The Extent of Inappropriate Use of Magnetic Resonance Imaging in Low Back Pain and its Contributory Factors

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Original Article

ABSTRACT

Background: Magnetic resonance imaging (MRI) is an expensive and commonly used technology with a variety of indications in patient diagnosis and treatments. The aim of this study is to identify a comprehensive list of indications and contraindications for MRI in patients with low back pain (LBP) and to determine the appropriateness of using this technology in these patients on the basis of this list.

Methods: A cross-sectional study was conducted in four radiographic centers in Tehran, Iran. A list of MRI indications and contraindications for LBP was developed by review of documents and expert panel. A pre structured checklist was designed and incorporated into a structured form. All 100 consecutive patients referring to four radiographic centers for performing MRI regarding LBP completed the questionnaire. Chi-square, Fisher's Exact Test and logistic Regression were used to assess statistical significance.

Results: In this study, 187 patients (46.7%) had an indication for MRI, but 186 patients (46.5%) had no indication, 18 patients (4.5%) had indication and contraindication at the same time and nine patients (2.3%) had contraindication. Moreover, 71 patients (17.8%) underwent MRI for LBP during the past 2 years, of which 14 (19.7%) had normal results. Patients with complementary private insurance had a history of previous MRI about 20% more than other patients ($P = 0.018$). There was a statistically significant relationship between complementary private insurance coverage and number of MRI performed ($P = 0.006$).

Conclusions: About half of the patients referring to radiographic centers with LBP for MRI had no indication for this test.

Keywords: Appropriate use, contraindication, low back pain, indication, magnetic resonance imaging

INTRODUCTION

Magnetic resonance imaging (MRI) is a relatively expensive technology with a wide range of application for diagnosis

and treatment of patients.[1,2] There has been an increasing trend of using MRI in recent years.[3] However, it seems that a proportion of patients using MRI have no clear indication for it and this might result in a large drain on health-care resources.[4]

Acute low back pain (LBP) is a very common health problem leading to a significant disability and costs.[5]

The aim of this study was to identify a comprehensive list of indications and contraindications for using MRI in patients with LBP and to determine the level of appropriate use of this technology in patients with LBP on the basis of this list in Iran.

METHODS

Review of indications/contraindications and expert panel

Medline was searched to identify reports regarding appropriateness criteria, standards, indications and contraindications of MRI in LBP. The 14 relevant documents were identified of which two reports provided a comprehensive list of the indications and contraindications.[6,7] We also added related items that were identified in other reports to complete list of indications and contraindications.[8-19]

The list of indications and contraindications was translated into Persian and checked by two physicians. Six specialist residents were selected from the three major specialties that are involved in the prescription of MRI for LBP, orthopedics, neurosurgery and neurology to check the face and content validity of the questionnaire. We sent the preliminary checklist to these residents and modified the questionnaire based on their comments. The final list of indications and contraindications was identified based on the general consensus that was made in a panel of these six residents [Table 1].

Setting, sampling and patient recruitment for field study

The field study was performed in four radiographic centers in two public hospitals, a private imaging center and a hospital affiliated with National Iranian Oil Company in Tehran. Then 100 patients referring with complaints of LBP, were consecutively selected from each radiographic center between September 2012 and December 2012.

The pre-structured checklist was used to obtain information from selected patients. The questionnaire included questions about age, gender, place of residence, formal education, employment status, LBP history, health insurance, total cost and out of pocket cost of MRI. The LBP history included questions about the history of treatment before MRI, time and type of treatment provided, the number of MRI done and results of previous MRI, specialty of physician requesting MRI, consultation with a specialist in rehabilitation medicine, indications and contraindications of MRI for LBP patients based on the final checklist [Table 1]. The questions included tick box and open questions.

Table 1: The list of indications and contraindications for utilization of MRI in patients with LBP

Indications	Contraindications
Trauma	Ferromagnetic cardiac pacemakers and defibrillators
Unexplained weight loss, insidious onset	Ferromagnetic intracranial aneurysm clips
Unexplained fever, history of urinary or other infection	Implanted pump
Immuno-suppression, diabetes mellitus	Certain otic implants
History of cancer	Ferromagnetic foreign bodies in critical locations, e.g., the eye
Osteoporosis or compression fracture	Stents-coils-filters
Prolonged use of corticosteroids	
Focal neurologic deficit(s) with progressive or disabling symptoms, cauda equina syndrome	
LBP duration longer than 6 weeks*	
Prior surgery	
HIV	
Sphincter or gait disturbance	

*If low back pain is not responding to treatment and the pain is getting worse instead of better. LBP=Low back pain, MRI=Magnetic resonance imaging, HIV=Human immunodeficiency virus

Data were collected via face-to-face interviews by two trained interviewers. Furthermore a general practitioner who had formal training and experience in the treatment of spinal disorders was available for consultation and clinical examination when necessary.

