

## Musculoskeletal Injuries Related to Yoga: Imaging Observations

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**OBJECTIVE.** The purpose of this article is to describe the imaging appearances of musculoskeletal injuries related to yoga. We performed an automated search in the database of a large tertiary care center and conducted a retrospective analysis of the imaging findings in 38 patients over a 9-year period.

**CONCLUSION.** The most frequently encountered musculoskeletal injuries were tendinous lesions, including tears of the supraspinatus, Achilles, and peroneus brevis tendons and fibrocartilaginous tears involving the medial meniscus, acetabular labrum, glenoid labrum, and lumbar disk with extrusion.

**Y**oga, a discipline developed 5000 years ago in ancient India incorporating and uniting principles of posture, breathing, and meditation, is thought to bring physiologic and psychologic benefits to practitioners [1, 2]. Characterized as a science of self-study and development of awareness through a series of specific *asanas* (body postures), *pranayama* (controlled breathing patterns), and meditation, yoga has been embraced in modern Western settings as a form of exercise and stress reduction.

In the century since yoga was introduced into the West, there has been a substantial proliferation in the number of schools of yoga. As of May 2011, the Yoga Alliance, a professional credentialing body for yoga, listed 1220 approved schools in the United States and 26,690 registered yoga teachers. According to a 2008 survey, an estimated 6.9% (15.8 million) of people in the United States practice yoga [3]. Additionally, another 4.1% (9.4 million) of those who are not currently practicing yoga said they would definitely try yoga during the next year [3]. Currently, yoga programs are relatively low in cost; widely available in the form of classes or through home video or book programs; and, when performed properly, have little risk of adverse effects.

Despite a large number of yoga practitioners worldwide, only a few case reports are available in the literature of injuries incurred by practitioners of this discipline [4–10]. To our knowledge, our study is the first to de-

scribe the specific appearances of musculoskeletal injuries related to yoga with imaging studies from a general population.

### Materials and Methods

This study was approved by our institutional review board with exemption status for individual informed consent. A retrospective automated search in the database of a large tertiary care center radiology department was performed and reports generated for 2,175,000 consecutive imaging examinations from January 2002 to January 2011. Radiology reports were filtered for selection of cases with yoga injuries by searching history, body, and impression for the term, "yoga." Exclusion criteria included duplicate cases and use of the word "yoga" out of context. Demographic data including age and sex of the patients, history, and imaging modality were recorded.

Radiographic, sonographic, CT, and MRI studies obtained were reviewed in consensus by one staff radiologist with 10 years of experience in musculoskeletal imaging and three fellows in musculoskeletal radiology. Imaging analysis focused on bone and soft-tissue injuries, including fractures; dislocations; and muscular, tendinous, ligamentous, and fibrocartilaginous tears. Full-thickness tendon tears were diagnosed when complete rupture of the tendon was noted [11–13]. Partial-thickness tendon tears were diagnosed when a defect in the tendon was noted and when there was evidence of at least some intact tendon fibers [11–13]. The fibrocartilaginous tears were diagnosed according to previously published MRI descriptions [14–17]. The selected patients were divid-

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ed into those with positive imaging findings and those with negative imaging findings.

Descriptive statistics were computed for all study parameters in both groups with positive and negative imaging findings. Continuous variables were described by the mean and range and qualitative variables by the count and proportion.

## Results

The term "yoga" was found in fifty-six radiologic reports over a 9-year period at our institution. The prevalence of the use of the word "yoga" was low in radiology reports (0.000026%). Eighteen reports were excluded, representing either duplicate cases or use of the word "yoga" out of context.

Thirty-eight patients (10 men and 28 women; mean age, 46 years; age range, 19–67 years) with acute symptoms related to yoga were included in our study. The selected patients were divided into those with positive imaging findings and those with negative imaging findings.

There were 23 injuries attributable to yoga in 20 patients (seven men and 13 women; mean age, 45 years; age range, 19–67 years). These imaging examinations included eight MRI, seven sonographic, three CT, and two radiographic studies. The anatomic regions screened included the knee in five cases, the shoulder, hip, and ankle in four cases each, the spine in two cases, and the abdominal wall in one case (Table 1).

The tendinous lesions represented 34.8% (8/23) of all injuries. The lesions included Achilles tendon partial-thickness tears (13.0%, 3/23), supraspinatus tendon articular-sided partial-thickness tears (13.0%, 3/23), supraspinatus tendon full-thickness

tear (4.3%, 1/23), and peroneus brevis partial-thickness tear (4.3%, 1/23) (Fig. 1).

