Original Article

Normal lumbar MRI scans in patients with lower back pain following injury

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Abstract
Background: There have been numerous studies highlighting abnormal lumbar spine magnetic resonance imaging (MRI) findings in asymptomatic patients, exhibiting a correlation of increased findings with age; however, little research has been done to investigate the likelihood of normal MRI scans in patients who present with lower back pain. [1] This study is pertinent to understanding (1) whether MRI scans are given to patients who do not necessarily require such extensive testing and whether current profligate medical and (2) work-related expenses can be avoided.

Methods: In this study, 189 lumbar spine MRI scans of patients who were 30 years or younger, presenting with lower back pain following a personal or work-related injury, were analyzed for potential findings or lack thereof. The patients were grouped into categories of "normal MRI" and "abnormal MRI" findings based on criteria created by two board certified orthopedic surgeons.

Results: The results showed that approximately 23% of the subjects had "normal MRI" scans and therefore lacked any form of significant findings which should be suggestive of lower back pain. No gender difference was observed between complaints and MRI findings.
Conclusion: These results demonstrate that the MRI scans of a significant portion of patients (23%) reporting lower back pain do not show significant abnormalities sufficient enough to explain their symptoms. This may indicate that a more thorough screening process needs to be developed due to patients report their symptoms under the influence of psychological and psychosocial factors, or that current MRI technology does not allow visualization of some anatomical component that may be causing lower back symptoms in these patients, or perhaps their causative pathology in unrelated to the spine.

Keywords
MRI, Imaging, Low back pain

Introduction

Numerous studies have described the incidence of abnormalities in imaging studies on asymptomatic patients[1-3]. A landmark study conducted by Boden, Davis, Dina, Patronas, and Wiesel (1990) studied the specificity of lumbar spine magnetic resonance imaging (MRI) scans in 67 asymptomatic subjects with no history of lower back pain, sciatica, or neurogenic claudication[1]. The authors found that 20% of the subjects less than 60 years old had abnormal findings and 57% of the subjects 60 years of age and older had abnormal findings. Another study in 1994 also analyzed the correlation between lumbar MRI scans and lower back pain using 98 asymptomatic patients. Of the 98 asymptomatic patients only 36% had normal disks at all levels while 52% had a disc bulge at one level or more, 27% had a disc protrusion, and 38% had abnormalities at more than one disc level[2]. These findings were similar in men and women and increased in prevalence with age. This high percentage of abnormal findings in asymptomatic patients highlighted the importance of correlating imaging findings, with clinical symptoms, causative pathology and age, prior to invasive therapeutic interventions.

These findings may lead to a new hypothesis, suggesting that these asymptomatic patients with abnormal findings on MRI scans may develop lower back pain in the near future if not present at the time of MRI. In regards to this claim, a 5 year follow up of a preliminary study that looked at 46 asymptomatic patients with a high rate of disc herniations, showed that abnormalities determined using lumbar MRI are poor predictors for low back pain-related medical consultation and resultant work incapacity[3]. In addition, a seven-year follow-up of the original study conducted by Boden and associates, reveals that abnormal findings on lumbar spine MRI in asymptomatic patients did not predict low back pain in the future, evidence against the previously suggested hypothesis[4]. This further enforces the belief that MRI findings should only be interpreted in the context of symptomatology and objective physical findings. Despite many studies of abnormal MRI findings in asymptomatic patients, no studies have evaluated the incidence of normal MRI findings in symptomatic patients. This may be particularly relevant in subjects with personal injury claims or worker's compensation cases who look to benefit financially from increased disability. We believe that perhaps patients citing lower back pain in their personal injury claims often overstate symptoms, which in combination with positive imaging findings, may lead to unnecessary invasive treatments such as injections and surgery. For that reason, we chose to evaluate the incidence of normal MRI in patients with personal injury or worker's compensation claims.