Collected data were analyzed using IBM SPSS Statistics 19 software. Chi-square and Fisher's exact tests were used to evaluate the statistical significance. The strength of the association in the logistic regression analysis was quantified by calculating odds ratios (ORs) with 95% of confidence intervals (95% CIs). A $P < 0.05$ was considered to be statistically significant.

RESULTS

In this study, 233 (58.3%) of patients were female and patients' average age was 45.5 years (standard deviation = 14.7) and 377 patients (94.2%) had insurance coverage. The majority of respondents were housewives (39%), had diploma education level (42.7%), lived in urban areas (97.5%) and 47 (11.8%) of patients had complementary health insurance.

Indications and contraindications of MRI in patients with LBP

From 400 patients, 187 patients (46.7%) had indications for MRI and 186 patients (46.5%) had no indications for MRI. A further 18 patients (4.5%) had indications and contraindications at the same time and nine patients (2.3%) only had contraindications for MRI. In other words, 187 patients (46.7%) had appropriate use of MRI for LBP (had indications and no contraindications) and the remaining 213 patients (53.3%) had inappropriate use of MRI (had no indications or had contraindications).

From 27 patients (6.8% of all patients), that performed MRI with contraindications, 10 patients (2.5%) had certain otic implants, followed by nine patients (2.3%) ferromagnetic cardiac pacemakers and defibrillators, six patients (1.5%) ferromagnetic foreign bodies in critical locations, e.g. the eye, two patients (0.5%) implanted pump and no ferromagnetic intracranial aneurysm clips or stents, coils and filters were seen in patients.

From 205 patients that had indications for MRI, 74 (18.5%) performed MRI because of LBP lasting longer than 6 weeks, followed by trauma (12.2%) [Table 2].

A significant relationship was found between age and performing MRI due to trauma, osteoporosis, immune-suppression and diabetes. In patients with trauma MRI was performed 4 times more in patients with 11-20 years compared to other age groups ($P < 0.0001$). In patients with osteoporosis or compression fracture MRI was performed 2.5 times more in patients over 50 years compared with other age groups ($P = 0.013$). In patients with immuno-suppression and diabetes MRI was performed 3.5 times more in patients over 50 years compared to other age groups ($P = 0.002$).

Factors affecting the use of MRI in patients with LBP

Of 400 MRI tests, 149 (37.2%) were requested by neurologists, followed by 132 (33.0%) orthopedists, 77 (19.2%) neurosurgeons, 10 (2.5%) physical medicine and rehabilitation specialists, 8 (2.0%) emergency physicians, 5 (1.3%) general surgeons, 5 (1.3%) oncologists, 4 (1.0%) rheumatologists and 10 (2.5%) other specialist physicians.

In addition to the LBP, a proportion of patients had pain in other sites of their body. The most common site of pain after LBP were "leg pain," "pelvic pain," "leg and pelvic pain," and "back, hand and shoulder pain," which were reported by 182 (45.5%), 32 (8.0%), 50 (12.5%) and 26 (6.5%) patients, respectively. Results indicated that 110 (27.5%) of participants did not cite any reasons for having MRI tests in addition to LBP.

Leg pain in aged over 40 years was statistically significant based on Chi-square statistical tests and correlations between variables ($P < 0.0001$).

Furthermore, pelvic pain ($P < 0.0001$) and leg pain ($P < 0.0001$) in housewives and employees were statistically significant.

Two hundred and eighty three (70.8%) patients did not receive any treatment for back pain prior to MRI. Among patients with prior treatment, 36 (9.0%) patients had drug treatment, 17 (4.2%) patients treated with rest and medication, 16 (4.0%) patients had surgery and 13 (3.2%) had received physiotherapy treatment [Table 3]. Patients with insurance coverage had received treatment for back pain prior to MRI about 3.5 times more than people without insurance coverage ($P = 0.007$).