Fibrocartilaginous injuries represented 34.8% (8/23) of all injuries. The lesions included medial meniscus tears (8.7%, 2/23), acetabular labrum tears (8.7%, 2/23), glenoid labrum tears (8.7%, 2/23), and lumbar disk annular tears with disk extrusion (8.7%, 2/23) (Fig. 2). Transient patellar dislocation was observed in two cases (8.7%, 2/23) (Fig. 3). The other encountered injuries were one disassociation of the polyethylene liner from its acetabular cup in a total hip replacement (Fig. 4), one inguinal hernia, and one fracture of the proximal phalanx of the great toe. A solitary joint effusion was identified in two other individuals. No other musculoskeletal injury was diagnosed.

Eighteen individuals (three men and 15 women; mean age, 46 years; age range, 19–67 years) presented negative imaging studies (47.4%, 18/38). These imaging examinations included CT ( $n = 9$ ), MRI ( $n = 4$ ), radiography ( $n = 4$ ), and sonography ( $n = 1$ ). The anatomic regions screened included the head in seven cases; the spine in three cases; the wrist in two cases; the foot and ankle in two cases; and the elbow, abdominal wall, hip, and leg in one case each. The most common symptom in our population was headache after yoga observed in seven patients (18.4%, 7/38), which was consistently associated with negative imaging.

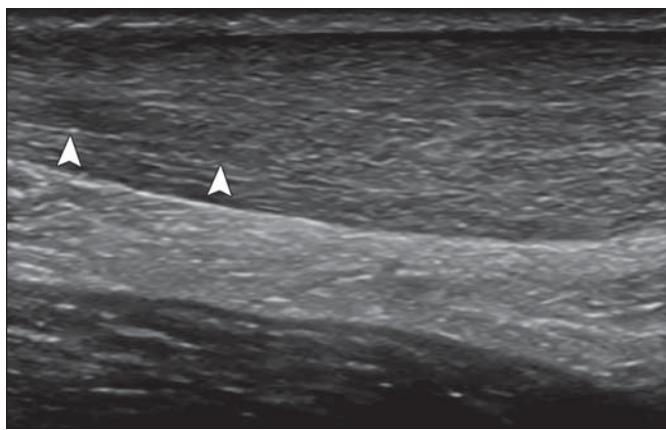
## Discussion

Yoga classically aims at facilitating development and integration of the human body, breath, and mind to facilitate self-transformation at every level of functioning, with the goal of improving the overall quality of

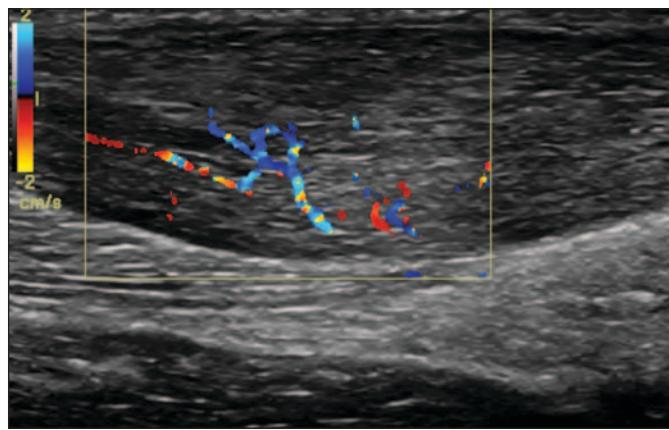
**TABLE I: Imaging for 23 Injuries Related to Yoga in 20 Patients**

Parameter	No.
Imaging modality	
Radiography	2
Sonography	7
CT	3
MRI	8
Anatomic region	
Knee	5
Shoulder	4
Hip	4
Ankle	4
Spine	2
Abdominal wall	1
Elemental lesion	
Tendon	8
Fibrocartilage	8
Other	7

life [1, 2]. Currently, the practice of yoga for fitness and wellness in yoga studios, gyms, and community centers is broadening into yoga therapy provided in schools, community treatment centers, and even hospitals. Although many clinicians remain unfamiliar with the practice of yoga, a 2008 survey indicated that 6.1% (14 million) of Americans said a doctor or therapist had recommended yoga to them [3]. Yoga is recognized by the National Institutes of Health (NIH) National Center for Complementary and Alternative Medicine (NCCAM) as a form of comple-



