

# Patients Older Than 40 Years With Unilateral Occupational Claims for New Shoulder and Knee Symptoms Have Bilateral MRI Changes

Tiffany C. Liu BA, Nina Leung PhD, Leonard Edwards BS,  
David Ring MD, PhD, Edward Bernacki MD, MPH,  
Melissa D. Tonn MD, MBA, MPH

Received: 11 December 2016 / Accepted: 31 May 2017 / Published online: 9 June 2017  
© The Association of Bone and Joint Surgeons® 2017

## Abstract

**Background** Minor events that occur in the workplace sometimes are evaluated with MRI, which may reveal age-related changes in the symptomatic body part. These age-related changes are often ascribed to the event. However, evidence of similar or worse pathophysiology in the contralateral joint would suggest that the symptoms might be new, but the pathophysiology is not.

---

One of the authors (MDT) owns OccMD Group PA (Dallas, TX, USA) that provided funding and/or whose products are mentioned in this manuscript.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research*® editors and board members are on file with the publication and can be viewed on request.

*Clinical Orthopaedics and Related Research*® neither advocates nor endorses the use of any treatment, drug, or device. Readers are encouraged to always seek additional information, including FDA-approval status, of any drug or device prior to clinical use.

The University of Texas at Austin approved or waived approval for the human protocol for this investigation, and each author certifies that all investigations were conducted in conformity with ethical principles of research.

Data were gathered at OccMD Group, PA, Dallas, TX, USA; and analysis was performed at Dell Medical School, Austin, TX, USA.

---

T. C. Liu, L. Edwards, D. Ring (✉)

Department of Surgery and Perioperative Care, Dell Medical School, The University of Texas at Austin, 1912 Speedway, Austin, TX 78712, USA  
e-mail: david.ring@austin.utexas.edu

N. Leung, E. Bernacki

Department of Population Health, Dell Medical School, The University of Texas at Austin, Austin, TX, USA

M. D. Tonn

OccMD Group PA, Dallas, TX, USA

**Questions/purposes** Using a convenience sample of occupational injury claimants with bilateral MRI to evaluate unilateral knee or shoulder symptoms ascribed to a single event at work, we sought to determine whether MRI findings of the shoulder and knee are more often congruent or incongruent with new unilateral symptoms.

**Methods** Two hundred ninety-four occupational injury claimants employed at companies throughout Texas that do not subscribe to workers' compensation insurance, who were older than 40 years, and with unilateral shoulder or knee symptoms, were studied. Starting in 2012, all patients seen by OccMD Group PA who present with unilateral symptoms ascribed to work undergo bilateral MRI, based on several previous occasions where bilateral MRI proved to be a compelling demonstration that perceived injuries are more likely age-related, previously well-adapted pathophysiology. MRI findings (anything described as abnormal by the radiologist; eg, defect size or signal change) was considered congruent if the abnormality of one or more structures on the symptomatic side was greater than that of the corresponding structures in the asymptomatic joint. Bivariate analysis was used to compare the frequency of MRI findings congruent and incongruent with symptoms. Logistic regression was used to evaluate factors associated with MRI findings of the shoulder or knee.

**Results** Less than half of the patients with shoulder (90 of 189; 48%;  $p = 0.36$ ) or knee (45 of 105; 43%;  $p = 0.038$ ) symptoms had worse pathologic features on the symptomatic side. Older age was associated with disorders in the infraspinatus tendon ( $59 \pm 8$  versus  $56 \pm 8$  years;  $p = 0.012$ ), glenoid labrum ( $60 \pm 9$  versus  $57 \pm 8$  years;  $p = 0.025$ ), and biceps tendon ( $60 \pm 8$  versus  $57 \pm 8$  years;  $p = 0.0038$ ). Eighty-seven percent of patients (91 of 105) had structural changes in the medial meniscus described by the radiologist.

**Conclusions** Occupational injury claimants 40 years of age and older with unilateral knee and shoulder symptoms ascribed to a work event tend to have bilateral age-related MRI changes. Age-related disorders should be distinguished from acute injury.

**Level of Evidence** Level IV, diagnostic study.

## Introduction

Musculoskeletal disorders affect 127 million adults in the United States and are more prevalent than chronic circulatory or respiratory conditions in adults older than 18 years [21]. The burden of musculoskeletal conditions is especially apparent in the workplace; in 2014, 32% of workplace injuries and illnesses requiring time away from work were the result of musculoskeletal complaints [19]. In a recent study, the total annual cost of musculoskeletal disorders to the workers compensation system of Ohio was USD 3 billion [5]. Problems of the knee and shoulder are among the most frequent and costly workers compensation claims. Among single injuries in Maryland in 2010, knee and shoulder complaints constituted 12% of claims and more than 25% of costs [14].

