Cole's reply:

Forward bends teach patience. It takes a long time to enter them deeply. Enlightenment does not necessarily occur when the head reaches the legs, so there is no need to get it there soon, if ever. The realization of yoga is to be fully conscious, present, and content at whatever stage of the practice you have attained. Paradoxically, when you are truly satisfied right where you are, your pose often opens up and you can easily move forward.

The physiological explanation for this may lie partly in the stretch reflex. This reflex causes a stretched muscle to automatically contract in opposition to the stretch. If you try too hard to bend forward, you trigger stretch reflexes in your hamstring muscles. You feel stretching pain and cannot bend further into the pose. Pushing yourself deeper into the pose just makes matters worse. The more pain you feel, the stronger the stretch reflex.

One way around this is to stop moving deeper into the pose as soon as you feel a slight challenge, long before you reach the point of pain. At this point, hold your position constant for a long time, without pushing into or backing out of the pose. Keep your knees straight and don't lose your pelvic tilt. You will find that, without moving, you get more and more comfortable right where you are. This most likely means that the stretch sensors (muscle spindles) in your muscles are getting reset, so that what formerly felt like a stretch to them now feels neutral. At this point, you feel comfortable in a position that previously felt like a challenge, so it's easy to feel satisfied where you are. The paradox is that by maintaining this sense of neutrality, your stretch sensors will most likely become ready to allow you to move deeper into the pose (without causing pain or a strong muscle contraction). You are ready to move to a new point of challenge and wait there, repeating the cycle.

The most important alignment points in Uttanasana (Standing Forward Bend) are to fold as much as possible at the hip joints (tilt the top rim of the pelvis forward) and to lengthen the front of the body as much as you can, so the spine only rounds over a little. If you pull the head toward the legs without tilting the pelvis or lengthening the spine enough, the spine rounds too much and you can injure your lower back or sacroiliac joints. Even folding at the hip joints has its dangers- if you push too hard, you can tear a hamstring muscle or tendon.

Regarding hyperextension, if your knees straighten past 90°, you don't want to force them any

further. However, forward bends pull on the hamstring muscles, and this tends to bend the knees, providing some protection against hyperextension.

If you are in good physical condition and your alignment is good, one way to progress in forward bends is to vigorously practice standing postures, with a strong Uttanasana between each posture. Standing postures like Utthita Trikonasana (Extended Triangle Pose), Utthita Parsvakonasana (Extended Side Angle Pose), and Virabhadrasana I, II, and III (Warrior 1, 2, and 3) work well. Do each standing posture twice on each side. Hold each pose (including Uttanasana) for 30 seconds to one minute. But don't do this practice six days a week-three or four is plenty.

Again, don't be in a hurry. I know one yoga teacher who struggled with forward bends for about 20 years with little progress. Past age 60, she eased up substantially on her practice and her forward bends suddenly progressed dramatically. She still cannot put her head on her legs, but she is happy. Which is more important?

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How to Recover from Upper Hamstring Tendon Injuries

By Roger Cole

What should you tell your students to do if they have an injured upper hamstring tendon? The recovery program below is based on the physiology of healing and the principles of yoga. It has three stages, corresponding to the three phases of the healing process: 1. Rest during the inflammation phase (72 hours). 2. Align during the repair phase (6 weeks). 3. Strengthen and lengthen during the remodeling phase (up to a year or more).

Stage 1: Rest. For 72 hours after the initial injury, the student should rest the area completely. This gives the body time to remove damaged tissue and bring in cells that will produce new capillaries and collagen. The student should *not* attempt any stretching or strengthening activities and should not apply heat. To prevent excessive inflammation and swelling, apply ice (20 minutes on, 20 minutes off) as often as is practical, compress the upper thigh just below the sitting bone (using an elastic sleeve), and elevate the pelvis above the heart (see Asanas for Hamstring Recovery).

Stage 2: Align. Over the next six weeks, very gently align the newly forming connective tissue fibers. Do this by gradually introducing modified asanas (see Asanas for Hamstring Recovery) that provide micro-strengthening actions with the hamstring muscles in the neutral, slightly shortened, and slightly lengthened positions. These asanas should apply just enough tension at just the right angle to induce the healing tendon to grow strong and flexible in the desired direction. Practice with subtlety. Do not perform the asanas too vigorously or stretch too far, because this can damage the delicate molecular/cellular matrix that is being created. If pain increases during this stage, back off and start over with Stage 1.

Stage 3: Strengthen and Lengthen. Over the next year or more, very gradually strengthen, then stretch the injured hamstring tendon. As in Stage 2, practice asanas that contract the hamstrings against resistance in the neutral, shortened, and lengthened positions (see Asanas for Hamstring Recovery). Start out where Stage 2 left off, then gradually increase the load and length demands on the muscles and tendons. Done properly, this systematically adds high-quality, correctly aligned collagen fibers to the injured area. Back off if pain increases. One of the key benefits of this program is that it strengthens the hamstrings not only while short, but also while in progressively longer positions, for several months before introducing full stretching postures.

Additional Tips

- Wrap a strap tightly around the uppermost part of the thigh just below the sitting bone while doing the asanas in Stages 2 and 3. This may help keep the healing tendon fibers aligned and close to the bone. You can create a similar effect when you finally reintroduce seated forward

bends by having the student sit on a sharp ledge that presses into the hamstring just below the sitting bone.

- If the student has an old hamstring injury that has not healed properly, certain types of therapeutic massage may help break down scar tissue. Some students have reported success applying their own massage by sitting and rolling on a tennis ball. Be careful with this, though, because massaging too hard or too often can cause injury. Also, do not practice massage on its own, but couple it with asana and rest to align and strengthen the new connective tissue that will replace the scar tissue. Remodel this scar tissue by applying gentle, sustained tension rather than sudden, sharp tension.

- Yoga teachers recovering from hamstring injuries can set a valuable example to their students by *not* practicing complete forward bends while healing, and instead focusing on other aspects of their practice. They should explain to students what they are avoiding and why, and what they are practicing instead. When appropriate, they can have students demonstrate forward bends in class rather than demonstrating themselves. Such restraint provides students with a positive role model for dealing with their own injuries. It also demonstrates other qualities of a yogi, including discipline, nonviolence (to the body), and humility.

Asanas for Hamstring Recovery

Stage 1: First 72 Hours
Purpose: To Elevate the pelvis and rest the hamstrings.
Supported Setu Bandha Sarvangasana (supported Bound Bridge Pose)
Place two bolsters (or long folded blankets) end to end. To enter the pose, first sit in the middle of one bolster, then turn your body to align your legs over the other bolster and lie back so your upper back drapes over the end of the first bolster. Lengthen your lower back, place your shoulders and head on the floor, and extend your legs straight. Do not enter the pose starting with your pelvis on the floor, because lifting it up onto the bolster would require a strong hamstring contraction. Also, take care not to stress the hamstrings while adjusting position or exiting the pose. Hold the posture for 10 minutes or more (but exit sooner if it causes discomfort). Do this pose during the first 72 hours after an injury. It's OK to repeat it several times a day, and to continue to practice it in Stages 2 and 3.

Stage 2: Next Six Weeks
Purpose: To gently pull the delicate, new collagen fibers of the healing tendon into alignment without tearing them.
The first time you try each asana in this sequence, do it just once, with the mildest possible muscle contraction, and hold it only briefly. If it does not cause pain, build up over several days to three repetitions, holding the pose for 30 seconds each time. Start with extremely mild muscle contractions, and build force gradually until you achieve moderate contraction strength at the end of six weeks. *Never contract or stretch with great force in Stage 2*. It may also be helpful to apply ice after your asana session.

To maintain standard alignment, point your knees straight ahead (no internal or external rotation

of thighs) and align your feet with your knees (no internal or external rotation of shins at knee joint). You may also wish to try variations in some cases to focus strength and stretch on particular parts of the hamstring tendons.

Partial Salabhasana (Partial Locust Pose)
Effect: Alignment and micro-strengthening in the neutral position.
Lie prone. Keep your knees straight. Keep your forehead and hands on the floor. Contract your hamstrings very gently as if to lift your legs without bending your knees, but *do not* lift your feet or legs off the floor for the first few weeks. Instead, use just enough effort to lighten the weight of the legs on the floor by a small amount. Gradually increase the strength of the lift until, after a few weeks, you lift your legs slightly off the floor. At the end of six weeks, your legs should lift a few inches only.

Dhanurasana Preparation (Bow Pose preparation, without hands)
Effect: Alignment and micro-strengthening in the partially contracted position.
Lie prone. Support your ankles on a bolster with your knees bent. Keep your forehead and hands on the floor throughout this practice. Contract your hamstrings very gently as if to bend your knees and lift your feet off the bolster, but *do not* lift the feet for the first week or two. Instead, use just enough effort to lighten the weight of the feet on the bolster by a small amount. Gradually increase the strength of lift until, after a week or two, you lift your feet slightly off the bolster. After holding your feet off the bolster for 30 seconds, bend your knees to 90 degrees and then slowly lower your feet back to the bolster. Over the next four or five weeks, support your ankles on a progressively lower and lower prop (such as folded blankets) as you perform the same sequence (30 second hold slightly off prop followed by 90 degree bend, then lower to prop again). By the end of six weeks, practice without any prop (start and end with feet on the floor).

Supported Partial Supta Padangusthasana (Supported Partial Reclining Big Toe Pose)
Effect: Alignment and micro-strengthening in partially stretched position.
Lie supine. Support the heel of your injured leg on a block. Keep both knees straight. Press your heel gently straight down into the block. Over six weeks, gradually increase the height of the heel support (for example, with folded blankets, a bolster, chair seat, door jamb, etc.), but do not lift your leg beyond 45 degrees from the floor (if a 45 degree lift causes the sensation of stretch in the hamstrings, use less lift). Gradually increase from a mild to a moderate push on the heel. Hold for 30 seconds, repeat three times.

Stage 3: Subsequent Year (or longer)
Pupose: To systematically strengthen the healing tendon by adding high-quality, well-aligned collagen fibers to it, and to build long, strong, flexible hamstring muscles to prevent re-injury. Stage 3 normally lasts about one year, but it can continue for a lifetime.

This stage starts out where Stage 2 left off and includes some of the same asanas, practiced at a slightly higher level of difficulty. It then proceeds to asanas that demand muscle contraction against greater and greater resistance, in neutral, shortened, and increasingly stretched positions. When practicing, align the poses carefully, as in Stage 2, and practice both sides of one-sided poses, so both the left and right hamstrings benefit.

Assuming an asana does not cause pain, perform three repetitions, holding for 30 to 60 seconds each time and resting for a minute between repetitions. Contract the hamstrings moderately at the beginning, and build gradually to a strong contraction over several months. However, never apply strong force to stretching the hamstrings; rely instead on conscious release during a sustained, modest stretch.

When the student can practice all of the Stage 3 postures deeply, strongly, and without pain, he can return to the practice of conventional, full hamstring-stretching postures. However, the Stage 3 practice remains valuable indefinitely.

Salabhasana (Locust Pose)
Effect: Alignment and strengthening in neutral position.
At the beginning of Stage 3, continue to increase the lift of your legs from where it left off at the end of Stage 2. Work gradually up to a full lift of the legs, then to a full lift of the upper body, as described in Yoga Journal's Salabhasana page.

Setu Bandha Sarvangasana (Bridge Pose)
Effect: Alignment and strengthening in shortened position.
This pose replaces Dhanurasana preparation from Stage 2. Lie supine with bent knees. Lift your pelvis off the floor, emphasizing a contraction in the hamstrings near your sitting bones. Lift the pelvis only a few inches at first. Gradually work up to the full pose, as described in Yoga Journal's Setu Banda Sarvangasana page, over weeks or months. After several months, when strong in the pose, you may elevate your feet on blocks (milder), then on a chair seat (stronger) to put greater strength demands on the hamstrings. Finally, for the greatest challenge, you may introduce Eka Pada Setu Bandha Sarvangasana, which is the same pose with one leg lifted straight up.

Supta Padangusthasana against Resistance (Reclining Big Toe Pose against Resistance)
Effect: Alignment and strengthening in stretched position.
At the beginning of Stage 3, continue to increase the height of the leg prop from where it left off at the end of Stage 2. Work gradually up to a 90 degree elevation of the leg supported by a door jamb. Then work past 90 degrees, holding the leg in place with a strap around the ball of the foot. At all angles of the leg lift, remember that your goal is to push the straight leg away from your body against the resistance of a support prop in order to contract and strengthen hamstrings, not to pull the foot toward the body and stretch the hamstrings.

Purvottanasana (Upward Plane Pose)
Effect: Higher-resistance strengthening in neutral position.
Introduce this pose only if full Salabhasana is achieved without difficulty. Sit in Dandasana (Staff Pose) with your hands about six inches behind your hips. Keeping your legs straight, press your hands and heels down firmly to lift your hips and chest as high as possible. When your hips are maximally lifted, slowly drop your head backward.

Parsvottanasana against Resistance (Side Stretch Pose against Resistance)
Effect: Higher resistance strengthening in stretched position.
Stand facing a wall. Place both of your palms on the wall at shoulder height. Step one foot forward so your toes are six to 12 inches from the wall. Step the other foot back about three and one

half to four feet from your front foot. Face your front foot directly toward the wall and turn your back foot out one third of the way (60 degrees to the wall). Center both feet on a line perpendicular to the wall. Bend forward at the hip joint of your front leg, keeping your spine in a neutral position (not flexing). Bend only enough to apply a mild stretch to the hamstring of the front leg. Adjust your foot and hip distances from the wall and from one another, and adjust your thigh rotation to maintain a mild stretch while strictly keeping the front knee squarely over the front foot, and the two hips square (equidistant from the wall and the floor). Keep both knees straight. Simultaneously press the bottom of your front foot into the floor and pull it backward toward the back foot, using the friction of the floor to keep the feet from sliding toward one another. This will isometrically contract the hamstrings of the front leg. After 30 seconds, keep this same alignment but place your hands on your pelvic rim and slowly stand upright. This will isotonically contract the hamstrings of the front leg against the resistance of gravity. If you don't experience any pain, repeat the same sequence with both feet slightly farther from the wall, so the pose creates a deeper forward bend at the hip joint. Remember, however, that the purpose of the practice is to *contract and strengthen the hamstrings,* not to maximally stretch them.