We elected to use standing MRI, which is a new technique that is not yet widely utilized, but has shown promise in detecting spinal pathology not captured as clearly in traditional supine MRI studies, with similar cost profile[5,6]. This includes quantifying spinal stenosis and degree of degenerative disc disease, which is due to the positional dependence of these diseases, which reflect dynamic changes in soft-tissue structures [6]. We standardized the study by only including standing MRI scans of the patients. Therefore, we hypothesized that a significant population of patients with a personal injury claim or a worker's compensation case for lower back pain would have normal MRI scans.

Materials and Methods

As noted in the studies conducted by Boden and Jensen, as the age of subjects increased, the number of abnormal findings in asymptomatic patients increased as well[-2]. In order to avoid the natural processes of aging that affect the spine[7], this study focuses on patients 30 years or younger who report lower back pain following an injury, personal or work related. The focus of the study is lower back pain, thus MRI scans studied were of the lumbar region of the spine, from T12-L1 to L5-S1. Selected MRI scans were taken in an upright (weight-bearing) position. Once these criteria were established, MRI scans were chosen from all patients seen in AIMS Radiology Clinic, who had their standing MRI procedure anytime between September 2011 and July 2014. Radiologists from AIMS Radiology Clinic analyzed the MRI scans for diagnoses and created MRI reports recording all findings. Access to MRI scans and reports were achieved via a research server that removed all identification information from the patients except for age, gender, and date of MRI scan. 194 patient MRIs fit the criteria and were used for this study.

Due to the grand detail of the MRI scans, it is very common to find some sort of abnormality even in asymptomatic patients, as was seen in the Boden and Jensen studies[1-2]. In order to avoid these relatively common, yet less serious injuries, findings were grouped as either significant or insignificant based on guidelines set by two board certified orthopedic spine surgeons, blinded

from the previous radiologic impression. MRI findings were deemed insignificant if the abnormality depicted is not sufficient to cause lower back pain in patients. MRI scans in which there were disc protrusions 2.0 mm or less in size and had no impingement on the nerve or thecal sac and did not cause spinal canal or neuroforaminal narrowing, were considered insignificant findings. If the disc protrusion seemed to abut or efface the thecal sac, it was considered as an insignificant finding. It was also determined that Schmorl's nodes are incidental findings and considered normal. Straightening of lumbar lordosis was determined to be non-specific and due to spasms post-trauma[8], and thus categorized as an insignificant finding, if within 12-14 weeks window of the injury. Other findings that had no relation to the spine, such as ovarian and renal cysts, were ignored. All other findings pertaining to the spine were grouped as significant findings and were considered a contributor of low back pain that the patients reported. Significant findings included disc protrusions greater than 2.0 mm, with evidence of impingement on the nerve or thecal sac or spinal canal or neuroforaminal narrowing, annular tear, and spinal stenosis [1-2].

The 194 patient MRI scans were analyzed and findings were tabulated. Patients with MRI scans including any sort of congenital findings or scoliosis were removed from the study. The remaining patients were then grouped, with the criteria set above, and placed into patients with significant and insignificant findings on MRI scan. Patients lacking any significant findings were grouped as "normal MRI" in regards to MRI imaging, while those with significant findings were placed in the "abnormal MRI" group. Of the "normal MRI" patients, subjects were then further divided into "unremarkable MRI" group, if the read was unremarkable or negative, and then the rest as the "insignificant MRI findings" group for disc protrusions less than 2.0 mm with no evidence of impingement or neuroforaminal narrowing as described previously. Finally, the percentage of symptomatic patients who had "normal MRI" findings was calculated as a whole and again based on gender.

Results

Of the 194 MRI scans, 4% of subjects (5) were removed from the study due to congenital defects. Of the remaining 189 scans, 34% of these scans were from female patients. Additionally, 23% (43) of the subjects lacked significant findings on their MRI scans and were thus grouped as "normal MRI." Therefore, of the entire population in this study, 23% of the subjects who reported lower back pain (n=189) lacked significant findings in their MRI scans corresponding to their pain (Table 1). To rule out any gender differences a comparison was run between males and females. Of the 34% of female patients who complained of lower back pain in this study, approximately 30% were found to have no significant findings on their MRIs and were therefore placed in the "normal MRI" group (Graph 1). Of the 125 randomly chosen males with reported back pain, approximately 19% were found to not have any significant findings in their MRI scans and were therefore placed in the "normal MRI" group (Graph 1). A chi-squared test conducted to check association between gender and normal MRI with associated pain gave a value of 2.65 (df=1, N=189), p=.10. Therefore, there was no significant association between gender and complaints of lower back pain associated with a normal MRI.