A

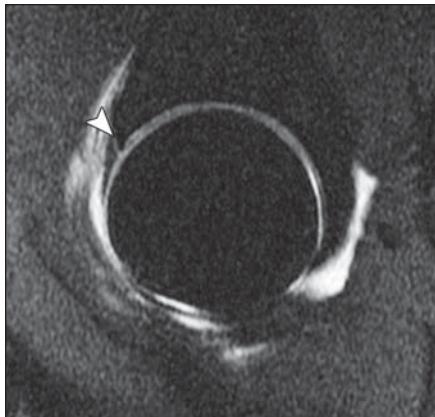


B

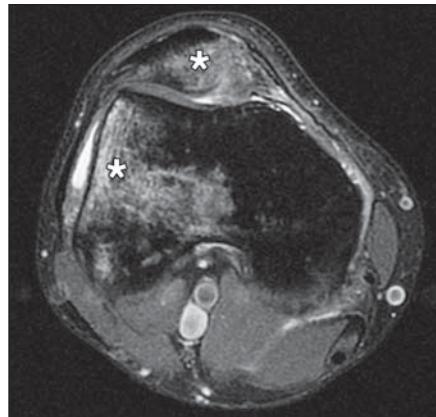
**Fig. 1**—55-year-old woman.

**A** and **B**, Longitudinal sonographic (**A**) and color Doppler (**B**) images show intratendinous tear (arrowheads, **A**) of Achilles tendon.

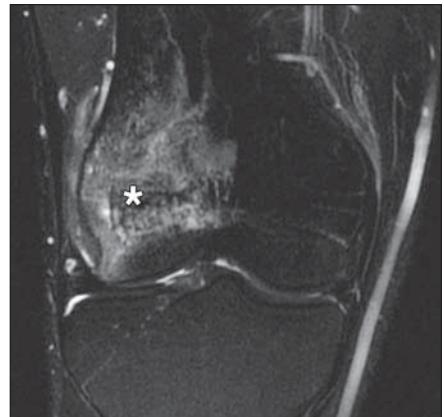
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**Fig. 2**—Sagittal T1-weighted MR arthrography image with fat-saturation shows tear of anterior acetabular labrum (arrowhead) in 36-year-old woman.



**Fig. 3**—34-year-old man with transient lateral patellar dislocation.



**A**

**B**

**Fig. 3**—**A** and **B**, Transverse (**A**) and coronal (**B**) proton density-weighted MR images with fat-saturation show bone marrow edema in medial aspect of patella (asterisks, **A**) and lateral femoral condyle (asterisk, **B**) in keeping with transient lateral patellar dislocation.

mentary and alternative medicine (CAM) in the category of “mind-body” medicine [18].

Other surveys assessing the familiarity and acceptance of CAM practices by the general public and medical practitioners report that yoga was ranked fifth of 39 therapies in terms of its perceived effectiveness and document a growing trend of yoga practice by adults and children, in particular by children whose parents use CAM [19]. Besides, several studies have been conducted, with recent epidemiologic research indicating that many individuals perceive yoga to be beneficial for musculoskeletal problems, mental health conditions, and overall health [1, 20]. In particular, yoga has been examined in the management of asthma, chronic obstructive pulmonary disease, cardiovascular diseases, irritable bowel disease, eating disorders, anxiety, fibromyalgia, and even in children with attention deficit or hyperactivity disorder [21–28].

Only a few works have focused specifically on the impact of yoga on musculoskeletal conditions, such as chronic low back pain, rheumatoid arthritis, hand osteoarthritis, or carpal tunnel syndrome [29–33]. Studies generally resulted in amelioration of pain and improved mobility. One MRI study even showed that a group of long-term practitioners of yoga studied had significantly less degenerative disk disease than a matched control group [34].

The popularity of yoga has created a need for empirical studies to evaluate the limitations and potential risks of yoga as a method of wellness. Yoga is thought to have great potential mental and physical health benefits

[1, 2, 20]. However, given the great variability of yoga practices and teaching styles, caution is required and yoga practices need to be tailored to the individual. Albeit rare in the literature, a few yoga injuries have, indeed, been reported including, pneumomediastinum, traumatic lymphocele, cervical artery dissection, and various musculoskeletal lesions [4–10, 35]. For instance, vertebral artery dissection has been described after minor head and neck trauma during yoga practice [35]. Subcutaneous emphysema, air in the retropharyngeal spaces, and pneumomediastinum have been reported after a Valsalva maneuver during a yoga exercise called *pranayam* [5]. In a similar fashion, rectus sheath hematoma has been observed after a *pranayama* session of yoga [6]. *Pranayama* consists of breathing exercises whereby the breath is manipulated through varying the actions of inhaling and exhaling air, keeping the abdomen taut and relaxed alternately [6, 7]. In addition, progressive glaucomatous optic neuropathy with visual field loss was reported, related to the *sirsasana* (headstand) yoga posture practiced daily for many years [36]. In the same way, musculoskeletal injuries related to yoga, such as pseudoarthrosis of the first rib and lateral collateral ligament rupture, have been reported [8, 9]. Thus, there is a need to provide clinicians with practical information about yoga-related injuries.