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Protect the Hamstrings in Forward BendsBy Roger Cole

Perhaps you've felt it. Standing with straight legs, you bend forward into Uttanasana (Standing Forward Bend), and immediately sense a nagging pain over one of your sitting bones. If you bend the knee on that side, the pain diminishes or disappears, but as soon as you straighten it again, the pain comes back. As you start to exit the pose, the pain momentarily worsens, but then disappears as you go higher. Thinking back, you realize that this has been going on for--can it be--a year and half already?

What you are feeling is probably a partial tear in one of the two short tendons that connect the hamstring muscles to the sitting bone. It may be right at the bone, at mid-tendon, or at the junction where the tendon merges into the muscle. If the injury is old, chances are you are working not only with tendon, but with scar tissue as well.

The anatomy of this injury is quite simple. You have three hamstring muscles. The upper end of each of them attaches to the sitting bone (ischial tuberosity). Two of the hamstrings (semitendinosus and biceps femoris) share a single, short tendon that joins them to the sitting bone. The third (semimembranosus) has its own short tendon. The lower ends of all three hamstrings attach just below the knee. When these muscles contract they bend the knee and extend the hip joint. To stretch them effectively, a student must simultaneously straighten the knee and flex the hip joint.

This is just what happens in Uttanasana and other straight-legged forward bends: the knee straightens and the hip joint flexes. This moves the sitting bone away from the back of the knee and lengthens the hamstring muscles. Hamstrings are strong muscles, so it can take a lot of force to stretch them. When the force is more than the tendon can bear, the tendon partially tears at or near the sitting bone. (Other types of hamstring injuries are also possible, including mild or severe damage to muscle, tendon, or bone caused by strong, hard muscle contraction. This article will focus only on mild or moderate partial tears of a hamstring tendon caused by over-stretching.)

In order to protect your students from an injury in a hamstring tendon, you need to understand what puts them at risk for such injuries. *Stretching too hard* is an obvious factor. It is especially likely to cause injury if you physically push a student into a stretch, so be sure to avoid this.

Stretching too fast, without proper awareness, can also lead to injury. When a student stretches too quickly, it can cause a reflex contraction of the hamstrings which makes the muscles that are supposed to lengthen shorten instead. Students whose muscles are both strong and tight are especially at risk for this kind of injury.

Stretching while cold may increase risk, because a cold tendon is less flexible and has less blood flow than a warm one. But *stretching while hot and fatigued* (for example, at the end of a long,

vigorous workshop) may also be risky. The heat may make the connective tissue in the tendon so flexible that its molecular structure can be torn apart by vigorous stretching. In addition, the fatigue makes it more difficult for the student to monitor and control the degree of stretch.

Another major risk factor is *weak hamstring tendons*. This is often a result of habitual overstretching and insufficient strength of the hamstring muscles (weak muscles and weak tendons go together, because activities that strengthen the muscles also strengthen the tendons). Habitual overstretching comes from an excessive practice of daily forward bends with insufficient recovery time in between. This can break down collagen molecules (the building blocks of the tendon) faster than the body can replace them. Yoga teachers are especially at risk for this, because they often maintain a strenuous personal practice and also demonstrate forward bends day after day in their classes.

Stretching unevenly can also place a hamstring tendon at risk. For example, if the semimembranosus muscle is significantly tighter than the other two hamstrings, its tendon will receive most of the stretching force that would normally be distributed evenly among all three hamstrings. Likewise, certain combinations of rotation and bend at the hip or knee joints can focus excessive stretch on a small part of a hamstring tendon, or can pull a tendon at an angle that tends to separate it from the sitting bone.

One of the most frustrating things about a hamstring tendon injury near the sitting bone is that it persists for so long. Tendons have a much poorer blood supply than muscles, so when you tear them, they heal much more slowly. Students very often try to stretch their way out of the injury too soon, too hard, or too often. This not only slows the healing process, it also produces excessive scar tissue. Scars don't stretch well, so later stretching in the same area can put excessive strain on the intact tendon fibers surrounding the scar, causing additional injury. This, in turn, produces more scar tissue, leading to a vicious cycle of progressively worsening injury.

The healing process after a tendon tear can be roughly divided into three phases: inflammation, repair, and remodeling. By understanding what happens in each of these stages, you will be better prepared to give your students advice on what to do and when to do it.

When a student first tears a tendon, many of the tiny blood vessels (capillaries) that feed it are destroyed. During the first 72 hours after injury (the inflammation phase), the body's main job is to stop bleeding, clear away damaged tissue, prevent infection and lay the ground work for later repair. Stressing the area with stretching or strengthening exercises during this time will only further tear the tendon and its capillaries, undoing much of the work the body has done and making the injury more severe.

If the inflammation phase is allowed to run its course without disturbance, the body will enter the repair phase, which lasts six weeks or so. It begins this phase by setting up a delicate molecular and cellular matrix that serves as the framework for reconstructing capillaries and connective tissue. It then starts the initial stages of filling in this matrix.

A healthy tendon is made of collagen fibers arranged in an orderly way, making it strong and somewhat flexible in the direction of pull applied to it. However, at the beginning of the repair phase, the body lays down new collagen fibers haphazardly. This is a crucial time. If the student systematically applies very mild force along the lines of the healing tendon (by practicing extremely gentle strengthening and stretching asanas), the collagen matrix will become aligned in an appropriate way. The body will then lay down new fibers of the right type and connect them to one another in the optimal orientation to produce a strong, slightly flexible tendon. If, instead, the student does not apply any stress to the tendon after the body lays down the initial collagen fibers, the body will continue to lay down new fibers haphazardly, and connect them randomly. The result will be a weak, thick, inflexible scar.

Another potential problem might arise if the student stresses the healing tendon too much by practicing asanas that demand more than just a little stretch or contraction of the hamstrings. If that occurs, the matrix will break down, the tendon may tear more, and the student will be thrown back to square one of the healing process (inflammation), quite possibly with a more severe injury than the original one.

The people who have the hardest time avoiding excessively stretching an injured hamstring are yoga teachers themselves. Many yoga teachers instinctively feel that they can "stretch their way out" of the injury, so they do too much too fast. They are often reluctant to give up the vigorous practice they love and the busy teaching schedule that earns their livelihood. They feel that to teach properly, they must demonstrate hamstring stretches to their students. Even those who back off from strong hamstring stretches at first often re-introduce them as soon as they start feeling better, which is usually too soon.

Of course, the best way to deal with hamstring injuries is to prevent them from happening in the first place. There are many ways to do this. The most important is to never push your students into hamstring stretching poses. The second most important is to instruct students never to push themselves to the point of pain at the sitting bones, especially in forward bends. Instead, help your students develop strong, stretch-tolerant hamstring tendons by systematically including asanas that strengthen the hamstring muscles in both the shortened and lengthened positions (see How to Recover from Upper Hamstring Tendon Injuries). When students are cold, start them with warming poses, including mild hamstring stretches such as Adho Mukha Svanasana (Downward-Facing Dog), before more extreme hamstring poses. Guide students to stretch consciously, and urge them to use extra care when their muscles are hot or fatigued. Teach good alignment to build tendon strength and flexibility in the desired direction and to distribute the stretching load evenly over the hamstrings tendons rather than focusing it on a single spot.

If a student has a known hamstring injury, or if you suspect one because she feels pain at or near the sitting bone in forward bends, urge her to immediately stop doing any pose that creates the pain and strictly follow the recovery advice. Advise her that such injuries must be taken seriously and "babied" for at least several months before she should return to a full practice. Finally, if you

are dealing with this problem yourself, take heart. With patience and diligence, there is hope for hamstrings.

Read about How to Recover from Upper Hamstring Tendon Injuries.

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Keep the Knees Healthy in Virasana

Popular opinion has it that Virasana is a no-no for the knees. But might the pose do those joints some good? Read on for a detailed exploration of the anatomy of the knee, plus instructions on how teach Virasana to a variety of students.

By Roger Cole

"Ten Exercises You Should Never Do." Every once in a while, you'll see a headline like this blaring from the cover of a women's magazine in the supermarket checkout line. One of the "exercises" you'll sometimes find on the blacklist--along with some of your other favorite yoga postures--is Virasana (Hero Pose). The article will caution that kneeling like this will injure your knees. How can it be, then, that many of the world's most respected yoga teachers routinely recommend this posture as one of the best ways to keep your knees healthy? Let's look at the anatomy of Virasana to see whether it really could damage your knees, and to learn how you can help your students safely get the most out of this simple yet powerful pose.

The knee joint is the junction between the femur (thighbone) and the tibia (shinbone). At the knee, the end of the femur bulges to form two large, rounded structures called the medial (inner) and lateral (outer) condyles. The femoral condyles are covered with cartilage to help them glide over corresponding condyles on the tibia. The tibial condyles are slightly concave on top, nearly flat, so their shape does little to accommodate the large, convex femoral condyles that rest on them. To partially make up for this deficiency, two crescent-shaped cartilages, the medial meniscus and the lateral meniscus, lie atop the tibial condyles to improve their fit with the femoral condyles. These cartilages help keep the bones lined up and help distribute the weight of the femur more evenly over the tibia, but they provide very little stability to the knee.

Because it is a shallow joint, the knee relies on strong ligaments and muscles to hold it together. The medial collateral ligament runs from the inner side of the femoral condyle to the inner side

of the tibial condyle. It keeps the knee from bending sideways toward the midline (into the knock-kneed position). The lateral collateral ligament runs from the outer side of the femoral condyle to the head of the fibula (the fibula is the long, narrow bone that runs parallel to the outer tibia; its head is just below the outer knee). The lateral collateral ligament performs a function similar but opposite to the medial collateral: it prevents the knee from bending outward (to a bowlegged position). However, there is an important difference between the medial and lateral collateral ligaments. The medial ligament is fused to the medial meniscus, while the lateral ligament does not touch the lateral meniscus.

This makes the medial meniscus more vulnerable to injury than the lateral one in two ways. First, it limits its mobility, so if your student accidentally applies a strong force to her medial meniscus, it is less likely to slide out of harm's way than her lateral meniscus would be under similar circumstances. Second, if your student forces her inner knee open strongly enough to tear the medial collateral ligament, she may tear the medial meniscus at the same time, because the two structures are not separate but blend seamlessly into one another. Tearing the lateral collateral ligament would not tear the lateral meniscus because they are not connected. As we will see, the vulnerability of the medial meniscus can be a significant issue in Virasana (although it's not difficult to keep it safe). But before we explore that, let's first consider the other major ligaments of the knee, the anterior and posterior cruciates.

The cruciate ligaments attach the end of the tibia to the end of the femur. They both start on the tibia between the menisci. Both ligaments end on the femur between the condyles. As your student straightens her knee fully, her anterior cruciate ligament pulls taut to prevent hyperextension. Both collateral ligaments also become taut when the knee is straight, adding more stability. When the knee bends, the two collateral ligaments go slack, but the two cruciate ligaments are arranged in such a way that in most positions of bend, at least part of one of them is taut. In this way, they help keep the knee stable throughout its range of motion.

The muscle group that straightens the knee is the quadriceps. As its name implies, it has four parts. Three of them originate on the front of the femur, the fourth on the front of the pelvis. All of them attach to the kneecap (patella). The kneecap, in turn, attaches by a strong ligament to a bulge on the front of the tibia just below the knee (the tibial tuberosity). When your student contracts her quadriceps, they pull her kneecap up, her kneecap pulls on her tibia, and her tibia moves toward the straight knee position. When she bends the knee to sit in Virasana, her tibia pulls her kneecap down, her kneecap pulls her quadriceps away from their origins, and they get longer. The three parts of the quadriceps that arise from the femur (vastus lateralis, vastus intermedius, and vastus medialis) all stretch to their maximum length when the knee is fully flexed. The fourth part (rectus femoris) will not stretch completely unless your student combines full knee flexion with full hip extension, as in backbends such as Supta Virasana.

Every joint needs to be moved through its range of motion regularly to keep it healthy. Moving one joint surface over another keeps the cartilage lining on each intact. Disuse often causes the cartilage, then the bone underneath it, to deteriorate. Bending and straightening the knee all the

way rolls the entire, cartilage-lined joint surface of the femoral condyles over the tibial condyles and menisci, which is healthy for the joint, while limiting knee flexion or extension leaves some parts of the joint surfaces unused. One major way that Virasana helps the knees is by bringing them through their complete range of flexion, nourishing joint surfaces that might otherwise be neglected.

How much flexion is good for your students' knees? Most people would agree that bending the knees far enough to sit on the heels is healthy (this pose is sometimes called Vajrasana, or Thunderbolt Pose). This raises two questions. First, is it safe and healthy for a student whose knees don't ordinarily flex that far to work the hips down to the level of the heels? Second, is it safe and healthy to separate the feet and lower the hips between the ankles to place the sitting bones on the floor, as in the full Virasana pose?

The answer to the first question is that it is usually beneficial for a student whose sitting bones don't reach her heels to work her way down over a period of weeks, months, or years. If her limitation is simply tight quadriceps muscles, the pose offers an excellent way to stretch them out to normal length and restore full range of motion to the knees. One obvious caveat is that she should not progress so quickly or practice so aggressively that she tears one of the quadriceps or causes some other injury.

It is usually best for a student whose sitting bones don't reach the level of her heels in Virasana to first support her pelvis on a prop, such as a stack of folded blankets. The stack should be narrow enough to fit between the heels without forcing them wider than the hips. She should align her thighbones parallel to one another (her knees won't quite touch each other), place her shinbones directly under her thighbones, and point her feet straight backward in line with the shinbones. She can then work her sitting bones gradually down to the level of her heels by reducing the height of the blankets very slightly from one practice session to the next. This will stretch her quadriceps bit by bit and make it easy for her to stop if she feels any pain.

The reason your student should point her feet backward in the same line as the shins when practicing Virasana is to avoid twisting her knees. Turning the feet outward (so that the toes point to the sides) rotates the tibias too far outward, misaligning the knee joint surfaces, severely overstretching the medial collateral ligaments, and, in extreme cases, possibly damaging the medial menisci. Turning the feet inward rotates the tibias inward but not so far, because joints in the feet do most of the movement. The modest inward rotation of the tibias that occurs when the feet turn in slackens the medial collateral ligaments but increases tension on the lateral collaterals. Turning the feet inward in Virasana is not as hard on the knees as turning them outward because the rotation of the tibias is not as great. Some students (those with certain types of medial knee problems) might even benefit from the slack it creates on the inner knee ligaments, although this must be weighed against the risk of overstretching the outer knee ligaments. Most students will experience the best balance between tension on the inner and outer knee ligaments (and the best alignment of the knee joint surfaces) if they keep their feet pointing in the same line as their shins, thereby keeping their tibias in a neutral, non-rotated position.