MRI is used to evaluate musculoskeletal disease, but normal age-related changes can be difficult to distinguish from acute changes that are the result of injury. Signal changes on MRI often are described using misleading words, such as “tear,” which imply an acute traumatic etiology [20]. However, these changes may simply reflect expected findings that occur with age in structures such as the triangular fibrocartilage complex in the wrist [9, 13], rotator cuff in the shoulder [8, 15, 18], and meniscus in the knee [1, 6]. These MRI abnormalities that are more common with advancing age are often present in patients with no symptoms or occur bilaterally in patients with unilateral symptoms [3, 4, 6, 10, 12, 22, 23]. When degenerative conditions become symptomatic in patients at work, they may be interpreted as work-related injuries. This presumption can be further reinforced by interpreting age-related signal changes as damage and describing MRI findings using terms that imply trauma and injury (eg, tear). The effect of these MRI interpretations can be substantial given the influence these diagnoses have on insurance claims and litigation.

In Texas and Oklahoma, employers can choose not to subscribe to workers compensation and have their employees receive care under commercial insurance. One of us (MDT) is an occupational medicine physician who runs a company that helps direct and interpret medical care to optimize worker recovery and productivity and help manage indemnity issues. While one can describe the

prevalence of age-related changes in the knee and shoulder on MRI, it has proved much more compelling to image both shoulders and both knees. The clear demonstration of the similar anatomy and pathophysiology makes it clear that new symptoms do not always indicate new damage. For several years it has been routine to order bilateral MR images in patients with shoulder and knee problems. That created a unique and useful dataset for study.

It is logical to expect that unilateral symptoms resulting from an injury attributable to an identifiable workplace event should exhibit worse pathologic features in the symptomatic joint. We therefore sought to determine (1) whether structural changes seen on MRI of the shoulder and knee are more often congruent or incongruent with unilateral symptoms in a population of workers submitting claims and, (2) if there is an association between patients' age and disorder of the 10 selected anatomic structures.

## Materials and Methods

### Study Design

These data were generated as part of a process-improvement project. When the decision was made to analyze and publish the data, all protected health information was removed from the dataset. Secondary data analysis of this deidentified dataset was deemed exempt from institutional review board overview.

Businesses and firms in Texas may elect to opt out of state-run workers compensation programs, and obtain coverage from privately administered insurance companies. These companies provide evaluation and management of workplace injuries, and compensation when appropriate. Starting several years ago as part of a process improvement project at one such company, all patients who presented with unilateral knee or shoulder pain attributed to a work injury were studied with MRI of the painful and the asymptomatic joint. In the process-improvement initiative, data were pulled on a consecutive sample of patients who had a knee or shoulder problem. Our inclusion criteria were (1) pain ascribed to a single event at work; (2) unilateral symptoms; (3) no prior surgery on either the knee or shoulder; (4) age 40 years or older; and (5) MRI of bilateral joints on the same date. Patients were excluded if they had radiologic evidence of fracture. Data for 322 patients were retrieved for this study. Thirteen patients were excluded owing to signs of fracture seen on MRI, and 15 patients were excluded because they were younger than 40 years, leaving 294 patients for analysis. Patients had a mean age of 57 years (SD, 8 years) and a mean BMI of 32 kg/m<sup>2</sup> (SD, 7 kg/m<sup>2</sup>). Slightly more than half were women (151; 51%) and the majority of patients had right-sided

**Table 1.** Patient demographics

Characteristic	Total (n = 294)	Shoulder (n = 189)	Knee (n = 105)	p Value, shoulder vs knee
Age (years; mean ± SD)	57 ± 8	58 ± 8	55 ± 8	< 0.001
Sex, number (%)				0.22
Women	151 (51)	92 (49)	59 (56)	
Men	143 (49)	97 (51)	46 (44)	
BMI (kg/m <sup>2</sup> ; mean ± SD)	32 ± 7	31 ± 6	34 ± 8	0.0011
Laterality, number (%)				0.99
Left	137 (47)	88 (47)	49 (47)	
Right	157 (53)	101 (53)	56 (53)	

symptoms (157; 53%). There were slight differences between the shoulder and knee groups (Table 1). These patients are employed by a diverse group of employers across many industries and throughout the state of Texas that did not subscribe to workers compensation. Their care was managed through standard health insurance products and overseen and directed by a company started by one of the authors (MDT).