The 43 subjects (26%) in the "normal MRI" group were further broken down into patients with "unremarkable MRI," meaning they had no findings on their MRI scans (described as a normal MRI or negative) and patients who were "normal w/ insignificant findings," meaning these patients

had findings on their MRI scans but these findings were deemed insignificant by the criteria cited above and therefore should not have caused pain. Of the 43 "normal MRI" subjects, 6 of them (14%) had MRI scans that were completely unremarkable and thus grouped as "unremarkable MRI." Of the remaining 37 subjects (86%) the most common insignificant findings noted on the MRI scans included 27 cases (73%) of straightening of lumbar lordosis, 19 cases (51%) of disc protrusion less than or equal to 2mm, and 5 cases (14%) of early signs of disc desiccation, which are all insignificant findings and without clinical correlation.

Discussion

Lower back pain is one of the most frequently encountered clinical symptoms presented in the United States population. It is estimated that 80% of the population experiences lower back pain at some point in life, and the total cost for spine care as a whole is estimated to reach a value of over $85 billion[9]. Workers compensation lower back injuries amount to the second most frequent body part injury, accounting for 15% of all lost-time claims from 2006 to 2010[10]. The United States spends more on health care than any other industrialized nation[11]. Estimates on the economic cost of low back pain in the United States are as high as 90 billion dollars, with as high as 30% of this cost attributed to imaging expenses[12]. The U.S. has approximately 91 people out of a population of 1,000 receive MRI scans, which is nearly double that of the OECD average[13]. In this study, of the 189 subjects who met the criteria of being 30 years or younger and having MRI scans of their lumbar spine following an injury, 43 subjects (23%) did not have any significant findings in their MRI procedures and therefore had normal MRI scans. Significant findings were categorized as those that were known to be associated with lower back pain and/or required some sort of treatment. Thus, 43 of the MRI scans (23%) in this post-injury population lacked any sort of significant MRI finding that could be attributed as the cause of lower back pain.

Two possible issues regarding the prominent number of insignificant MRI findings are 1) whether these diagnostic exams are being used in cases that do not necessarily require such extensive testing, or that 2) the current MRI exam may not show some anatomical components that may contribute to the patient's pain or the pain may originate from a source not picked up well on MRI. We believe that the first possibility of whether or not the MRI is being used in the proper circumstances as a diagnostic tool can further be divided into two causes: 1a) physicians are requesting MRIs in cases that do not clinically call for one or 1b) many of these cases include a psychosocial component due to economic incentives such as in malingering cases[14]. The psychosocial component to these cases may lead to exaggerated or entirely fabricated symptom reporting and as a result may have a large contribution to the substantial amount of MRI scans with insignificant findings, especially when one considers cases in the context of personal injury or workers' compensation claims. In regards to the proper usage of MRI scans diagnostically, the American College of Physicians and the American Pain Society have created guidelines to establish when it is appropriate to take MRI scans of a patient with lower back pain in order to regulate spending on such procedures[15]. This includes limiting MRI scans for patients with severe or progressive neurologic deficits or when serious underlying conditions are suspected on history and exam. Nonetheless, the questions still arise as to whether or not the guidelines are strict enough or if doctors are in actuality following these guidelines as resources. In a study by Emery et al., the overuse of MRI scans for the lumbar spine using the RAND-University of California, Los Angeles, appropriateness method found that only 443 of 1000 MRI requests were considered

appropriate while the rest were divided between inappropriate or uncertain value[16]. That means greater than 50% of MRI scans in that study were given to patients whose appropriateness of receiving an MRI for their clinical presentation was questionable, a number farther greater than our study.