Another caveat for a student who is gradually working her sitting bones down to the level of her heels is that she should adapt the pose appropriately for any pre-existing injury. Most students with knee injuries can benefit from systematically lowering the pelvis, although it may not be appropriate to let it descend all the way to heel level in some cases. It's best to ask a health professional who understands both yoga and the individual student's injuries to help you and your student decide how far to bring the hips down. In addition to support blankets, other props can be useful for injured knees, but not all props are appropriate for every student. For example, a student with a torn meniscus may benefit from placing a rolled washcloth behind her knee because it may increase the space between her femur and her tibia, reducing the likelihood of pinching her meniscus, whereas a student with a torn cruciate ligament might not benefit from the same washcloth because increasing the distance between her femur and tibia might apply too much stretching force to an already overstretched ligament.

The biggest question about Virasana, though, is not whether it is healthy to bring the hips down to the level of the heels, but whether it is healthy to move the feet aside, lower the hips beyond the heels, and place the sitting bones on the floor between the ankles. This action has two crucial effects: it flexes the knees several degrees more than sitting on the heels does, and it creates an angle between the tibia and the femur (whereas before these bones were parallel to one another, the femur directly atop the tibia).

The increased flexion caused by bringing the hips to the floor could theoretically be good for the knees by allowing contact between joint surfaces that would otherwise be left unused. This might help prevent deterioration of the cartilage linings on the rear-most part of the femoral condyles. On the other hand, since flexion pulls one or both cruciate ligaments taut, it is conceivable that the additional flexion produced in the last stage of Virasana might overstretch the cruciates in some people. It’s not clear whether this actually happens, though.

The angle created between the tibia and the femur when the feet move out to the sides of the hips is probably of greater concern than the extreme flexion in full Virasana. It creates a sidebend that opens the inner knee by widening the gap between the medial femoral condyle and the medial tibial condyle. This pulls the two ends of the medial collateral ligament away from one another. If the pose is performed in a way that keeps the inner knee gap small (for example, by rotating the thighbones inward and keeping the feet close to the sides of the hips), then the only thing the opening of the inner knee is likely to do is take up the slack that typically forms in the medial collateral ligament when the knee is bent. In fact, bending the knee to full flexion produces more slack in the medial collateral than any other position, so Virasana has a built-in margin of safety against overstretching this important ligament. However, if the pose is practiced in a way that makes the inner knee gap very large (for example, by taking the feet far out to the sides, leaving a space between the feet and the hips, or by turning the feet out so the toes point sideways), or if the student doing the pose has a particularly short medial collateral ligament, then sitting between the ankles might overstretch the ligament. This might gradually destabilize the knee or, if done too quickly and forcefully, might even tear the ligament and its attached medial meniscus.

No one knows how often this occurs (if it occurs at all), but there are some simple things you can do to protect against it, and to avoid other possible problems in Virasana. Read Practice Tips for Virasana for specific advice that will help keep your teaching safe and effective.

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Practice Tips for Virasana

Here are some ways to safely teach Virasana to a wide variety of students.

By Roger Cole

Follow these suggestions to help your students stay safe while getting the most benefit from Virasana (Hero Pose). This article is a companion to Keep the Knees Healthy in Virasana.

Don't force. Teachers and students should never force Virasana at any level.

Avoid pain. If the student feels pain anywhere in the pose (especially in the knees), she should back off immediately.

Prop up. Have students prop the pelvis at an appropriate height. If props are not available, have students either sit on their heels (if they can readily go that far), or provide an alternative pose (Bhekasana, or Frog Pose, with knees only partly bent is one alternative). Note that sitting on the heels puts a lot of pressure on the ankles, so some students may need to support their ankles on a rolled blanket, or drape them over the edge of a stack of folded blankets, in order to do the pose comfortably. This type of ankle propping often also requires additional props under the pelvis.

Work gradually. Don't go too fast. Help your students bring their hips downward systematically over many practice sessions, lowering props as needed.

Point the feet in line with the shins. This provides the best alignment for the knees. In particular, encourage students to avoid turning the feet outward. Note that telling your students to place their feet "in line with shins" is not always the same as telling them to point their feet "straight backward," because if your student sits between her feet with her thighs parallel to one another, her shins are no longer parallel but angle away from each other from front to rear. Her feet should do the same.

Avoid overstretching the knees. The knees need the stability that their ligaments provide, so don't encourage movements that stretch them too much. If your student feels strong sensations within or around the knee joints in the pose, there's a good chance she is stretching ligaments. It may be legitimate to gradually and moderately stretch some ligaments in a student who cannot flex her knees fully, but if a student can sit on her heels (or on a prop at heel height), give her the option of stopping there rather than learning to go down all the way between her ankles. Explain that putting the pelvis on the floor between the feet is probably helpful for many, perhaps most, people's knees, but it may overstretch some people's knee ligaments, making the knees a little less stable. Let the student make the final decision as to whether the benefits of the full pose outweigh the risks. If your student does not want to go all the way down, one possible compromise is to have her sit with her outer hips, rather than her sitting bones, resting on her heels. Anatomi-

cally, sitting this way rotates her thighs inward a bit and puts her greater trochanters (the outermost part of her upper thighbones) atop her heels. This position provides nearly full flexion of the knees without any side bending at all.

Rotate the thighs inward as the feet move outward. Teach your student to rotate her thighs inward, moving her thighs, shins, and feet as a single unit, so her shins and feet move out to the sides as she lowers her pelvis. In this way, part of the range of motion your student needs to bring her feet to the sides comes from rotation in her hip joints, rather than side bend in her knees. In fact, if she keeps her pelvis propped at or above the level of her heels, she may be able to place her feet wider than her hips without side bending her knees at all. If she continues to lower her pelvis beyond her heels, though, she will eventually reach a point where her thighs cannot turn inward any farther. If she descends past this point, her knees will bend sideways and her inner knees will open. However, the degree of opening will be much less than it would have been had she not rotated her thighs in first. This helps protect your student from overstretching her inner knee ligaments.

Keep the ankles near the hips. If your student sits between her feet, encourage her to keep her ankles as close as possible to her hips. This will reduce the side bend in her knees, so the gap between her medial femoral condyles and her medial tibial condyles is as small as possible, minimizing stress on the inner knee ligament (the medial collateral ligament). If you see a student placing her feet far wider than the sides of her hips, encourage her to bring them toward her body until they touch the outer hips--but make sure she still keeps her feet in line with her shins).

Monitor adjustments. Many students have learned to use their hands to adjust the position of their legs as they bring their hips down into Virasana. Sometimes these adjustments are helpful, sometimes they are not. One common self-adjustment is to push the flesh of the calves outward. This allows greater flexion of the knees because it gets the calves out of the way of the descending thighs. This increased flexion is probably OK for most students, but it might be too much for some who have tight ligaments, injuries, or other problems. A more important issue with this adjustment is that, unless the student makes a conscious effort to hold the shinbones stable, she will probably rotate them inward as she pushes her calves aside (the fronts of the shins will turn in, the backs of the shins will turn out along with the calves). If she does this, you will see her outer ankle bones sticking farther out to the sides than her calves and feet. Rotating her shins (tibias) this way may relieve tension on her inner knee (medial collateral ligament) while adding tension to her outer knee (lateral collateral ligament), so it might be either helpful or harmful, depending on where her knees are tight.

Strengthen muscles that stabilize the knee. Virasana is a great way to stretch the fronts of the thighs, but stretching without complementary strengthening can make your students' knees less stable. Don't teach Virasana in a vacuum. Use it as part of a well-rounded asana program that includes standing poses and other postures that strengthen the quadriceps and other leg muscles.

Virasana is a wonderful posture for keeping your students' knees mobile and healthy. Teach it

with care, and they will reap its benefits for a lifetime.

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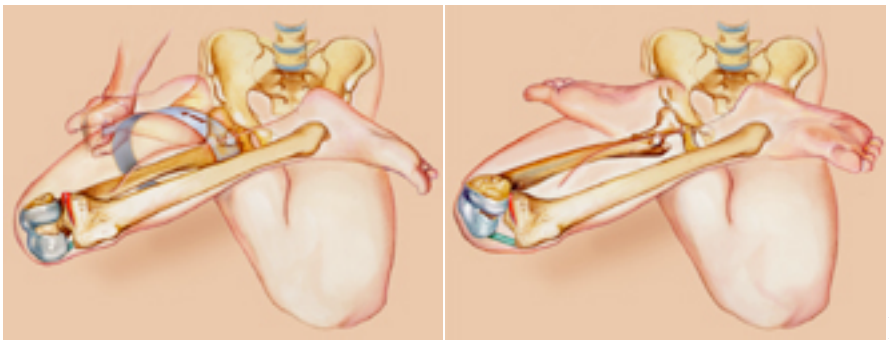
Protect the Knees in Lotus and Related Postures

By learning basic anatomical principles, you can teach your students how to safely open their hips without injuring their knees.



By Roger Cole

Safe knee placement

Lotus Pose (Padmasana) is a supreme position for meditation, and Lotus variations of other asanas can be profound. However, forcing the legs into Lotus is one of the most dangerous things you can do in yoga. Each year, many yogis seriously injure their knees this way. Often the culprit is not the student but an overenthusiastic teacher physically pushing a student into the pose.

Fortunately, there are techniques that make Padmasana much safer to learn. Even if you don't teach full Lotus, you can use the same techniques to protect students in related postures, such as Ardha Baddha Padmottanasana (Half-Bound Half-Lotus Forward Bend), Baddha Konasana (Bound Angle Pose), and Janu Sirsasana (Head-to-Knee Pose). These poses can do wonders for the hip joints and the muscles around them. Unfortunately, many students feel a painful pinching sensation in the inner knee in all of them. To understand why, and how to prevent it, consider the underlying anatomy.

The problem starts at the hip joint, where Lotus and its relatives require an astounding degree of

mobility. When you move from a neutral, seated posture, such as Dandasana (Staff Pose), to Baddha Konasana, the ball-shaped head of the thighbone must rotate outward in the hip socket about 100 degrees. Bending the knee and placing the foot in preparation for Janu Sirsasana requires somewhat less external rotation, but as a student bends forward in the pose, the tilt of the pelvis relative to the femur brings the total rotation to about 115 degrees. Padmasana requires the same amount of external rotation (115 degrees) just sitting upright, and the angle of rotation is somewhat different, making it more challenging for many students. When we combine the Padmasana action with a forward bend, as we do in Ardha Baddha Padmottanasana, the total external rotation required at the hip joint jumps to about 145 degrees. To put this in perspective, imagine that if you could turn your thighs out 145 degrees while standing, your kneecaps and feet would end up pointing behind you!

If a student can achieve all of this outward rotation at the hip in Lotus, they can then safely lift the foot up and across onto the opposite thigh without bending the knee sideways (see Figure 1). Some people with naturally mobile hips can do this easily, but for most people, the thighbone stops rotating partway into the pose. This limitation may be due to tight muscles or tight ligaments or, in some cases, to bone-to-bone limitations deep in the hip. When the femur stops rotating, the only way to get the foot up higher is to bend the knee sideways. Knees are not designed to do this-they are only designed to flex and extend.

If an overzealous student continues to pull the foot up after his thigh stops externally rotating, or if a student or teacher forces the knee downward, the thighbone and shinbone will act like long levers that apply great force to the knee. Like a pair of long-handled bolt cutters, they will pinch the inner cartilage of the knee between the inner ends of the femur and tibia. In anatomical terms, the medial meniscus will be squeezed between the medial femoral condyle and the medial tibial condyle. In layman's terms, the inner ends of the thigh and shin will squeeze the inner cartilage of the knee (See Figure 2). With even moderate force, this action can seriously damage the meniscus. Such injuries can be very painful, debilitating, and slow to heal.

Poses like Baddha Konasana and Janu Sirsasana can cause similar pinching. In these postures, we do not usually pull up on the foot, so the problem comes mainly from the lack of outward rotation of the thigh relative to the pelvis. Let's first look at Baddha Konasana.

Remember, to stay upright and stable while placing the feet in Baddha Konasana, the heads of the femurs will turn strongly outward-about 100 degrees-in the hip sockets. Because this requires so much flexibility of the entire hip region, many students instead allow the top rim of the pelvis to tilt backward while placing the feet in Baddha Konasana. They move the thighs and pelvis as a single unit. This requires little rotation of the heads of the femurs in the hip sockets, and it demands little flexibility. It also defeats the aim of mobilizing the hip joints and causes the entire spine to slump.

As a teacher, you may find yourself instructing the slumping student to tilt the top rim of the pel-

vis forward in order to bring them upright. If their hips are loose enough, this instruction won't create a problem; the pelvis will tilt forward, the thighs will remain externally rotated, and the spine will come upright. But if the hips are too tight, the femurs and pelvis will roll forward as a single unit. While the thighbones rotate forward, the shins will not, resulting in the aforementioned pinching in the inner knees. This explains why some students do not feel any knee pain in Baddha Konasana until they attempt to tilt the pelvis completely upright.

Some students complain of knee pain only when they bend forward in poses that require external rotation. That's because a forward bend like Janu Sirsasana demands even more external rotation at the hip joint. Again, in the tight student, the pelvis and femur roll forward as a single unit, pinching the inner knee. Of course, in either Baddha Konasana or Janu Sirsasana, pushing the knee(s) downward makes the problem worse, because tight muscles make the femur rotate forward as it is pressed.

Now back to Lotus Pose. Forcing the knees into Padmasana by lifting up on the ankles can also injure the outside of the knee. When a student lifts the shinbone without adequately rotating the thigh, it not only closes the inner knee, it opens the outer knee, overstretching the lateral collateral ligament. If a student then forcibly turns the feet so the soles point upward (which people often do to get the feet higher up on the thighs), they can worsen the strain. This action of turning the soles actually pulls the anklebone away from the knee, creating a chain reaction all the way up to the lateral collateral ligament.