#### Response Variables

MR images were read by expert musculoskeletal radiologists who were not provided clinical history and were not aware which side was symptomatic. One of four physicians (CB, BB, HF, RM) reviewed each patient's MRI report to determine the degree of involvement of the contralateral joint based on 10 specific anatomic structures. For the shoulder, we included imaging of the supraspinatus tendon, infraspinatus tendon, acromioclavicular joint, glenoid labrum, and biceps tendon. For the knee, we included imaging of the MCL, medial meniscus, lateral meniscus, ACL, and PCL. Abnormalities, as identified by the radiologist (eg, defect size or degree of signal change), were considered congruent if the abnormalities of one or more structures on the symptomatic side were greater than those of the corresponding structures in the asymptomatic joint.

#### Statistical Analysis

To test whether congruent MRI findings were seen more frequently than incongruent features, chi-square tests were performed. Student's t-tests or Mann-Whitney U tests were performed for each structure to compare the mean age of patients with and without abnormalities observed on MRI. Bivariate logistic regressions were used to identify factors independently associated with pathologic features. Odds ratios and 95% CIs are reported. All statistical analyses

were performed with Stata® 14 (StataCorp, College Station, TX, USA).

Post hoc power analyses of the bivariate analysis were performed using G\*Power 3.1.9.2 (Universitat Dusseldorf, Dusseldorf, Germany) assuming a two-sided significance level of 0.05 [7]. Post hoc power was 7% in the shoulder and 23% in the knee.

## Results

### Congruency of MRI Findings

We found no evidence on MRI for worse changes on the injured versus uninjured side in patients with either shoulder or knee symptoms. MRI findings congruent with unilateral shoulder symptoms were observed in 90 of 189 patients (48%), while MRI findings incongruent with symptoms were observed in 99 of 189 patients (52%;  $p = 0.36$ ). In the knee, MRI findings congruent with symptoms were observed in 45 of 105 (43%) patients, while 60 of 105 (57%;  $p = 0.038$ ) patients had structural changes incongruent with symptoms (Table 2). Abnormalities were seen in 99% of symptomatic shoulders (188 of 189) and 98% of asymptomatic shoulders (186 of 189). In the knee, abnormalities were seen in 87% of symptomatic knees (91 of 105) and 79% of asymptomatic knees (83 of 105). We found that age, gender, BMI, and laterality of symptoms were not independently associated with congruent structural changes in the shoulder (Table 3) or the knee (Table 4).

### Association Between Age and MRI Findings

Older patients with shoulder symptoms were more likely to have MRI findings of structural changes than younger patients, but there was no association between age and structural changes in patients with knee symptoms. Patients

**Table 2.** Congruency of MRI findings with unilateral symptoms

Joint affected	Congruent MRI findings	Incongruent MRI findings		p value, congruent versus incongruent
		Structural changes worse on symptomatic side	Structural changes worse on asymptomatic side	
Shoulder	90 (48%)	67 (35%)	32 (17%)	0.36
Knee	45 (43%)	27 (26%)	33 (31%)	0.038

**Table 3.** Factors independently associated with congruent MRI findings in the shoulder

Variable	Odds ratio	95% CI		p value
		Lower	Upper	
Age	1.0	0.99	1.1	0.25
Gender (male)	0.98	0.55	1.8	0.95
BMI	0.95	0.90	1.0	0.080
Laterality (left)	1.1	0.60	2.0	0.80

**Table 4.** Factors independently associated with congruent MRI findings in the knee

Variable	Odds ratio	95% CI		p value
		Lower	Upper	
Age	1.0	0.96	1.1	0.91
Gender (male)	1.8	0.83	4.1	0.13
BMI	0.98	0.93	1.0	0.54
Laterality (left)	0.85	0.38	1.9	0.68

with changes in the infraspinatus tendon, glenoid labrum, and biceps tendon were older than patients without features in these structures (Table 5).