A second potential issue may be due to possible anatomical components that cause symptoms of pain but are not seen with the current MRI scans, including soft tissue components or sacroiliac dysfunctions. A recent retrospective review shed light on this topic in regard to adolescents with lower back pain attributed to spondylolysis[13]. In this study, of 11 adolescents with a history and physical exams consistent with spondylolysis, only 4 showed the diagnosis on their MRI scans. An alarming 7 of the 11 cases (64%) lacked any such finding on their MRI scan, concluding that further radiologic evaluations should be considered in adolescent patients with a high clinical suspicion for spondylolysis. Although this study pertains to patients in a particular age range, it raises skepticism that current diagnostic modalities for low back pain may be missing a subset of potential causes. One final consideration is that there may be psychological and work related factors that play a major role in contributing to lower back pain but have no association with significant findings on MRI, such as depression, somatization, and job dissatisfaction[18-19]. Unfortunately, some of these may stem from economic incentive.

Despite the lack of a definitive reason for the large percentage of insignificant MRI findings in patients with lower back pain following a personal or work related injury, we suggest an alternative methods in dealing with litigation when patient workups come up negative with the initial MRI, which includes working up or considering other etiologies not captured well by MRI, such as sacroiliac joint dysfunction, spondylolysis, or psychological or social factors. Lower back pain workers' compensation cases alone had an average cost of $8,000 per case and represented 33% of all workers' compensation costs[20]. These costs not only include the direct medical costs but also the indirect cost of time away from work. By understanding the limitations of MRI as an imaging modality, a more expedited process of dealing with patients with a negative workup in both workers' compensation and personal injury cases is achievable, as was observed in nearly 25% of the cases in this study, potentially decreasing the continued expenses due to excessive medical treatments and loss of time from work.

References

1. Boden, S. D., Davis, D. O., Dina, T. S., Patronas, N. J., & Wiesel, S. W. (1990). Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects. A prospective investigation. *Journal of Bone & Joint Surgery, 72*(3), 403-408.
2. Jensen, M. C., Brant-Zawadzki, M. N., Obuchowski, N., Modic, M. T., Malkasian, D., Ross, J. S. (1994). Magnetic resonance imaging of lumbar spine in people without back pain. *The New England Journal of Medicine*, *331*(2), 69-73.OECD. (2011).
3. Boos, N., Semmer, N., Elfering, A., Schade, V., Gal, I., Zanetti, M., . . . Main, C. J. (2000). Natural history of Individuals with asymptomatic disc abnormalities in magnetic resonance imaging: predictors of low back pain-related medical consultation and work incapacity. *Spine Journal. 25*(12), 1484-1492.
4. Borenstein, D. G., O'Mara, J. W., Boden, S. D.,Lauerman, W. C., Jacobson, A., Platenberg, C., . . . Wiesel, S. W. (2001). The value of magnetic resonance imaging of the lumbar spine to predict low-back pain in asymptomatic subjects. *Journal of Bone & Joint Surgery. 83*(9), 1306-1311.
5. Kubosch D, Vicari M, Siller A, et al. The Lumbar Spine as a Dynamic Structure Depicted in Upright MRI. *Medicine (Baltimore)*. 2015;94(32):e1299.
6. Alyas, F., Connell, D., Saifuddin, A. (2008). Upright positional MRI of lumbar spine. *Clinical Radiology. 63*(8), 1035-1048.
7. Boos N, Weissbach S, Rohrbach H, Weiler C, Spratt KF, Nerlich AG. Classification of age-related changes in lumbar intervertebral discs: 2002 Volvo Award in basic science. *Spine (Phila Pa 1976)*. 2002;27(23):2631-2644.