What's the solution? First, use common sense. Never force a student into Lotus or related poses, and discourage students from forcing themselves. Teach students not to push into pain, especially knee pain. Do not adjust the pose by pulling on the foot or ankle, nor by pushing down on the knee. Instead, either teacher or student should apply firm outward rotating action to the thigh, turning the femur around its long axis, using the hands or a strap.

If your student already has knee pain but can do basic standing poses comfortably, teach these poses first, with careful alignment. This can bring her a long way toward recovery. When you reintroduce problem seated poses such as Baddha Konasana and Janu Sirsasana, use the hands or a strap to apply the same outward rotating action described above for Lotus.

For students who are ready to learn Lotus, introduce it gradually, working from poses that require less external rotation at the hip (such as sitting in Ardha Baddha Padmottanasana without bending forward) to those that require more (such as full Padmasana). Wait until last to introduce poses that require the most external rotation (forward-bending variations of full Padmasana). As students are learning these poses, teach them to rotate their thighs outward either with a hands-on adjustment or a self-adjustment. Instruct them to monitor and avoid pinching sensations in the inner knees.

Encourage your students to go slowly, be patient, and persist. In time, they may be able to sit

comfortably and meditate deeply in Padmasana. If not, remind them that true meditation lies not in some specific posture but in the spirit of their practice. Help them find a posture that suits them, then guide them to settle in and experience the stillness that is yoga.

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Intuitive Alignment: Sirsasana

Students who master alignment in Mountain Pose may have trouble maintaining it in Headstand when their world turns upside down. Here are some specific exercises to help your students attain verticality by sensing their alignment from the inside out.

By Roger Cole

Kadaliiasana (The Banana Pose). Vyaavritta Churikaasana (The Jackknife Pose). Vakraattasana (The Leaning Tower Pose). These are three variations of Salamba Sirsasana (Headstand) you've undoubtedly seen your students perform, but wish they wouldn't. Despite all your instructions, adjustments, and props, many students just don't seem to "get it" when you try to teach them how to line up their bodies straight and vertical in the pose. In last month's column we explored ways you can help students align their hips in Tadasana by encouraging them to cue into internal sensations rather than relying on external props or adjustments. This month, we'll explore how to help them intuitively align their legs, hips, and trunk in Sirsasana without outside assistance, focusing on front-to-back alignment.

The instructions below assume that your student already has a strong, well-aligned foundation in Salamba Sirsasana I. She should be able to:

Balance without support
Place her head so weight falls on, or a little in front of, the crown of her head
Press the little-finger side of her forearms (her ulna bones), her outer wrists, and her hands straight down into the floor so they support part of her body weight
Keep her elbows shoulder width apart
Lift her shoulder blades (scapulae) toward the ceiling while pressing them firmly against her back.

With her head, shoulders, and arms in place, you can teach her the three elements of front-to-back alignment in Sirsasana:

Neutralize pelvic tilt
Neutralize flexion/extension of the hip joints
Align trunk, hips and legs with gravity

Neutralize pelvic tilt: Your student can neutralize her pelvic tilt in Sirsasana the same way she

does in Tadasana (Mountain Pose). Last month's column, Intuitive Alignment: Tadasana Hips describes in detail how to teach her to do this. In short, she can learn to feel where her front hip bones (anterior superior iliac spines, or ASISs) and pubic plate (pubic symphysis) are, and place them on the same vertical plane. You'll need to teach her to do this in Tadasana before she tries it in Sirsasana, because part of the learning process requires her to place her fingers on her hip bones, then on her lower back, and she can't do this while standing on her head.

Here's how to proceed. First, follow the instructions in the Tadasana Hips column to help your student neutralize her pelvic tilt. While still in Tadasana, have her run her hand up and down her lower back (lumbar spine) to sense the shape of her normal lumbar curve. Then, with her hand still in place at mid-lumbar, have her deliberately tilt her pelvis forward (top rim forward, pubic area back) and backward (vice-versa), so she puts first too much, then too little arch in her lower back, and finally returns to neutral. Next, have her do the same thing without her hand on her back so she gets an intuitive, internal sense of what her back feels like when she has too much, too little, and just the right amount of lumbar curve.

Now have your student practice Headstand, and instruct her to try to find the same neutral pelvis and normal curve. Here is an important point: Tell her that in order to keep her lumbar from arching too much in Headstand, she will probably have to put a little more effort into pressing her sitting bones toward her heels (tilting her pubic symphysis forward and her ASISs backward) than she did in Tadasana. That's because in Sirsasana, gravity tends to make the sitting bones drop toward the floor, increasing the lumbar curve. Tell your student that she can maintain her neutral pelvic alignment by gently contracting the muscles where her thighs join her sitting bones in back (the upper hamstrings and part of the gluteus maximus). Caution her not to overdo this, though, because it can flatten her lumbar too much. Also, instruct her to rotate her thighbones inward as she contracts these muscles in order to keep her thighs, knees, and feet pointing straight ahead or slightly inward (without this instruction, they would probably rotate outward).

One way to teach your student to rotate her thighs slightly inward in Headstand is to have her touch the sides of her feet together at the base of her big toes (the medial side of her distal first metatarsal bones) while keeping her heels about an inch apart. While doing this, she should also push the inner edge of each foot up, away from the floor, and pull the outer edge down, toward the floor.

Neutralize flexion/extension of the hip joints: The actions and sensations your student needs to learn to place her hip joints in the neutral position between flexion and extension in Sirsasana are described in detail in last month's Tadasana Hips column, under the heading "Neutralize front-to-back placement of the pelvis." She simply needs to balance the sensation on her front hip creases (front groins) halfway between "too stretched" (legs too far back, hips extended) and "too soft" (legs too far forward, hips flexed). Teach her this in Tadasana, then have her immediately practice it in Headstand.

There are a few special points to note, though. First, the Tadasana instructions call for your stu-

dent to shift her pelvis "fore and aft," decreasing the range of movement until she finds the point where the stretch on her front hip creases feels halfway between stretched and soft. In Sirsasana, as your student shifts her hips she should simultaneously shift her legs in the opposite direction, so her feet move forward as her hips move backward, and vice-versa. Second, in Headstand, as in Tadasana, your student's pelvic tilt has to be neutral for the adjustment to work properly, because the degree of tilt of her pelvis will affect the amount of stretch in her hip creases. Finally, the Tadasana column describes a second way for your student to monitor her front-to-back hip placement, namely, balancing the sensation of firmness vs. softness just below her sitting bones (at the hamstring origins); however, this does not work as well in Sirsasana because of the increased muscle tension needed in this area to maintain the pelvic tilt.

Align trunk, hips and legs with gravity: If your student successfully neutralizes her pelvic tilt and her hip flexion/extension in Sirsasana, her body will be in a straight line, but this will not necessarily be a vertical line. In other words, if you view her from her side, you will be able to trace a single line through her shoulder, hip and ankle joints, but this line might not rise at a right angle from the floor. She needs a truly vertical line to feel the magic of a precisely balanced Headstand. Some students will spontaneously find this position simply by following the pelvis and hip alignment instructions in the previous sections. Those who do not will most often tilt the whole body forward toward their elbows. Many students find that this feels more secure than either balancing perfectly or leaning backward, because it allows them to lean on their elbows to prevent falling, and in case they do fall, at least they won't fall backward.

Luckily, once your student's body is in a straight line in Headstand, teaching her to bring that line precisely to vertical is surprisingly easy. That's because her brain is already automatically making all the necessary calculations; she just needs to learn to attend to the right cues. The cues are simple: the body is vertical when her abdominal muscles in front (rectus abdominis) and her lower back muscles (lumbar erector spinae group) are both relaxed at the same time.

The rectus abdominis muscle runs vertically from the middle part of the front of the ribcage and the base of the breastbone to the pubic bones. When it contracts, it brings the front ribs closer to the pubic bones, thereby flexing the lumbar spine. In Sirsasana, if the whole pose leans too far back, or if the legs lean back behind the pelvis in a "banana" shaped Headstand, the rectus abdominis prevents the pelvis (and therefore the legs) from falling further backward. If this muscle were to let go in either of these situations, the student would arch back and fall over. Therefore, the laws of physics make it certain that if your student is still managing to stay up in either of these misaligned Headstands, her rectus abdominis is contracting. The laws of biology allow her brain to automatically contract this muscle as needed without her even noticing it.

Similar reasoning dictates that the lumbar erector spinae group of muscles will be contracting if your student is leaning too far forward in her Headstand, or if her feet and legs are forward of the vertical line. The lumbar erectors spinae run vertically from the back of the lower spine and ribcage to the back of the sacrum and upper pelvis. When they contract, they arch the lower back. In Sirsasana, they prevent the pelvis (and therefore the legs) from falling further forward when the

whole pose leans too far forward, or when the legs angle forward of the pelvis in a "jackknife" shaped Headstand.

To teach your student to cue into these muscles, first help her feel them in Tadasana. Have her press the four fingertips of one hand into the front of her abdomen in such a way that they straddle her navel, two on each side, gently indenting the rectus abdominis muscle there. Ask her to lean her trunk and shoulders back until she feels the muscle harden beneath her fingertips. Then have her lean forward, as if starting to go into Uttanasana (Standing Forward Bend), until she feels the muscle soften. Have her lean backward again so the muscle hardens once more, then very slowly lean forward just to the point where she can completely soften it. Have her stop at that point.

Now have your student do a similar exercise with her thumb and fingers palpating her lumbar erectors spinae. Have her reach one hand behind her lower back and press her thumb into the muscles on one side of her spine, about one inch from the midline, at the level of her navel. Have her press the fingers of the same hand into the corresponding muscles on the other side. Ask her to lean her trunk and shoulders forward, as if starting to go into Uttanasana, until she feels the muscles harden beneath her fingertips. Then have her lean backward until she feels the muscles soften. Have her lean forward again, then very slowly lean backward just to the point where she can first completely soften her lumbar erectors spinae. Have her stop at that point.

Next, have your student press the fingertips of one hand into her rectus abdominis and the thumb and fingertips of the other hand into her lumbar erectors spinae at the same time. Ask her to lean forward and backward until she feels that both sets of muscles are relaxed simultaneously. This is the critical point where the brain has calculated that her trunk is balanced exactly vertically, so no muscle contraction is needed to prevent it from falling either forward or backward.

Before your student leaves Tadasana, have her try the same forward/back leaning exercise again, but this time, instead of sensing the hardness or softness of the muscles with her fingertips, have her notice what the muscles themselves feel like from within. At first, have her do this with her fingertips in place, so she can compare her muscular sensations to her fingertip sensations. Then, have her do it with her hands at her sides, so she can tell, without touching, when either her abdominals or her erectors are hard, and when both are relaxed at the same time.

The last phase of the process is to translate this muscle balance into Headstand. Of course, your student can't palpate her belly or back in the pose, but, with her permission, you can do it for her. Be careful, though! If your touch is heavy-handed or uneven, you might knock her over. Don't palpate students who are insecure in their balance. For those who are secure, proceed with caution, common sense, and respect.

Have your student take Headstand and neutralize her pelvic tilt and hip flexion/extension, as described above. Kneel at her side. Carefully place the thumb and fingers of one of your hands on her rectus abdominis alongside her navel, with your thumb on one side and your fingers on the

other. At the same time, place the thumb and fingers of your other hand astride her spine, about an inch from the midline at the level of her navel, to palpate her lumbar erectors spinae. Press your fingertips into the muscles enough to feel which ones are contracted and which are relaxed. Before telling your student what you feel, ask her what she feels. There are several possible scenarios.

(1) Erectors contracted, abdominals relaxed. This means that either her hips are flexed so her legs are forward of vertical or else her pose is straight but her whole body is leaning forward. If her hips are flexed, ask your student to shift her pelvis horizontally forward while shifting her feet backward. If her whole pose is tilted forward, ask her to preserve her line but lean her entire body slightly backward. In either case, instruct her to make the adjustment gradually, and to stop precisely at the point where her erectors relax, before her abdominals begin to contract.

(2) Abdominals contracted, erectors relaxed. This means that either her hips are extended so her legs are behind the vertical line or that her pose is straight but her whole body is leaning backward. If her hips are extended, ask your student to shift her pelvis horizontally backward while shifting her feet forward. If her whole pose is tilted backward, ask her to preserve her line but lean her entire body slightly forward. In either case, instruct her to make the adjustment gradually, and to stop precisely at the point where her abdominals relax, before her erectors begin to contract.

(3) Erectors and abdominals both contracted. This means that your student is gripping her trunk muscles unnecessarily. Perhaps she is insecure in her pose, perhaps she is trying too hard, or perhaps she just doesn't know how to let go. If she is insecure, work on stabilizing her basic Headstand before fine-tuning her alignment. If she is secure, she might be able to learn to selectively relax either the front or the back of her trunk by deliberately bringing her legs far into a jackknife or banana position in Sirsasana. If this doesn't work, she may need to go back to Tadasana and learn selective relaxation there.

(4) Erectors and abdominals both relaxed. Voila! Eureka! When your student finds this place, step back and observe her pose from the side. You will see a beautiful vertical line from shoulder to hip to knee to ankle. Most likely, your student's body will appear firm yet relaxed, her face will look calm and focused, and she may have a big smile! Let her enjoy her newfound Headstand.

Once you have helped your student find her front-back balance in Sirsasana by palpating her abdominal and erector muscles, help her graduate to feeling the muscle sensations on her own in the pose. If she can't feel what is contracted and what is relaxed at first, have her deliberately bring her feet first too far forward, then too far backward and notice the erector and abdominal muscle responses to these movements. When she can feel what her back and belly are doing, have her neutralize the position of her hips and pelvis again so her body is in one straight line, then have her tilt that whole line, from shoulders to ankles, slightly too far forward, then too far backward, and notice how her back contracts as she leans forward and her belly contracts as she

leans backward. Finally, have her maintain her line and find for herself that exquisite point where both the front and the back of her body relax and the gates of heaven open.

When your student succeeds at creating this wonderful balance by relying on her own internal cues, you will have done something better than giving her the gift of a joyful Headstand. You will have helped her learn to give herself that gift, over and over again, for the rest of her life.

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Keep the Neck Healthy in Shoulderstand

So you want to teach your students Shoulderstand, but you have some questions about this challenging pose. Is it necessary to use props? Is the posture safe for the neck? Roger Cole answers these questions and more.