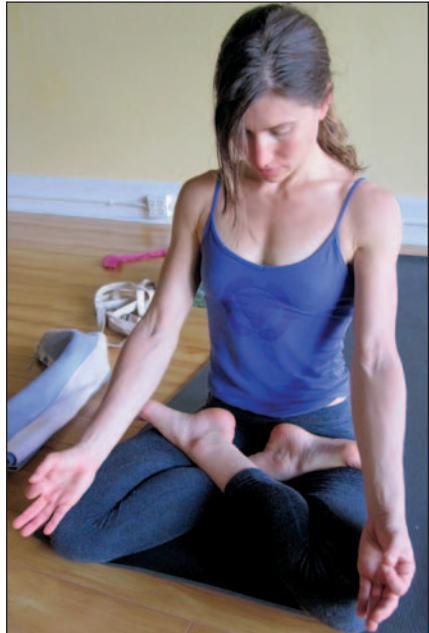
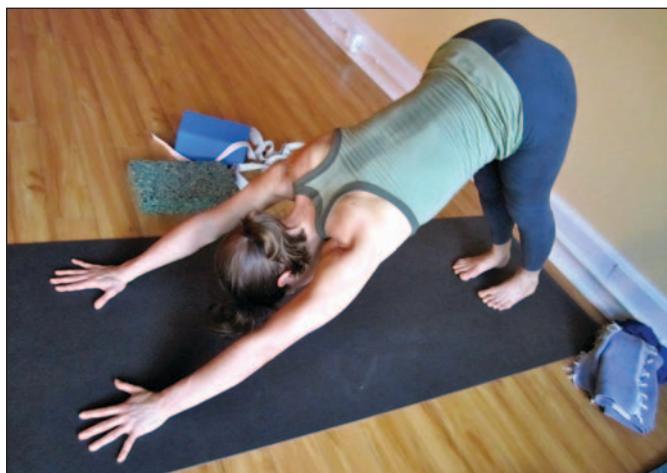
In our study population, headaches were the most frequent yoga-related symptom requiring imaging. The frequent occurrence of headaches after yoga *asana* practice is not surprising. Tension headaches are common,

possibly resulting from muscle tension in the supporting musculature of the head and neck. Flowing forms of yoga, for example *ashtanga*, *vinyasa*, flow, or power yoga, are popular and involve a repetitive connected and flowing sequence of postures that often requires the practitioner to flex the shoulder joint with or without weightbearing on the hands.

In the setting of poor shoulder joint flexibility, the larger stabilizers of the shoulder girdle, in particular the trapezius, rhomboid,



**Fig. 4**—Frontal radiograph of pelvis shows disassociation of polyethylene liner from its acetabular cup (arrowhead) in total hip replacement in 65-year-old woman.

**A****B****C****D****Fig. 5—**Yoga positions.

**A–D**, Photographs show *padmasana* or lotus posture (**A**), *eka pada sirsasana* or leg behind head posture (**B**), *salamba sirsasana* or headstand posture (**C**), and *adho mukha svanasana* or downward facing dog posture (**D**).

and levator scapulae, can become overused and go into spasm in these yoga practices. Inverted postures, such as the shoulder stand (*salamba sarvangasana*) and headstand (*shirshasana*) (Fig. 5) can also put significant strain on the neck when performed with improper alignment because the body weight is directed downward toward the shoulders, head, and neck in these positions. It is conceivable that such inverted postures also cause slightly elevated intracranial pres-

sure through increased resistance to venous drainage, although this is unlikely to affect healthy individuals. Heated forms of yoga (*Bikram*, *Moksha*, and hot yoga) are also quite popular, and practitioners may experience headaches due to dehydration or electrolyte imbalances from excessive sweating in temperatures up to 108°F or may experience symptoms from hyperventilation or holding the breath during exertion. The greatest concern in patients presenting with

headaches from yoga practice is certainly the possibility of cervical artery dissection, which can result from minor trauma, including twisting or torquing motions of the neck. Any patient presenting with headaches should have a full neurologic examination, and head CT and CT angiography from arch to the circle of Willis should be considered in patients with neurologic symptoms.