8. Giuliano V, Giuliano C, Pinto F, Scaglione M. Soft tissue injury protocol (STIP) using motion MRI for cervical spine trauma assessment. *Emerg Radiol*. 2004;10(5):241-245.
9. Friedly J., Standaert, C., Chan, L. (2010). Epidemiology of spine care: the back pain dilemma. *Phys Med RehabilClin N Am. 21*(4): 659-677.
10. Davis, J. (2012, July). Workers compensation claim frequency-2012 update. Retrieved February 14, 2015.
11. Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. *Spine J*. 8(1):8-20.
12. Squires, D. (2012). Explaining high health care spending in the United States: an international comparison of supply, utilization, prices, and quality.
13. Health at a Glance 2011: OECD Indicators. OECD Publishing. Retrieved February 14, 2015, from http://dx.doi.org/10.1787/health_glance-2011-en
14. Boos N, Rieder R, Schade V, Spratt KF, Semmer N, Aebi M. 1995 Volvo Award in clinical sciences. The diagnostic accuracy of magnetic resonance imaging, work perception, and psychosocial factors in identifying symptomatic disc herniations. *Spine (Phila Pa 1976)*. 1995;20(24):2613-2625.
15. Chou, R., Qaseem, A., Snow, V., Casey, D., Cross, J. T., Shekelle, P., Owens, D. K. (2007). Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Annals of Internal Medicine, 147*(7), 478-491.
16. Emery, D. J., Shojania, K. G., Forster, A. J., Mojaverian, N., Feasby, T. E. (2013). Overuse of magnetic resonance Imaging. *JAMA Internal Medicine, 173*(9), 823-825

17. Yamaguchi, K.T., Skaggs, D., Acevedo, D.C., Myung, K.S., Choi, P., Andras, L. (2012). Spondylosis is frequently missed by MRI in adolescents with back pain.*J Child Orthop*., 6(3):237-40.

18. Fayad F., Lefevre-Colau, M. M., Poiraudeau, S., Fermanian, J., Rannou, F., WlodykaDemaille, S. . . . Revel, M. (2004). Chronicity, recurrence, and return to work in low back pain: common prognostic factors. *Ann Readapt Med Phys, 47*(4), 179-89.

19. Pincus, T., Burton, A. K., Vogel, S., Field, A. P. (2002). A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain.*Spine, 27*(5), E109-120.

20. *The Commonwealth Fund, 10*, 1-14Webster, B.S., Snook, M. (1994). The Cost of 1989 Worker's Compensation Low Back Claims. *Spine, 19*(10): 1111-5.

Table 1. Normal vs Abnormal MRI Scans Broken Down by Gender

Total Number of MRI Scans 189 (100%)			
Total Number Female Subjects 64 (34%)		Total Number of Male Subjects 125 (66%)	
Normal Results 43 (23%)		Abnormal Results 146 (77%)	
Female Subjects 19 (44%)	Male Subjects 24 (56%)	Female Subjects 45 (31%)	Male Subjects 101 (69%)

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41. Boos N, Rieder R, Schade V, Spratt KF, Semmer N, Aebi M. 1995 Volvo Award in clinical sciences. The diagnostic accuracy of magnetic resonance imaging, work perception, and psychosocial factors in identifying symptomatic disc herniations. *Spine (Phila Pa 1976)*. 1995;20(24):2613-2625. http://www.ncbi.nlm.nih.gov/pubmed/8747239. Accessed March 30, 2017.

2. Boos N, Weissbach S, Rohrbach H, Weiler C, Spratt KF, Nerlich AG. Classification of age-related changes in lumbar intervertebral discs: 2002 Volvo Award in basic science. *Spine (Phila Pa 1976)*. 2002;27(23):2631-2644. doi:10.1097/01.BRS.0000035304.27153.5B.

3. Giuliano V, Giuliano C, Pinto F, Scaglione M. Soft tissue injury protocol (STIP) using motion MRI for cervical spine trauma assessment. *Emerg Radiol*. 2004;10(5):241-245. doi:10.1007/s10140-004-0327-6.

4. Kubosch D, Vicari M, Siller A, et al. The Lumbar Spine as a Dynamic Structure Depicted in Upright MRI. *Medicine (Baltimore)*. 2015;94(32):e1299. doi:10.1097/MD.0000000000001299.

5. Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. *Spine J*. 8(1):8-20. doi:10.1016/j.spinee.2007.10.005.

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