By Roger Cole

If you've ever practiced Salamba Sarvangasana (Shoulderstand) in an Iyengar-style yoga class, odds are the teacher asked you to support your shoulders on a stack of folded blankets or a similar prop, keeping your head at a lower level (see illustration). Yogis have been happily practicing Shoulderstand without this extra lift for several thousand years, so why did B.K.S. Iyengar come along and change the drill? Mr. Iyengar himself demonstrates the pose without shoulder support in his classic book, *Light on Yoga.* So why does he insist that most students do it with their shoulders elevated? There are lots of good reasons, but the most important is that it can protect the neck from injury. This article explains how teaching your students to support their necks can help them perform Shoulderstand safely and effectively.

The neck (cervical spine) has seven vertebrae. Flexible disks separate all but the first two. The disks create space for spinal nerves to exit between the bones. They also allow the neck to bend and turn. (For more on disks, see Protect the Disks in Forward Bends and Twists.) The vertebrae and disks are normally arranged so the back of the neck curves inward. When curved this way,

the neck bears the weight of the head most efficiently.

Reinforcing this inward curve of the neck is a ligament (the ligamentum nuchae) that runs lengthwise down the back of the neck. This ligament joins the bony spines (spinous processes) that protrude from the backs of the vertebrae. The ligamentum nuchae is more elastic than most ligaments, so it tends to spring back after it is stretched. Therefore, if your student bends her neck forward, then returns it to neutral, the ligament helps restore the inward curve.

Shoulderstand bends your student's neck forward into flexion. The amount of flexion depends on how she does the pose. If she performs it flat on the floor, but rolls her weight backward so it rests on the back part of her shoulders and tilts her upper spine and chest diagonally away from her head, then she can balance quite comfortably without putting much pressure on her neck. This is the standard way to do the pose in some systems of yoga, and it is usually perfectly safe for the neck. If, on the other hand, your student does the pose with her shoulders and head flat on the floor but attempts to lift her spine and chest into a completely vertical position, pressing her breastbone strongly toward her chin, then she will force her neck into extreme flexion, using her entire body weight to apply pressure. A few people may be able to do this safely, but most people's necks simply cannot bend this far without causing either subtle or obvious damage.

In a way, Mr. Iyengar may have inadvertently contributed to neck problems in Sarvangasana by pointing out that a truly vertical Shoulderstand is a more powerful and effective pose than a non-vertical one. As more and more people try to mimic Iyengar-style alignment in the pose without using the props he recommends, they run smack into their limited neck flexibility. It's not that a completely vertical Shoulderstand without support is a "bad" pose--in fact, it might be the ideal pose--it's simply that it is so extreme for the neck that only advanced yogis can do it without risking injury. By analogy, wrapping both feet behind the head in an extreme forward bend like Kurmasana (Tortoise Pose) is not a "bad" pose, but most people cannot do it safely. Because of the anatomical structure of the human body, a truly vertical Shoulderstand, performed with the head and shoulders flat on the floor, is a much more extreme pose for the neck than Kurmasana is for the lower back. Even those who can do it safely can usually do the pose better when they put support under their shoulders. So just about everyone can benefit from the lift, and most people truly need it.

What happens if your student forces her neck too far into flexion in Shoulderstand? If she is lucky, she will only strain a muscle. A more serious consequence, which is harder to detect until the damage is done, is that she might stretch her ligamentum nuchae beyond its elastic limits. She may do this gradually over many practice sessions until the ligament loses its ability to restore her normal cervical curve after flexion. Her neck would then lose its curve and become flat, not just after practicing Shoulderstand, but all day, every day. A flat neck transfers too much weight onto the fronts of the vertebrae. This can stimulate the weight-bearing surfaces to grow extra bone to compensate, potentially creating painful bone spurs. A still more serious potential consequence of applying excessive force to the neck in Shoulderstand is a cervical disk injury. As the pose squeezes the front of the disks down, one or more of them can bulge or rupture to the

rear, pressing on nearby spinal nerves. This can cause numbness, tingling, pain and/or weakness in the arms and hands. Finally, a student with osteoporosis could even suffer a neck fracture from the overzealous practice of Shoulderstand.

Supporting the shoulders on a prop in Sarvangasana, with the head at a lower level, helps protect the neck simply by reducing the amount that it has to flex to achieve the pose. The prop opens up the angle between the neck and the body. This allows most students to perform a vertical or near-vertical Shoulderstand without neck strain. Nevertheless, the prop is not a panacea. You still have to take certain safety precautions when teaching the pose.

Give alternatives for special needs. Full Shoulderstand with the shoulders on a lift may not be safe for students with excessive neck or shoulder tightness, existing neck injuries, osteoporosis, obesity, or other issues. These students may need to do a modified Shoulderstand, an easier inversion such as Viparita Karani (Legs-up-the-Wall Pose), or some other alternative pose. One Shoulderstand modification that is often helpful is to support the hips on a chair in a way that takes most of the weight off the neck.

Make the prop high enough (but not too high) and firm enough. If your student is supporting her shoulders on a stack of blankets, make sure she uses enough of them (but not too many), and make sure they are not too mushy to provide stability.

Prepare the body. Practice poses that warm and stretch the back, neck, and shoulders before doing Shoulderstand.

Start out slowly. For example, it's a good idea to have your less experienced or less flexible students practice the pose with their back to a wall, walking their feet up the wall to lift the body.

Look out for balance. Students not accustomed to support props may find their balance precarious, especially if tight muscles force their elbows to lift up or move apart. Walking the feet up the wall can help with balance, as can extra props (like a wedge or rolled sticky mat under the elbows, or a belt around the upper arms).

Don't force. Don't try to make the neck bend farther than it is ready to bend.

Lift the chest toward the chin; don't pull the chin down toward the chest. Instructing your students to do this can help prevent them from tightening the flexor muscles on the front of the neck.

Don't sag the center of the neck. Because it's usually good practice to leave space under the center of the neck, rather than resting the middle of the neck on the support prop, encourage your students to lift the center of the neck toward the ceiling rather than letting it sag it into the space.

Don’t turn the head. Turning the head in Shoulderstand dramatically increases the strain on the

muscles, ligaments, and disks of the neck, so warn your students not to do it.

If you teach the pose without shoulder support props, don't bring your students fully vertical. In a "flat on the floor" Shoulderstand, discourage your students from forcing themselves straight up; instead, instruct them to rest their weight toward the back of their shoulders and jackknife the body enough to take pressure off the neck.

Take care with variations. Some Shoulderstand variations, such as Halasana (Plow Pose), put even more pressure on the neck than the standard pose, so use extra caution when teaching these.

Observing these cautions not only makes Salamba Sarvangasana safer, it makes it better. A good Shoulderstand is one of the most beneficial and enjoyable poses in yoga. Helping your students enter it safely is one of the greatest gifts you can give them.

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High Blood Pressure and Inversions

I have high blood pressure that is controlled by medication. Is it safe to practice inversions, particularly Shoulderstand and Headstand?

By Roger Cole

Roger Cole's reply:

You should check with your doctor about your individual case, but standard medical advice for people whose blood pressure is controlled on medication is to engage in exercise and other healthy activities that a person with normal blood pressure would do. Therefore, it seems reasonable that you can safely introduce inversions if you do so gradually. In fact, inversions trigger several reflexes that temporarily reduce blood pressure, so theoretically, regular practice may enhance treatment of your high blood pressure. Note, however, that people whose high blood pressure is not under control should bring the pressure down first by other means before practicing inversions.

First, let me explain how inversions affect blood pressure. In an inverted posture, gravity causes pressure to increase inside the blood vessels (arteries, veins, and capillaries) of the head and neck. The vessels of the brain and eyes are largely protected from this pressure increase because they are bathed in fluid—cerebrospinal fluid inside the skull and vitreous humor in the eyes—the pressure of which also increases during inversions: The pressure of the fluid pushing in on the blood vessel walls from outside counteracts the pressure of the blood pushing out on the vessel walls from inside.

Blood vessels that lie outside of the skull and eyes, such as those supplying the inner lining of the nose, do not have this protection. Instead, many are protected by local reflexes that respond to elevated blood pressure by contracting muscles in the vessel walls. This contraction prevents the vessel walls from being overstretched. If inversions are introduced gradually, you are in theory systematically strengthening the vessel wall muscles by challenging them to contract against greater and greater pressure.

How much blood pressure increases in the head during an inversion depends mainly on two factors: how far above the head the heart is, and how far above the heart the legs and trunk are. Therefore, a mildly inverted posture like Adho Mukha Svanasana (Downward-Facing Dog), which lifts the heart only a little above the head and does not elevate the legs, only increases pressure in the head a little. Supported Setu Bandha Sarvangasana (Bridge Pose, lying on bolsters, legs horizontal, feet at hip level) increases pressure in the head somewhat more because the legs and trunk are slightly above the heart, and the heart is slightly above the head. Salamba Sarvangasana (Shoulderstand) increases pressure in the head still more, because the legs and trunk

are raised to their maximum vertical position above the heart, and the heart is raised somewhat higher above the head than in Setu Bandha. Sirsasana (Headstand) increases blood pressure in the head the most, because the legs and trunk are maximally elevated and the head is as far below the heart as it can get.

To safely practice inversions, I recommend that you introduce them over several months, starting with mild or partial inversions first, then gradually attempting steeper inversions, and moving on to Headstand last.

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Locating the Groin Muscles

What parts of the body are instructors referring to exactly when they speak of "groins?"

By Roger Cole

Roger Cole's reply:

Medically, the groin is the junction between the abdomen and thigh. When you lift your thigh toward your chest, a crease forms at this junction. Technically, the groin runs along the entire length of the crease, and it's still the groin after the thigh descends and the crease goes away.

When a teacher talks about moving the groin, they often mean to move the very uppermost part of the thigh immediately below the groin. The plural "groins" simply refers to the groin of the left leg and that of the right leg, taken together. However, when some teachers say "groin," they are referring only to the part of the groin nearest the inner thigh. Other teachers call this area the "inner groin" and its counterpart near the outer end of the hip crease the "outer groin." In this case, they sometime use the plural "groins" to refer to the inner and outer parts of the groin of the same leg, as in, "lift the inner and outer groins equally."

To make matters worse, B.K.S. Iyengar has expanded the definition of "groin" to include the whole junction of the thigh and pelvis, around the entire circumference of the thigh. Thus, he calls the crease below the buttock where it joins the back of the thigh the "back groin." This logically gives rise to terms like the "inner back groin" and the "outer back groin." It's enough to make you groan!

But, in fact, when you understand what the teacher is saying, and you learn to make the various parts of the groin move as directed, it can really enhance your asana practice. As you can see, different teachers use the word "groins" differently. It's good teaching practice to define a confusing word like this to the class before using it, so you might consider asking your yoga teacher to do so for your class next time the term is used.

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Lifting the Arms, Part 1: Cinch Down, Turn Out to Protect the Rotator Cuff

Tears and inflammations of the rotator cuffs are often caused by misunderstanding the actions of the arms. This introduction to the outward rotation of the humeri includes basic anatomy and suggestions about instructions to use to keep your students safe.

By Roger Cole

When we ask our students to lift their arms overhead (for example, in Urdhva Hastasana [Upward Hand Pose], it may seems like a simple request, but it's actually a complex biomechanical challenge. Raising the arms requires a precisely coordinated sequence of movements of the humeri (upper arms bones), shoulder blades (scapulae), clavicles (collar bones), ribcage, and spine.

Different students accomplish this in different ways. There are thousands of possible variations and permutations of motion and timing, some of which work better than others. The coordination of shoulder blade and upper arm movement as the arms lift is called the scapulo-humeral rhythm. In this column, we will explore a small but crucial part of this rhythm--the outward rotation of the humeri--so that you can help your students move their arms more safely and effectively in yoga poses. Next month, we will take a closer look at movements of the shoulder blade.

Let's start by identifying some anatomical structures. The bulging top end of the upper arm bone is called the head of the humerus. The half of the head that faces inward toward the body is a smooth hemisphere that forms a joint with the shoulder blade (the gleno-humeral joint). The half of the humeral head that faces outward, away from the body and shoulder blade, is capped by an irregular bump called the greater tubercle, which forms a point of attachment for several muscles that move the arm. The front of the humeral head also has a bump, the lesser tubercle, that is an attachment point for several arm muscles.

Now let's explore the scapula. If you reach one of your hands across your body over the opposite shoulder, you can palpate a horizontal ridge of bone that protrudes from the top-back of the shoulder blade. This is the spine of the scapula. The outermost (lateral) extremity of this spine is called the acromion process. You can find it by running your fingertips outward along the scapular spine to where it turns forward at its end. The whole spine of the scapula forms the back wall of a sort of trough that sits atop the shoulder blade. If you try to press your fingers into this trough by pushing down in front of the scapular spine, you will find that the space is filled with muscle. The muscle closest to the surface is the trapezius, but underneath it lies a second muscle that concerns us more here: the supraspinatus.

The supraspinatus is one of the four muscles of the rotator cuff. Its tendon runs out to the side, underneath the acromion process and over the top of the head of the humerus, where it attaches to the greater tubercle. This arrangement turns out to be very significant: the supraspinatus ten-

don is sandwiched between the acromion (above it) and the head of the humerus (below it). When the supraspinatus contracts, it pulls the greater tubercle inward (medially) and upward toward the shoulder blade. This lifts the rest of the arm outward (laterally), away from the body, into abduction.

This is one of the early steps in the scapulo-humeral rhythm. It begins the movement of the arm from hanging downward alongside the body to reaching out away from the body on its way to lifting overhead. But this action can cause trouble if it occurs too early. If the supraspinatus contracts strongly while the arm is in its neutral, non-rotated, Tadasana position, it can lift the greater tubercle straight up into collision with the acromion process. This can pinch the supraspinatus tendon between the acromion and the humeral head. Doing this repeatedly or forcefully can fray, inflame, or even tear the tendon. This is perhaps the most common type of rotator cuff injury.

Preventing this problem is quite simple, and is a natural part of a healthy scapulo-humeral rhythm. The first step to lifting the arm overhead is not abduction, but rather a combination of "cinching down" the head of the humerus, so there is more space between it and the overlying "roof" formed by the acromion process, and externally rotating the humerus, which moves the greater tubercle backward, so that most of it no longer lies under the acromial "roof." Two rotator cuff muscles, the infraspinatus and teres minor, are primarily responsible for these actions.