**Discussion**

Given that MRI signal changes of the shoulder and knee are increasingly prevalent with age regardless of symptomatology, considering newly symptomatic joints with MRI signal changes as injuries related to an acute traumatic event may not be accurate. The distinction between new pathophysiology and newly symptomatic preexisting pathophysiology is nuanced, but most observers would accept that if the pathologic features are either less or equal in the symptomatic compared with the asymptomatic shoulder or knee, then the problem can likely be attributed

**Table 5.** Association between structural changes and age

Structure affected	Structural changes		No structural changes		p value
	Number (%)	Age (years; mean ± SD)	Number (%)	Age (years; mean ± SD)	
<b>Shoulder</b>					
Supraspinatus tendon	185 (98)	58 ± 8	4 (2)	51 ± 5	0.069
Infraspinatus tendon	135 (71)	59 ± 8	54 (29)	56 ± 8	0.012
Acromioclavicular joint	182 (96)	58 ± 8	7 (4)	58 ± 10	0.096
Glenoid labrum	98 (52)	60 ± 9	91 (48)	57 ± 8	0.025
Biceps tendon	90 (48)	60 ± 8	99 (52)	57 ± 8	0.0038
<b>Knee</b>					
MCL	33 (31)	56 ± 9	72 (69)	54 ± 8	0.53
Medial meniscus	91 (87)	55 ± 8	14 (13)	54 ± 8	0.78
Lateral meniscus	52 (50)	54 ± 8	53 (50)	55 ± 8	0.76
ACL	27 (27)	53 ± 8	78 (73)	55 ± 8	0.093
PCL	10 (9)	57 ± 6	95 (91)	54 ± 8	0.11

to atraumatic age-related changes. This analysis of a unique dataset of a diverse population of patients, in whom bilateral MRI was routine, sought to determine whether new symptoms in the shoulder or knee that occurred at work are associated with asymmetric structural changes on bilateral MRI. We also assessed the relationship between structural changes and patient age.

This study has limitations. This study evaluated MR images from a convenience sample of patients with occupational injuries in urban and rural Texas; all of the patients were older than 40 years, and the gender distribution was fairly even between men and women. Our findings should be interpreted cautiously in populations dissimilar to ours. The interpretation of radiology reports by each physician introduces a source of potential bias. We audited the accuracy of the reports but could not control for consistency of interpretation or rating of “severity” of MRI findings. However, our simplistic classification (normal versus abnormal) is likely to be highly reliable. This study design also lends real-world relevance to our study. Next, we had no information available regarding the nature of the injury or work involved. One strength of the study is that this was a population of patients in whom bilateral MRI was used routinely—there was no bias in the decision regarding when to order MRI of the uninvolved shoulder or knee. A post hoc power analysis showed that even the largest samples of congruent pathologic features were too small to test the hypotheses adequately. If the difference observed in the knee was, in truth, the actual difference, we

would need approximately 500 patients to detect significance with a power of 80%. In other words, the effect size here, if any, is small. Similarly, the analyses of the secondary research question were hindered by substantial skewing of the data.

We found no difference between the frequency of congruent MRI findings in the shoulder and the frequency of incongruent MRI findings. Indeed, among this convenience sample of occupational injury claims filed for patients with new unilateral shoulder symptoms, structural changes that were worse on the asymptomatic side or equal bilaterally were observed more than half the time. Previous studies have shown that the prevalence of abnormalities in the shoulder is high in the general population and that the presence of MRI changes does not necessarily correlate with symptoms. Gill et al. [8] reported an equal prevalence of shoulder disorders in people with current shoulder pain, a history of shoulder pain, and people who have never had shoulder pain. In a systematic review, Teunis et al. [18] found that 56% of asymptomatic patients 80 years and older had rotator cuff abnormalities. Such a high prevalence of asymptomatic change makes it difficult to associate pathophysiology with shoulder symptoms and to assume that new symptoms indicate new pathophysiology [18]. The concept that most shoulder and knee pathophysiology in symptomatic workers is likely the result of age-appropriate changes is reinforced by our findings that MRI of the contralateral shoulder or knee often shows similar or greater pathophysiology on the asymptomatic joint.