Musculoskeletal injuries related to yoga can occur as a chronic repetitive strain injury, an

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acute event, or a combination of an acute event superimposed on chronic strain. Anatomically, tendons, myotendinous junctions, and fibrocartilages are the most vulnerable structures to injury [6]. Yoga postures can be fairly demanding of flexibility and require strength of the stabilizing muscles to be performed safely and provide benefits. Particularly in large classes without adequate instruction, new yoga practitioners may attempt to perform postures that their bodies are not ready to accommodate. Even if a movement or posture does not elicit immediate injury, if performed incorrectly, it can strain structures over time at the weakest point, which eventually may progress to a frank injury.

The rotator cuff is particularly vulnerable in forms of yoga that involve flowing sequences that put weight on the hands. Sun salutations (*surya namaskar*) are a common sequence of postures performed in flowing forms of yoga practice whereby the practitioner moves from standing to the downward dog (*ado mukha svanasana*) position (Fig. 5) in a repeated fashion. The combination of movement through postures while partially bearing weight on the hands through different shoulder positions can result in impingement on the rotator cuff, particularly the supraspinatus.

In the same way, excessive stretching of the Achilles tendon may occur in yoga postures that require squatting. However, given the lack of impact, the posture would be unlikely to cause sufficient pressure to tear the Achilles unless it was tight or already strained. In the knee, excessive pressure is particularly common in yoga practices that involve variations of lotus position (*padmasana*) or half lotus. In practitioners whose hip joints and groins are not flexible enough to accommodate the external rotation required for this posture, torque of the knee joint is common and results in compression of the medial joint space, with chronic changes or acute tears of the posterior horn of the medial meniscus.

More advanced practitioners who perform postures that put the leg behind the head (Fig. 5) may also experience stretching of the lateral aspect of the knee joint that results in strain of the iliotibial band, distal biceps tendon, or lateral collateral ligament. In addition, the extreme abduction, flexion, and internal rotation required by leg-behind-the-head postures may result in tears of the anterior and lateral acetabular labrum.

The spine may be injured from either flexion (forward folds) or extension (back bends)

movements performed in all forms of yoga. If an intervertebral disk is already degenerated, forward folding movements can increase pressure on the disk and result in a disk herniation. Yoga practitioners who perform deep back bends may put pressure on the facet joints if the backbend is performed in an unbalanced fashion with accentuation of the bend usually in the lower back. Because yoga is more commonly practiced by women, we found a higher prevalence of this injury in women in our population.

In our study, injury was more frequent in women (65%). Note that, given the usual sex ratio in yoga classes, with between 80% and 90% women, men in our study were at relatively increased risk of injury during yoga [3]. Because women tend to come to yoga with greater overall flexibility than men but less upper body strength, men have an overall increased injury rate but women present a higher incidence of shoulder pain. In addition, men may also have a tendency to "go for it" more.

Some limitations may be considered inherent to the materials and methods used in this study. First, the population included in our study was obtained after a retrospective search in the database of our radiology department for a specific keyword. This probably underestimated the incidence of yoga injuries in our institution because cases could have been missed, misspelled, or misinterpreted in the original radiology report. Second, we have to emphasize that the prevalence of yoga injuries in this study refers to injury detection in a large consecutive population of patients undergoing imaging for an assortment of conditions. Our prevalence therefore does not reflect the true prevalence of musculoskeletal injuries in yoga practitioners. Finally, we do not have detailed information of the preexisting medical conditions of the patients or of the detailed mechanisms of their injuries. In the same way, the years of experience in yoga was not available in the report or clinical notes for our patients.

The growing number of yoga schools in the West is evidence that this tailoring to different needs, interests, and conditions persists. The process of matching and individualizing yoga to each participant is quintessential to yoga and is recommended for yoga classes, but it is an even more significant aspect of yoga therapy. In the environment of burgeoning large yoga studios aimed at profit, the specific needs of the individual student are likely to be missed, and physicians should be aware of the potential for injury. Musculoskeletal in-

juries related to yoga can occur as a chronic repetitive strain injury, an acute event, or a combination of an acute event superimposed on chronic strain. In this article, we have reported our experience with imaging of yoga injuries in a retrospective analysis of radiologic studies performed at our institution. We have observed that tendons and fibrocartilages are the most vulnerable structures to injury and have described yoga postures that may be linked to the reported cases.

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