You can palpate infraspinatus by reaching your left hand over your right shoulder and pressing your fingers into the flesh a couple of inches below the spine of the scapula. If you then rotate your right arm firmly outward, you will feel the infraspinatus contract under your fingertips. Infraspinatus is primarily an external rotator; it does not cinch down the head of the humerus much. This is because its tendon runs more or less horizontally from the back of the shoulder blade, across the back of the humeral head to the greater tubercle, and therefore pulls the tubercle mostly backward rather than downward.

Teres minor is a little harder to palpate than infraspinatus because you have to reach farther over your shoulder and out to the side. It runs along the lower part of the outer border of the back of the shoulder blade, alongside the bottom portion of infraspinatus. You can feel it contracting when you rotate your arm outward, but it is not just an external rotator. Because it lies lower on the shoulder blade than infraspinatus, its tendon runs more vertically behind the humeral head to reach the greater tubercle. When it contracts, it pulls the tubercle not only backward, but also downward, producing much of the downward cinching action that prevents the tubercle from colliding with the acromion as the arm abducts.

So when you ask your students to lift their arms overhead, instruct them first to rotate their upper arms outward and pull them downward. As they do this, subscapularis, the fourth rotator cuff muscle, will modify the action for better or worse. Subscapularis lies on the front surface of the shoulder blade, between the blade and the ribcage. Its tendon runs in front of the humeral head and attaches to the lesser tubercle. This arrangement makes it primarily an internal rotator, but it

can also help cinch the humeral head downward. So when you tell your students to externally rotate their arms and pull them down, subscapularis must release enough to allow the rotation. In spite of this, it might be worthwhile to keep enough tension on the muscle to aid in the downward action. One way to instruct your students to do this is to tell them to pull their arms inward toward the midline of the body and keep some inward-turning resistance on them as they rotate them outward.

For a healthy scapulo-humeral rhythm, the rotating and cinching actions should start before the arms begin to lift; however, that's not the end of the story. The same actions must continue throughout the pose, both during the process of lifting and after the arms are fully elevated. Maintaining these actions will help keep the supraspinatus tendon in a safe position, away from the acromion.

Instructing your students to do this can get confusing if you're not careful. When your students' arms are at their sides, the instruction to "rotate your arms out" means to turn the outer (triceps) side of their arms backward and the inner side forward. Once the arms are overhead, the same direction of rotation turns the outer arms forward (triceps forward) and the inner arms backward. Although this is technically still "outward rotation" to an anatomist, to a student it may look like inward rotation. So avoid the terms "outward rotation" and "inward rotation" when their arms are overhead, and instead tell your students to "turn your arms so the outer side moves forward and the inner side moves backward" while you show them by example what you mean.

If you can successfully communicate these movements to your students before and during arm elevation, they will strengthen the muscles that reinforce the action, stretch those that antagonize it, and learn nerve patterns that help them do the right thing at the right time to lift the arms with safety, efficiency, and grace.

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Lifting the Arms, Part 2: Rotate and Elevate the Shoulder Blades for Fuller, Safer Movement

Should you teach your students to raise or lower their shoulder blades when their arms are lifted? Roger Cole settles the question once and for all with an answer based on the shoulder's complex anatomy.

By Roger Cole

Try this quick multiple-choice test. When you teach your students how to reach their arms high overhead, should you (a) tell them to pull their shoulder blades down toward the floor, (b) tell them to lift their shoulder blades up toward the ceiling, or (c) throw up your hands in confusion and say "I don't know what you're supposed to do with your shoulder blades?" If you've taken enough yoga workshops with enough different teachers, choice (c) might seem the most natural to you. Some teachers insist that when you lift your arms up you must hold your shoulder blades down at all costs, while others are equally adamant that you must raise your shoulder blades as high as you can. To solve this confusion, this column will advocate choice (b), lifting, but only if it's done in a certain way, which, paradoxically, involves a good bit of downward pull. Why go with (b)? The action of lifting will help protect your students against rotator cuff injuries, give their arms maximum height, and make it much easier for them to progress from arm elevation to backbending movements of the arms and shoulders, like those required for Adho Mukha Sva-nasana (Downward Facing Dog Pose) and Urdhva Dhanurasana (Upward Facing Bow Pose).

To understand how to teach your students to lift their arms freely, it helps to know some basic shoulder anatomy. The shoulder blade, or scapula, is shaped roughly like a right triangle with its point facing downward, its inner (medial) edge running vertically alongside the spine (vertebral column), and its top edge running horizontally. The medial edge is called the vertebral border of the scapula. The upper-inner corner of the shoulder blade, at the top of the vertebral border, is called the superior angle. The lower tip, at the bottom of the vertebral border, is called the inferior angle. The most prominent feature of the top edge of the shoulder blade is a horizontal ridge of bone that runs along its length. This is the spine of the scapula, and it is palpable just under the skin if you reach one hand across your body to touch the top-rear part of your opposite shoulder. The outer end of this ridge, at the upper-outer corner of the scapula, is called the acromion process. Recessed under the acromion is the glenoid fossa, a slightly concave circle of bone the size of a small coin.

The shoulder blade is capable of several of movements. Abduction (also called protraction) is the movement of the scapula away from the midline of the body and around toward the front. Adduction (retraction) is the movement toward the midline. Elevation is the vertical lifting of the scapula. Depression is the downward push. Anterior tilt is the tipping of the top edge of the scapula forward and the inferior angle backward. Posterior tilt is the tipping the top edge backward and the inferior angle forward. Upward rotation is a more complex scapular movement. The inner edge of the scapula moves down while the outer edge moves up, so, when viewed from the rear, the whole bone turns either clockwise (left scapula) or counterclockwise (right scapula). Upward rotation is crucial to arm elevation. To understand why, let's consider the upper arm bone (humerus), and its relationship to the shoulder blade.

The top end of the humerus has a rounded head that sits under the acromion process of the scapula and abuts the glenoid fossa. The junction between the glenoid and the humeral head is the gleno-humeral joint. This joint allows most of the familiar arm movements at the shoulder, including abduction (reaching the arm out to the side), adduction (moving the arm across the body), flexion (bringing the arm forward), extension (bringing the arm backward), internal rotation (turning the arm in) and external rotation (turning the arm out). However, all of these movements can be enhanced by supportive movements of the scapula, and one arm movement, elevation (lifting the arm overhead), cannot be accomplished at all by movement at the gleno-humeral joint alone. It also requires strong upward rotation of the scapula.

When a student brings her arm from straight down at her side to straight up overhead, she lifts it through an arc of 180 degrees. However, even under the best of circumstances (that is, strong external rotation of the humerus), the gleno-humeral joint only allows about 120 degrees of arm lift. The remaining 60 degrees come from upward rotation of the scapula. Last month's column explained that it is important to turn the humerus outward while lifting the arm upward in order to help prevent pinching one of the rotator cuff tendons (the supraspinatus tendon) between the head of the humerus (below it) and the acromion process (above it). If the arm is not turned outward, it can only lift about 20 to 30 degrees before the bony outer side of the humeral head (called the greater tubercle) jams against the acromion and pinches the supraspinatus tendon. But

even with maximal outward rotation of the arm, the greater tubercle starts jamming against the acromion (and pinching the supraspinatus tendon or nearby structures) at about 120 degrees of lift. The only reason the typical student can raise her arm all the way to 180 degrees is that she unconsciously rotates her scapula upward as her humerus tilts up. This tips her acromion up and out of the way of her humeral head so her arm can reach the vertical position without impingement.

Upward rotation of the scapula during arm elevation is produced automatically by nerve firing patterns that are programmed into the brain and spinal cord. To understand just how deeply ingrained these patterns are, try this. Stand in Tadasana with your right arm hanging at your side and your left hand reaching across your body so it rests atop your right acromion. Then start to reach your right hand out to the side, as if starting to bring it up overhead. Notice that your hand doesn't get far at all before your acromion starts to lift! Even if you try to prevent upward rotation by pulling your outer right shoulder blade strongly downward and turning your arm strongly outward while lifting your hand, it's very difficult to get your arm above horizontal without raising your acromion. This provides a clue that will help us answer our initial question. Should we instruct our students to pull their shoulder blades down or to lift them up when they raise their arms? From what we just observed, even if they try to pull them down, at least the outer edges will lift up anyway as the arms go up. This is a good thing, because if their acromion processes didn't lift, their supraspinatus tendons might be pinched, and they couldn't raise their arms all the way to vertical. So it makes sense to recommend, at the very least, that students lift the outer sides of their shoulder blades when they take their arms up.

This brings up a practical question. Is it anatomically possible for a student to voluntarily elevate the outer edge of her shoulder blade more than the inner edge? The answer is yes, absolutely. Here's why: the two main muscles that elevate the shoulder blade are the upper fibers of trapezius and the levator scapulae. The upper trapezius runs from the middle of the back of the neck and the base of skull to the outer end of the collarbone (clavicle). The end of the collarbone, in turn, is attached to the acromion. Therefore, when the upper trapezius contracts, it pulls the outer clavicle up, which in turn pulls the acromion up, which lifts the whole outer shoulder blade, leaving the inner shoulder blade behind. The upper fibers of trapezius therefore help upwardly rotate the scapula.

The levator scapulae does something quite different. It runs from the side of the neck (transverse processes of the upper cervical vertebrae) to the upper inner shoulder blade (the superior angle). When it contracts, it selectively lifts the inner border of the scapula and leaves the outer border behind. This means it performs downward rotation, which is just the opposite of what our students need for lifting their arms overhead. When contracted too hard, it also bunches uncomfortably at the base of the neck (see right photo). Therefore, it makes sense to discourage students from activating this muscle while they lift their arms. However, as we'll see, contracting the levator scapulae moderately can be helpful for maximizing final elevation after the scapula is rotated completely upward (see middle photo).

We're getting closer to formulating specific instructions we can give to students to get their arms overhead most effectively. These instructions will include lifting the outer shoulder blades up without actively lifting the inner shoulder blades, but this is not the whole story and it would be misleading to stop here. To complete the tale, we need to look at the anatomy of the trapezius.

The upper fibers of the trapezius alone are not sufficient to upwardly rotate the scapula. The middle trapezius, lower trapezius, and serratus anterior are also needed. The middle trapezius runs roughly from the vertebral column between the shoulder blades to the acromion process. Its action picks up where the upper trapezius leaves off. When the scapula is rotated partially upward, it pulls the acromion horizontally toward the vertebral column, and thus continues the rotation.

The lower trapezius runs from the middle of the vertebral column below the shoulder blades (that is, from the spinous processes of the lower thoracic vertebrae) upward to the medial end of the spine of the scapula. When it contracts, it pulls the inner margin of the scapula down, thus complementing the lift of the outer margin of the scapula produced by the upper and middle trapezius. The net result of all three parts of the trapezius working together is upward rotation of the scapula without elevation or depression. The downward pull of the lower trapezius on the inner end of the spine of the scapula is especially important because it provides an axis around which the whole scapula can upwardly rotate. Since the lower trapezius actually does apply a downward force to the inner shoulder blade, it makes anatomical sense to instruct your students to actively draw their inner shoulder blades downward when you want them to rotate their scapulae upward as they lift their arms. However, this action will eventually be eased when it comes time for final elevation of the shoulder blades.

It takes some imagination to visualize the complex course and actions of serratus anterior. This muscle originates on the front-side ribs of the mid-to-lower chest, runs backward around the body, passes underneath the shoulder blade, and attaches to the underside of the vertebral border of the scapula. When it contracts, it pulls the whole shoulder blade away from the vertebral column and around toward the front of the body (that is, it produces scapular abduction), but it abducts the lower end farther than the upper end, creating upward rotation of the scapula. Its contribution to upward rotation is so great that without it, it is impossible to lift the arms completely overhead. Its abducting action is also crucial for offsetting the adducting actions of all three parts of the trapezius.

When instructing your students in how to lift their arms, it is important to communicate the need to strongly activate this scapular abductor. To help your students fully engage their serratus anterior muscles, encourage them to roll their shoulder blades apart and around toward the front of the body while they lift their arms. This instruction will become even more important during the final elevation phase of lifting the arms.

So what is this final elevation phase? So far, we've implied that it's a good thing without explaining exactly what it is or why it's desirable. To understand what it is, it's useful to compile the in-

structions we've collected so far into a coherent sequence, and see where they leave us. Try this: Stand in Tadasana. Cinch your arms downward and rotate them outward as far as possible. Begin lifting your arms to the sides, continuing to rotate them out. Draw your inner shoulder blades downward, but let your outer shoulder blades rise as your arms lift. As your arms continue above horizontal, roll your shoulder blades apart and around toward the front of your body. Continue the same rotation of your arms, the same downward action of your inner shoulder blades, the same upward action of your outer shoulder blades, and the same rolling of your shoulder blades apart even after your arms reach the full vertical position. But what should you do next? The best way to understand this is with a demonstration.

Follow all the instructions in the previous paragraph. When your arms are pointing straight up, pull your inner shoulder blades down even more strongly. (If you want to make this demonstration even more dramatic, hold both the inner and outer shoulder blades down, as in the left photo.) Now, continuing this downward pull, try to move your hands and arms backward as far as you can without bending your elbows (that is, move your arms toward the position they might take in a full backbend like Urdhva Dhanurasana). If you are like most people, your response to this last instruction will be "Yuck! It jams my shoulders! My arms won't move back!"

Now try an alternative. Return your arms to the straight up position with the inner shoulders pulling down. Roll your shoulder blades apart as far as you can. Now gradually let go of most of the downward pull as you lift both shoulder blades upward. Lift the outer side of each shoulder faster than the inner side at first, but eventually lift the whole shoulder blade, inner and outer, as high as it will go. If you do this carefully, your levator scapulae muscles will engage modestly, but so will your upper trapezius, while your lower trapezius remains slightly active. With this combination of muscle contractions, you won't lose any of the upward rotation of your scapulae; instead, you'll probably enhance it while you elevate both shoulder blades in the upwardly rotated position. After your first lift, roll your shoulder blades apart once more, then lift them even further. You'll probably find that the higher you lift your shoulder blades, the more they move toward one another. This is because both of the lifting muscles, the upper trapezius and the levator scapulae, are also adductors, especially when the scapulae are high. Actively using serratus anterior to try to abduct the shoulder blades as you lift them will help prevent a bunching of the levator scapulae at the base of the neck and will enhance upward rotation.