In the knee, congruent MRI findings were observed less often than incongruent MRI findings. The same principles hold as in the shoulder and are supported by previous studies. Englund et al. [6] found an overall prevalence of meniscal abnormalities in 35% of patients sampled from the general population, 61% of whom had no clinical symptoms in the past month. Boks et al. [2] found that 42% of patients with knee pain had meniscal changes on the symptomatic side and 12% had changes on the contralateral knee with no changes on the symptomatic side. Overall, 63% with symptomatic meniscal changes showed asymptomatic contralateral meniscal changes as well [2]. Given the high prevalence of asymptomatic meniscal signal changes, congruent MRI findings do not establish causation; rather, it is likely that MRI is merely revealing existing, underlying structural changes. While conventional thinking would suggest that the severity of the meniscal abnormality might influence severity of symptoms, recent evidence questions whether mechanical symptoms can be attributed to meniscal changes. For instance, a post hoc analysis of a randomized controlled trial found no difference in outcomes between sham surgery and meniscectomy in patients with catching and locking [16, 17]. Therefore,

perhaps differentiating between displaced flaps and anterior horn fraying may not be clinically necessary when considering first line, nonoperative management of degenerative meniscal changes in middle-aged and older patients, especially since defects such as bucket-handle tears are less likely in this population.

Our finding that age was independently associated with MRI findings in the shoulder is consistent with previous research in asymptomatic individuals with no history of injury. Sher et al. [15] reported an increasing prevalence of rotator cuff defects with age, in which up to 54% of individuals older than 60 years had a partial- or full-thickness defect, whereas no patients younger than 39 years did. Teunis et al. [18] similarly found a prevalence of abnormalities in up to 62% of patients 80 years and older. An understanding of the natural history of changes that occur in the shoulder with age is helpful when assessing patients with shoulder symptoms.

There was no association between age and MRI findings in any of the five structures of the knee. This finding is counter to previous studies. Englund et al. [6] reported that the prevalence of meniscus changes ranges from 32% and 19% in men and women 50 to 59 years old, respectively, to 56% and 51% in men and women 70 to 90 years old. Our results likely differ owing to the skewing of our sample. The median age of patients with knee symptoms in our study was 54 years, and 79% of patients with knee symptoms were younger than 60 years.

Humans tend to interpret nociception (the pathophysiology of actual or potential tissue damage) as injury, but a substantial proportion of musculoskeletal nociception is degenerative or idiopathic. The pain intensity for a given nociception is determined largely by psychosocial factors. For instance, an older laborer with limited education wondering how he will make a living if his aging body is less suited for heavy work will have more pain with this realization than when he is confident and focused on his work. Limb pain often is nonspecific and difficult to associate with discrete pathophysiology [11]. Confidently ascribing structural changes detected on MRI to a specific mechanism or event is difficult, especially given that signal changes are so common after age 40 years. Notably, extensive evidence of an increasing rate of age-related asymptomatic signal changes has not greatly influenced our tendency to misinterpret and mislabel these changes. Misinterpretation of newly symptomatic degenerative pathophysiology as an injury can affect management and recovery, particularly when the symptoms occur at work. Referring to signal changes on MRI as a tear or injury reinforces these misconceptions.

Patients with newly symptomatic knees and shoulders are more likely to have expected age-related changes than acute injuries. MRI is not helpful and should be avoided

unless there is a high probability (based on circumstances, symptoms, and examination) of pathophysiology that will benefit from surgery. In particular, the utility of MRI data should be carefully considered in patients older than 40 years submitting work claims, as age-related changes can easily be misinterpreted as acute injuries.

**Acknowledgments** We appreciate the efforts of Cynthia Ball MD, Ben Burris MD, Hiroko Furo MD, and Rini Mathew MD (all from OccMD Group PA, Dallas, TX, USA) who collected and organized the data.