When you have lifted your shoulder blades as high as you can, keep them up while you take your arms backward as far as possible into the backbending position you tried before. This time, if you're like most people, you will have much more freedom in the backbending movement, in sharp contrast to the restriction you experienced when you held your scapulae down. It's not clear why this happens, but it may be that lifting the shoulder blades so high while in full upward rotation frees them to tilt much farther posteriorly than they can when they are pulled down. This tilt would point the gleno-humeral joints backward, making it easier to reach the arms back.

So we can sum up the rationale for lifting the shoulder blades while reaching the arms overhead as follows: Lifting the outer shoulders more than the inner shoulders rotates the scapulae upward.

This angles the acromion processes upward, making it easier to reach the arms straight up without impingement. Once the scapulae are rotated completely upward, elevating them as high as possible without losing their upward rotation creates maximum space for tilting them backward. This posterior tilt angles the gleno-humeral joints backward, making it easier to move the arms into a backbending action.

Although the anatomical explanation of why to lift the shoulder blades while lifting the arms is complicated, it's worth taking the time to think it through and explore it in your practice so you can share it with your students. Lifting the arms high is a universal expression of jubilation. When you help your students do it freely and fully, you help them find not just mobility, but also exhilaration and joy.

Photo Captions

Left photo. Pulling the shoulder blades down while lifting the arms prevents full upward rotation of the scapulae, encourages rotator cuff impingement, and makes it difficult to move the arms backward into a backbending position.

Center photo. Lifting the shoulder blades up as high as possible after rotating them completely upward safely raises the hands to maximum height and frees the arms and shoulders for backbends. It's important to move the shoulder blades apart while lifting them up to maintain upward rotation and to reduce bunching of the levator scapulae muscles near the neck. The angle of the vertebral border of the scapulae reveals greater upward rotation in this photo than in the right and left photos. Note also the difference in the height of the hands in the three photo Right photo. Contracting the levator scapulae muscles too soon during the process of raising the arms or too hard after the arms are up causes the muscles to bunch uncomfortably at the base of the neck, prevents full upward rotation of the scapulae, encourages rotator cuff impingement, and restricts backbending action of the arms.

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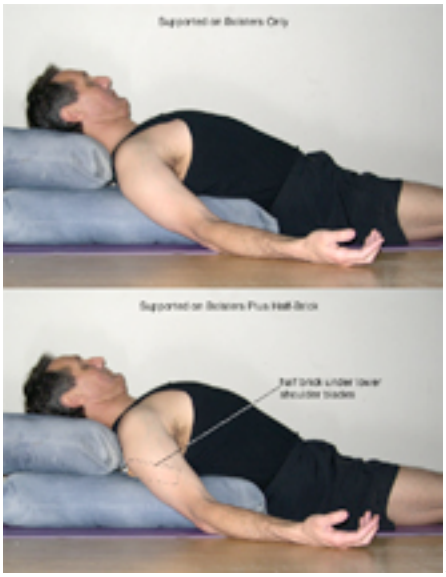
How (and Why) to Support the Trunk and Head in Savasana



Diehard Savasana fans may wonder why you'd ever mess with such a good thing, but variety may be the spice of relaxation and renewal. Here are some reasons to bring variations of Supported Savasana into your teaching.

By Roger Cole

Many students say Savasana (Corpse Pose) is their favorite pose, and who could argue? It almost always feels wonderful, and sometimes it's downright enlightening. In classical Savasana, the entire body—from head to heels—rests flat on the floor. This asana is the most neutral of all poses because it does not elevate one body part above others, it does not stretch any body part

very much, and it does not demand that any muscles contract. Instead, it promotes an exquisite, balanced state of rest.

If it's so perfect as it is, why do we so often prop our students up in Savasana, supporting the trunk and head on blankets, bolsters, blocks and other props? Why not leave well enough alone? Most of the time, we probably *should* leave well enough alone. More often than not, plain old flat Savasana is the preferred pose. But there are legitimate reasons to use support in Savasana—not just occasionally, but frequently. And luckily, the supported and classical versions of the pose are not mutually exclusive. You can teach them both, even in the same class, even one right after the other. To understand when you might want to elevate a student's trunk and head in Savasana, let's look at some effects that yoga teachers have observed when they prop the pose this way. Supported Savasana:

Keeps students more alert than classical Savasana
Reduces nasal congestion
Opens the chest
Helps students feel the alignment of their back ribs
Rolls the tops of the shoulder blades back
Improves breath awareness and pattern
Teaches the beginning of Jalandhara Bandha (Chin Lock)

Note that every one of these effects can be helpful in the practice of pranayama. That's why many teachers put students in Supported Savasana as part of their pranayama instruction. Other reasons to support Savasana include helping students rest when they have a cold or allergies, improving posture (by counteracting slumping of the chest), improving the left-right symmetry of the trunk, and treating shoulder injuries (by creating freedom in certain movements of the shoulder blades, upper ribs, and upper spine).

Perhaps the most familiar way to support Savasana is to place a bolster lengthwise under the back from the lumbar spine (the lower back) to the head, and to place a second bolster or a folded blanket under the head to lift it still higher (see top photo). However, there are many alternate ways to prop the pose, and each has its pros and cons. Knowing the anatomy and physiology of the effect you are trying to produce can help you choose the best setup for each student.

Let's consider alertness first. Although no one has ever proven it scientifically, Supported Savasana probably makes students more alert in two ways. One is by stimulating sensory nerves in the back, chest, abdomen and shoulders, either with the direct pressure of the prop on the back or the resulting stretch on the front of the body. The harder the prop is, the stronger this stimulation will be (for example, a wooden block will be more stimulating than a bolster). The second is by reducing blood pressure in sensors located in the neck and upper chest. The higher these sensors are lifted above the heart, the less pressure they feel, because gravity resists the heart's efforts to

pump blood up to them. The fall in pressure at the sensors can be strong enough to trigger a reflex that speeds up the heartbeat and activates the brain. The higher the prop, the stronger this reflex will be, and the more the brain will be activated. So if you are trying to keep a student alert in Savasana, a tall, hard prop (such as a wooden block standing on end) will usually work best. Once you've chosen your chest prop, you'll need to choose a suitable head prop to go with it. We'll discuss how to do this later.

Now let's look at how Supported Savasana reduces nasal congestion. This effect is probably also produced by a fall in blood pressure, but this time in the nose. Raising the nose above the heart causes gravity to drain fluids away from it. Note, however, that if the tilt is too steep, the reflex that speeds up the heart may kick in so strongly that the heart actually pumps *more* fluids up to the nose than it would in a milder tilt, making the congestion worse. Also, if your goal is to help your student rest, too much tilt might activate her brain more than you want it to. So if you are trying to clear your student's nose and help her relax, find the minimal lift that produces the desired decongesting effect, and refrain from taking her any higher. You may be able to enhance this effect by putting a little extra support under her head but not her chest, to increase the lift of her nose without increasing the lift of her trunk. Another factor to consider for clearing the nose is the way you prop the chest. Opening the chest in this pose may help dry the nasal region by creating a big, low-pressure space for fluids to drain into. If the prop is too soft it won't open the chest enough to do this efficiently, but if it's too hard it may be too activating, so a firm but somewhat yielding prop (like a stack of long-folded, tightly woven blankets) may provide the optimal compromise for opening the nasal passages while promoting relaxation.

If you are using Supported Savasana to help a student open her chest, bend her spine back, feel the alignment of her back ribs, or roll her shoulder blades backward, a hard prop (one or more wooden blocks, half-blocks, wedges, or some other firm surface) under the back is usually more effective than a yielding prop like a bolster or a stack of blankets. You can focus a hard prop more accurately on a particular spot, it doesn't collapse under your student's weight, and it gives clearer tactile feedback. You have to choose the shape and placement of the prop carefully to achieve the effect you're after. If you want to broaden your student's back, tilt her shoulder blades backward, promote her awareness of her back ribcage, or open the lateral part of her ribcage, use a broad prop (try two blocks laid flat, side by side, in contact with one another and oriented lengthwise along her trunk). If you want to focus on backbending her spine back, puffing the center of her chest, or leaving space for the back of her ribcage to expand downward on inhalation, use a narrow prop (like a single block laid on its edge or standing on end, oriented lengthwise along her spine between her shoulder blades).

Students—and teachers—often ask how far up the back (toward the head) they should place the prop that supports the trunk. The answer depends on the purpose of the pose and varies from student to student, but here are some general guidelines. One common mistake is to place the prop too low on the back, so the front lower ribcage opens but the uppermost part of the ribcage, just below the collarbones, does not. This often occurs in the two-bolster setup mentioned earlier, especially if the floor bolster is tall and the student's sacrum is placed too near its end as she pre-

pares to lie back into the pose. Sitting too close to a high bolster or other prop prevents the sacrum from tilting backward sufficiently in the pose and forces the lumbar spine to bend sharply around the end of the prop; this focuses the pose on the lower spine instead of the chest. It's usually best to leave at least a few inches of space (sometimes much more) between the sacrum and the end of the prop when your student prepares to recline, so her pelvis can tilt back and her lumbar can lengthen as she lies down. Another way to improve the two-bolster setup is to add a broad, firm prop, like a wooden half-brick or wedge, on top of the floor bolster to support the lower half of the shoulder blades (see bottom photo). If you do this, make sure that the prop pushes the lower half of the shoulder blades strongly upward (forward) into the rib cage but does not push the top half upward (forward). This will translate not only into an effective backward tilt of the shoulder blades, but also into a good opening of the front and side ribcage.

Whatever technique you use to support a student's trunk in Savasana, there are certain rules of thumb that almost always apply to supporting the head. First, unless you have a specific reason not to, tilt the head so the forehead is positioned higher than the chin. Assuming the shoulder blades stay depressed toward the waist, this tilt will put a gentle stretch on the upper trapezius muscles, which run from the base of the skull and the back of the neck to the upper-outer shoulder blades. Many yogis believe that the forehead-elevated position promotes inward mental focus, in contrast to a chin-lifted position, which they believe promotes daydreaming.

Note that whenever you increase the height of the support under the upper back (for example, by adding a half-brick to a bolster, as in the bottom photo), you lift the upper thoracic spine the part of the spine—that's attached to the upper ribcage—higher relative to the head and neck. This will tilt the head and neck backward relative to the upper chest, lifting the chin more than the forehead. So when you raise the prop under the upper back, you usually also have to raise the prop under the head to keep the forehead as far above the chin as it was before. The half-brick-supported pose shown in the bottom photo does *not* have extra head support, but it could benefit from it.

Second, students usually find the head support prop to be much more comfortable if it also supports the entire length of the neck, all the way to its base. The head/neck prop can brush the skin that overlies the upper trapezius muscles at the point where they angle off from the neck, but take care that the prop does not roll this skin, or any part of the shoulder, forward.

Finally, if you are using Supported Savasana to teach the early stages of Jalandhara Bandha, remember that this bandha ultimately presses the breastbone into the chin and vice-versa. So as you raise the support under the head and neck to bring the chin down, you should also raise the support under the spine between the shoulder blades to lift the breastbone up.

When all is said and done, in the gentle competition for your students' hearts and minds, Supported Savasana may still be unable to beat the sublime neutrality of classical Savasana. Nevertheless, a good Supported Savasana can do many things that a classical Savasana cannot. It's well worth learning how to get the most out of it.

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What To Do About Dizziness During Yoga

My yoga teacher has us take long deep breaths and hold before an exhale. I often get dizzy during this practice. I always get dizzy if I do a backbend with this deep breath. Am I doing something wrong

Roger Cole's reply:

The dizziness that comes with deep breathing is usually caused by breathing out carbon dioxide faster than the body produces it. This makes the blood less acidic, which apparently causes a chemical alteration in nerve function that makes you feel light-headed. The cure is to breathe more slowly and/or less deeply.

Holding the breath during asana practice is not a good idea. Asanas require free circulation of the blood and plenty of oxygen to the muscles and organs. Holding the breath lowers oxygen levels. Although it raises carbon dioxide levels, it can increase pressure in the chest so much that it is difficult for blood to return from the body to the heart. Too little blood goes in, so the heart pumps too little blood out. Dizziness may result when blood pressure sensors in the heart, upper chest, and neck detect too little blood volume within the heart, or too little pressure being pumped up toward the head.

Similarly, standing up suddenly from Uttanasana (Standing Forward Bend) can cause so much blood to flow downhill into the legs and abdomen that too little blood fills the heart. Normally, reflexes quickly compensate for this by raising the heart rate and constricting blood vessels to raise pressure. However, if the reflexes are too sluggish, pressure will fall in the heart, chest, neck, and head, and you will feel dizzy.

To prevent this, do three things when coming out of Uttanasana. (1) Contract the calf and thigh muscles strongly to squeeze blood from leg veins toward the heart. Start this action before you start to come up and continue it while coming up and after you are upright. (2) Come up slowly to give reflexes time to respond. (3) Inhale while coming up. This lowers pressure in the chest, thereby helping blood flow into the heart.

The breathing pattern you describe probably contributes to your dizziness in backbends, but excess back bending of the neck might also cause this. Blood flows to your brain by four arteries: two carotid arteries in your frontal neck and two vertebral arteries that are threaded through holes in the vertebrae of the neck. Extreme back bending of the neck might theoretically constrict the vertebral arteries. If this occurred, and the carotid arteries were unable to compensate for any reason (for example, if they suffered from narrowing, or stenosis), you would experience reduced blood flow to your head. You can often avoid excess bending of the neck in backbends by learning to lift your chest more, so you bend more from the uppermost part of your back instead of

your neck.

Treating Adrenal Exhaustion

What poses would you recommend to treat adrenal exhaustion?Roger Cole's reply:

By "adrenal exhaustion" I presume you mean the fatigue that comes from being under chronic stress without sufficient recovery. Yoga practice is great for providing recovery and can also help you deal with stressful circumstances without having such a strong negative reaction. But I encourage you to go beyond just postures and consider the "practice" of yoga rather broadly. If any of the life circumstances that are causing you distress are at all under your control, part of your practice is to change them for the better.