## References

- Adelani MA, Mall NA, Brophy RH, Halstead ME, Smith MV, Wright RW. The use of MRI in evaluating knee pain in patients aged 40 years and older. *J Am Acad Orthop Surg.* 2016;24:653–659.
- Boks SS, Vroegindeweyj D, Koes BW, Hunink MM, Bierma-Zeinstra SM. Magnetic resonance imaging abnormalities in symptomatic and contralateral knees: prevalence and associations with traumatic history in general practice. *Am J Sports Med.* 2006;34:1984–1991.
- Chan JJ, Teunis T, Ring D. Prevalence of triangular fibrocartilage complex abnormalities regardless of symptoms rise with age: systematic review and pooled analysis. *Clin Orthop Relat Res.* 2014;472:3987–3994.
- Couzens G, Daunt N, Crawford R, Ross M. Positive magnetic resonance imaging findings in the asymptomatic wrist. *ANZ J Surg.* 2014;84:528–532.
- Davis K, Dunning K, Jewell G, Lockey J. Cost and disability trends of work-related musculoskeletal disorders in Ohio. *Occup Med (Lond).* 2014;64:608–615.
- Englund M, Guermazi A, Gale D, Hunter DJ, Aliabadi P, Clancy M, Felson DT. Incidental meniscal findings on knee MRI in middle-aged and elderly persons. *N Engl J Med.* 2008;359:1108–1115.
- Faul F, Erdfelder E, Lang AG, Buchner A. G\*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods.* 2007;39:175–191.
- Gill TK, Shanahan EM, Allison D, Alcorn D, Hill CL. Prevalence of abnormalities on shoulder MRI in symptomatic and asymptomatic older adults. *Int J Rheum Dis.* 2014;17:863–871.
- Iordache SD, Rowan R, Garvin GJ, Osman S, Grewal R, Faber KJ. Prevalence of triangular fibrocartilage complex abnormalities on MRI scans of asymptomatic wrists. *J Hand Surg Am.* 2012;37:98–103.
- Kemp MA, Lang K, Dahill M, Williams JL. Investigating meniscal symptoms in patients with knee osteoarthritis: is MRI an unnecessary investigation? *Knee.* 2011;18:252–253.
- Kortlever JT, Janssen SJ, Molleman J, Hageman MG, Ring D. Discrete pathophysiology is uncommon in patients with non-specific arm pain. *Arch Bone Jt Surg.* 2016;4:213–219.
- Lin E. Magnetic resonance imaging of the knee: clinical significance of common findings. *Curr Probl Diagn Radiol.* 2010;39:152–159.
- Metz VM, Schratte M, Dock WI, Grabenwöger F, Kuzbari R, Lang S, Wanivenhaus AH, Puigg S, Imhof H. Age-associated changes of the triangular fibrocartilage of the wrist: evaluation of the diagnostic performance of MR imaging. *Radiology.* 1992;184:217–220.
- Mroz TM, Carlini AR, Archer KR, Wegener ST, Hoolachan JI, Stiers W, Shore RA, Castillo RC. Frequency and cost of claims by injury type from a state workers' compensation fund from 1998 through 2008. *Arch Phys Med Rehabil.* 2014;95:1048–1054.e6.
- Sher JS, Uribe JW, Posada A, Murphy BJ, Zlatkin MB. Abnormal findings on magnetic resonance images of asymptomatic shoulders. *J Bone Joint Surg Am.* 1995;77:10–15.
- Sihvonen R, Englund M, Turkiewicz A, Järvinen TL. Mechanical symptoms as an indication for knee arthroscopy in patients with degenerative meniscus tear: a prospective cohort study. *Osteoarthritis Cartilage.* 2016;24:1367–1375.
- Sihvonen R, Paaola M, Malmivaara A, Itälä A, Joukainen A, Nurmi H, Kalske J, Järvinen TL; Finnish Degenerative Meniscal Lesion Study (FIDELITY) Group. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *New Engl J Med.* 2013;369:2515–2524.
- Teunis T, Lubberts B, Reilly BT, Ring D. A systematic review and pooled analysis of the prevalence of rotator cuff disease with increasing age. *J Shoulder Elbow Surg.* 2014;23:1913–1922.
- United States Department of Labor Bureau of Labor Statistics. Nonfatal Occupational Injuries and Illnesses Requiring Days Away From Work in 2014. Available at: <https://www.bls.gov/opub/ted/2015/nonfatal-occupational-injuries-and-illnesses-requiring-days-away-from-work-in-2014.htm>. Accessed May 25, 2017.
- Vranceanu AM, Cooper C, Ring D. Integrating patient values into evidence-based practice: effective communication for shared decision-making. *Hand Clin.* 2009;25:83–96, vii.
- Weinstein SI, Yelin EH, Watkins-Castillo SI. United States Bone and Joint Initiative (BMUS). The Burden of Musculoskeletal Diseases in the United States: Lost Work Days. 3rd ed. Rosemont, IL, Available at: <http://www.boneandjointburden.org/2014-report/id2/lost-work-days>. Accessed August 30, 2016.
- Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease: a comparison of asymptomatic and symptomatic shoulders. *J Bone Joint Surg Am.* 2006;88:1699–1704.
- Yamamoto A, Takagishi T, Osawa T, Yanagawa T, Nakajima D, Shitara H, Kobayashi T. Prevalence and risk factors of a rotator cuff tear in the general population. *J Shoulder Elbow Surg.* 2010;19:116–120.