The adrenal gland has two parts. The adrenal medula secretes epinephrine (adrenaline) and norepinephrine (noradrenaline). These hormones make your heart pound, raise your blood pressure, help make your muscles tense, and put your brain on high alert. The adrenal cortex secretes cortisol and other hormones. Cortisol is a natural steroid that raises your blood sugar level (so the muscles have plenty of fuel) and suppresses inflammation, but it also suppresses the immune system.

The adrenal hormones are catabolic, which means they foster biological processes that burn energy and break down cellular structures. If you activate the adrenal glands over and over again without sufficient recovery in between, your body becomes depleted and exhausted, and you are susceptible to a variety of illnesses.

To recover from this exhaustion, you need to do things that turn off the adrenal hormones and promote secretion of anabolic hormones, such as growth hormone. Growth hormone is secreted by the pituitary gland almost exclusively during the deepest stages of sleep (slow wave sleep). To promote slow wave sleep, avoid alcohol and caffeine, and take a warm bath before bed. Do not lie awake in bed for more than 15 minutes at a time. If you can't sleep, get out of bed and do some quiet activity until you feel ready to attempt sleep again. Avoid strenuous yoga postures (especially standing postures and unsupported backbends) at any time of day, because these may stimulate the adrenal glands.

To help turn off the adrenal glands and calm the mind, practice restorative yoga postures daily in a warm, dark, quiet environment. Here is a series that can work wonders. It purposely includes few postures, so you can hold each one for as long as it is comfortable.

1. Supported Sukhasana (Simple Cross Legs Pose) bending forward, with forehead and arms resting on a padded chair seat. Stack folded blankets on the chair seat until you reach a comfortable height. This pose releases tension in the back and neck muscles, and feels very calming. If your legs are not too tight, you can also add similar forward-bending postures with one or both

legs extended straight while the forehead rests on the chair. Most people need to raise the pelvis on one to three folded blankets while practicing these postures.

2. Viparita Karani (legs up the wall, pelvis elevated on a bolster or folded blankets). If the legs tire of being straight, bend the knees and cross the legs, with knees near the wall. This pose stimulates baroreceptors (blood pressure sensors) in the neck and upper chest, triggering reflexes that reduce nerve input into the adrenal glands, slow the heart rate, slow the brain waves, relax blood vessels, and reduce the amount of norepinephrine circulating in the bloodstream.

3. Supported Setu Bandha Sarvangasana (Bound Bridge Pose), supported on a bolster or on long, folded blankets. This pose also stimulates the baroreceptors, so it has many of the same effects as Viparita Karani. It relieves tension in the chest and front body, and prepares the lungs for breathing practice.

4. Savasana (Corpse Pose), with normal inhalation and long, slow exhalation. This pose allows complete relaxation in a neutral position. Emphasis on exhalation slows the heart and calms the mind.

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This Is Your Body on Stress

Stress is just your body's natural response to perceived danger. But what happens when your stress reaction never shuts off?

By Roger Cole

People have struggled with bumps on the path of life since before the dawn of history, but it was not until the middle of the 20th century that physiologist Hans Selye labeled our reaction to life's challenges with a simple word: stress. Now, 50 years later, there's a conversation you hear so often, it's almost a chorus: You ask a friend, "How are you?" and she replies, "I'm OK, but I'm feeling a little stressed."

You know just what she means; you've felt the same way all too often yourself. For you, the stress shows up as insomnia, while your friend sleeps well but has a lingering stomachache and painful knots in her shoulders. Individual stress symptoms can differ, but all have their roots in the physiological changes that our bodies undergo when we feel we're in danger. To understand these changes, why they happen, and what you can do to reduce and avoid them, let's consider a day in the life of a typical American working woman.

The Story of Sally Stresscase

For Sally Stresscase, the day went from bad to worse. She awoke with allergies clogging her nose. Work was full of hassles. Her car stalled in rush hour traffic, and other drivers honked and scowled at her, turning her frustration into fury.

Sally picked up her four-year-old, Sara, at day care. That cheered her up, but when they arrived home to a dark house, her heart sank. Her husband, Sam, was not there—again. He had been working late a lot recently, and acting so distant and withdrawn that Sally was feeling insecure and suspicious.

She had just set up Sara with a coloring book in her favorite spot in the living room and started to cook dinner when she heard strange noises coming from the garage. Sally's mind raced; she and Sam never used the garage. Although a door linked it to the kitchen, they always parked in the driveway and came in through the front door. But now someone was out there.

The sounds grew louder. She heard footsteps approaching the kitchen door and realized with horror that it was unlocked. A knot formed in her stomach, her mouth went dry, blood pounded in her temples, and her palms sweated so much that the ceramic bowl she was holding slipped from her hands and shattered.

Sally tried to jam the heavy, iron-framed kitchen table against the door, but it wouldn't fit. In the process, she cut her arm, but she didn't notice it. She dashed into the living room and grabbed the fireplace poker. Placing herself squarely between Sara and the kitchen, she turned to face the intruder. Everything seemed to be going in slow motion as a man emerged from the kitchen.

It was Sam, with a big smile on his face. High in front of him, he proudly dangled a large key ring. His smile quickly faded to an openmouthed stare as he beheld Sally—nostrils flaring, eyes so wide that he could see the whites all the way around, arm cut but barely bleeding—brandishing the poker in her white-knuckled hand. She exuded a wild ferocity he had never imagined she was capable of. There was a moment of stunned silence.

"Hi, Daddy!" Sara said.

Sam's smile returned, tentatively. "Hi, Sara! Uh...hi, Sally."

Sally slowly lowered the poker. She tried to speak, but only a croak came out. Oddly, despite her jumbled thoughts, she noticed that her nose was clear for the first time all day.

"Sorry," Sam apologized. "I guess I really scared you! Maybe I can make up for it with some good news. You know I've been working late. I didn't want to say anything in case it fell through, but I've been trying to land a new account. I finally got it—and a big commission. Come to the garage. I bought you a new car!"

Silently, Sally picked up Sara and followed Sam. "Why are you shaking, Mommy?" Sara asked. Sally hugged her tightly and gave her a big kiss.

At dinner, Sally found she had no appetite. At bedtime, she still felt keyed up, so she took a warm bath, where she finally noticed the cut on her arm. Even after her bath, it took her much longer than usual to fall asleep.

Danger! Danger!

Stress is a slippery word to define, but most people would agree that Sally felt it that evening. And scientists would concur. In their eyes, all stress, great or small, arises from our struggle to survive and reproduce. We experience it when we sense a threat to ourselves or our children. That's why Sally's reaction reached a crescendo when she stood defending Sara.

A situation doesn't have to threaten imminent death to cause stress. As social creatures, we all instinctively know that we, and our children, depend on others for our long-term well-being. That's why Sally was so disturbed by social threats like job hassles, problems in her marriage, and the angry scowls of other drivers. One key thing to remember about stress is that a threat doesn't have to be real to cause it; we just have to believe it's real. Sally didn't need an actual burglar to get her blood pumping—an imagined one did the job well enough.

Scientists differentiate between short-term (acute) stress and long-term (chronic) stress. Acute stress evokes physical and emotional responses that activate the body and mind to deal with an immediate threat. When the threat passes, the reactions subside. Long-term stress evokes similar responses, usually at a lower intensity, but keeps repeating them day after day without respite. When they repeat too often for too long, the life-saving responses that are so helpful in the short run can actually become life-threatening.

The short-term stress reaction is often called the fight-or-flight response. That's what Sally experienced when Sam opened the door. She perceived danger, so her brain and body automatically readied themselves for intense action, either combat or escape. To do either of these well, our bodies need maximum alertness, powerful muscle action, and the ability to keep going even if injured. Sally's brain activated a bogglingly complex set of physiological processes to support these needs. Many of these processes had already started, at a lower intensity, in response to the minor stressors she had endured before Sam came home.

Sally's stress response began with her perceptions. When her car stalled, the reasoning part of her brain (the cerebral cortex) perceived a problem that required quick action but was not a life-or-death emergency. Then the emotional part of her brain (the limbic system, especially an almond-shaped structure called the amygdala) increased her sense of urgency by responding with fear and anger to the honking horns and hostile faces of passing drivers. Her cortex and her limbic system triggered some responses more or less directly, including increased heart rate and muscle tension, but they delegated most of the responsibility for activating the rest of her responses to a sort of 911 control center located in the rear part of the hypothalamus (a brain area that coordinates basic drives like hunger, sleep, and self-defense). The threat situation was only moderate, so the stimulus to the hypothalamus wasn't that strong.

But when Sally thought an intruder was entering her kitchen, her cortex and limbic system screamed "Danger!" at the top of their neural lungs. The posterior hypothalamus got the message loud and clear. In a flash, this little complex of brain cells turned on all the physiological systems she needed to get her muscles and mind going at full power, and turned off everything that might interfere. It told her pituitary gland to send out a chemical messenger to her adrenal cortex, the outer layer of her adrenal glands, stimulating it to release the stress hormone cortisol into the bloodstream. It told her brain's sleep centers to shut off and its wakefulness centers to kick into their highest gear. It activated brain centers that control muscle tone, increasing tension everywhere in her body. It told breathing centers at the base of Sally's brain to increase respiration to provide oxygen for all the extra muscle and brain activity about to occur. And, most important of all, it cranked her entire sympathetic nervous system up to full throttle.

All Revved Up, No Place to Go

The sympathetic nervous system is a network of nerve cells that extends throughout the body. It helps support our normal activities; for example, it makes our heart beat faster when we climb

stairs. In an emergency, though, it goes into overdrive —and Sally felt the results. To get more blood to her heart, skeletal muscles, and brain, the sympathetic nervous system widened arteries in those places, narrowed them in others, and started her heart racing and pounding. That's why she felt a throbbing in her temples. In her digestive tract, Sally's sympathetic system narrowed arteries and inhibited other functions. That's why she felt a dry mouth and a knot in her stomach. To help her get more oxygen, sympathetic nerves opened up her air passages. That's why her nostrils flared, her nose cleared, and her voice faltered when she first saw Sam.

Other sympathetic nerves worked to make sure Sally could see everything going on around her. They dilated her pupils and opened her eyelids so wide that Sam could see the whites all the way around. To keep her from overheating, still other sympathetic nerves activated sweat glands.

The sympathetic nervous system triggered most of these responses by releasing a major chemical messenger called norepinephrine (or noradrenaline) at nerve endings on target tissues like blood vessels and sweat glands. It also stimulated the adrenal medulla (the core of the adrenal glands) to flood the bloodstream with more norepinephrine plus a second essential chemical, epinephrine (also called adrenaline). These chemicals not only intensified the stimulation of organs directly targeted by sympathetic nerves, they also acted on parts of the body that don't have these nerve connections. For example, they made Sally's blood clot faster (so her cut did not bleed much), made her muscle fibers contract more strongly (so she could easily lift an iron table), and made her brain activity speed up (so the world around her seemed to slow down).

The hormone cortisol, acting alone and in combination with epinephrine and norepinephrine, supported Sally's fight-or-flight response in other ways. It stimulated her liver, muscles, and other organs to release extra fuel (glucose and glycogen) into her bloodstream, contributing to her strength and mental activity. It increased her pain tolerance so she didn't notice her cut, and it suppressed inflammation and swelling, a response that would have enabled her to keep going even if she had a more serious injury, like a sprained ankle.

Effects from a fight-or-flight response take a long time to wear off. Muscles that have tensed are left shortened and do not automatically go back to their former length. On the contrary, spinal reflexes make them contract if they begin to lengthen: After the danger has passed and the brain lets the muscles relax a little, the spinal cord immediately tells them to tense up again. At first, they go through a very rapid cycle of relaxing a little and then contracting, again and again. That's why Sally trembled after her scare was over. Eventually, the stretch reflex abates enough for the trembling to subside, but the muscles still don't settle back to their former resting length. They remain relatively short and tense until the reflex is reset by a relaxing experience, like the gentle, conscious stretching that occurs during a massage or a yoga session.

Muscles aren't the only part of the body slow to recover from a fight-or-flight reaction. Stress hormones remain in the bloodstream for quite a long time, and more may be released in response to memories of the danger. That's why Sally was not hungry for dinner after her fright (her digestive tract was still shut down) and why she had trouble falling asleep that evening (her brain was

still highly activated).

Sally's story shows what can happen when we face acute, major stress. But what happens when we experience moderate stress repeatedly, day after day? Our bodies activate the same emergency systems, although to a lesser degree. Unfortunately, when invoked chronically, physiological responses that help us cope with danger can become dangerous themselves. Suppression of digestion can contribute to gastrointestinal problems, and promotion of high glucose levels in the blood may contribute to diabetes. Constricted blood vessels, a pounding heart, and rapid clotting can eventually lead to high blood pressure, heart disease, or stroke. Suppression of inflammation can also suppress the immune system, making us more susceptible to infection and possibly even cancer. Chronic stress can also lead to infertility, poor healing capability, and exhaustion.

Stress Busters

Luckily, there are lots of ways to reduce stress or even to head it off in the first place. They fall into three main categories: changing your situation, changing your attitude, and taking good care of yourself. Changing your situation—getting a new job, moving to a new neighborhood, or leaving an unhealthy relationship—can be very effective, but it's often not practical or even desirable. Changing your attitude—deciding you don't have to knock yourself out working overtime to prove your self-worth, for example, or deciding it's not your responsibility to make your partner change—can be very powerful, even life-transforming, because it puts you in control. When you realize you can choose how you react, many events you formerly found stressful may lose their power to push your buttons. Taking care of yourself—eating right, avoiding harmful drugs, exercising, making rest a priority, and scheduling time in pleasant environments with nice people—helps you recover from stress and keeps it from building up again.

One of the best stress busters around is yoga. It directly counteracts both the physiological and psychological components of stress, simultaneously helping you take better care of yourself and change your attitude. The stretching you do in yoga relieves muscle tension. Upside-down poses and reclining poses slow the heart, relax the blood vessels, inhibit production of norepinephrine, and calm the brain. Pranayama (yoga's classic breathwork) slows respiration. As you practice being more aware and mindful, you gain a sense of self-control, equanimity, and peace. Perhaps most important of all, meditation and the teachings of yoga philosophy can help you realize that most of the things that upset you just aren't worth getting stressed about.

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