Table 2: Patients with indications and contraindications at the same time for utilization of MRI (*n*=400)

Reason for MRI	Indications	Contraindications
	N (%)	*N* (%)*
LBP duration longer than 6 weeks**	74 (18.5)	0 (0.0)
Trauma	49 (12.2)	11 (2.7)
Immuno-suppression, diabetes mellitus	35 (8.8)	6 (1.5)
Prior surgery	25 (6.2)	5 (1.2)
Osteoporosis or compression fracture	19 (4.8)	3 (0.8)
History of cancer	17 (4.2)	3 (0.8)
HIV	11 (2.8)	4 (1.0)
Prolonged use of corticosteroids	7 (1.8)	0 (0.0)
Unexplained weight loss, insidious onset	4 (1.0)	0 (0.0)
Unexplained fever, history of urinary or other infection	3 (0.8)	0 (0.0)
Focal neurologic deficit (s) with progressive or disabling symptoms, cauda equina syndrome	2 (0.5)	0 (0.0)
Sphincter or gait disturbance	1 (0.2)	0 (0.0)
Total (indications/contraindications)	247	32
Patient with three indications simultaneously	5 (1.3)	4 (1.0)
Patient with two indications simultaneously	32 (8.0)	6 (1.5)
Patient with one indication	168 (41.9)	8 (2.0)
Patients with indication	205 (51.2)	18 (4.5)
No indications	195 (48.8)	9 (2.3)
Total	400 (100.0)	27 (6.8)

*The declared percentages are from the total sample, **If low back pain is not responding to treatment and the pain is getting worse instead of better. MRI=Magnetic resonance imaging, LBP=Low back pain, HIV=Human immunodeficiency virus

Table 3: Patients treatments before having MRI test (*n*=400)

Treatments	Frequency	Percentage
No treatments	283	70.8
Drug treatment	36	9.0
Surgery	16	4.0
Physiotherapy	13	3.2
Complete bed rest	8	2.0
Physiotherapy and drug treatment	18	4.5
Complete bed rest and drug treatment	17	4.2
Drug treatment and surgery	6	1.5
Physiotherapy and surgery	2	0.5
All of the treatments	1	0.3

MRI=Magnetic resonance imaging

353 (88.2%) patients had not consulted with a specialist in rehabilitation medicine before referral to diagnostic centers and MRI. Women and men constituted 72% and 28% of those who had consulted with a rehabilitation medicine specialist (47 patients) respectively that based on Chi-square test, this difference is statistically significant (P = 0.037), but no significant differences between age, occupation, education, place of residence and insurance coverage were observed ($P > 0.05$).

Among visitors to MRI centers, 390 (97.5%) referred due to physician advice and 10 (2. 5%) due to family or own discretion.

In this study, 329 (82.2%) patients had no history of previous MRI during the last 2 years while 71 (17.8%) patients underwent MRI for LBP during the past 2 years that among them 45, 17 and 9 cases experienced MRI once, twice and more than 2 times respectively. Patients with complementary private insurance had a history of previous MRI about 20% more than other patients (P = 0.018). Furthermore, there was a statistically significant relationship between complementary private insurance coverage and number of MRI performed (P = 0.006). Among them, 14 patients (19.7%) expressed that their previous MRI result was normal.

Factors contributing to having indications for MRI are shown in Table 4.

Table 4 shows that there was a significant relationship between hospital ownership, receiving treatment prior to MRI, having a history of

Table 4: Determination of the effective factors on indication of performing MRI by using logistic regression method

Variable	Condition	Indication		OR	CI (95%)	*P* value	Logistic regression		
		Yes *n*=205	No *n*=195				OR	CI (95%)	*P* value
Gender	Man	86	81	1	-	-	1	-	-
	Woman	119	114	1.02	0.68-1.51	0.93	1.13	0.64-2.00	0.67
Age	≤20	10	7	1.17	0.42-3.26	0.76	0.54	0.16-1.84	0.32
	21-30	15	30	3.35	1.65-6.80	0.001	1.74	0.60-5.04	0.31
	31-40	36	49	2.28	1.31-3.95	0.003	1.53	0.67-3.50	0.31
	41-50	57	57	1.67	1.01-2.77	0.04	1.17	0.57-2.38	0.67
	51≤	87	52	1	-	-	1	-	-
Education level	Illiterate	35	20	1	-	-	1	-	-
	Primary and secondary school	65	63	1.70	0.89-3.25	0.11	1.70	0.71-4.00	0.23
	Diploma	80	91	2.00	1.06-3.72	0.03	1.98	0.76-5.17	0.16
	Academic degree	25	21	1.47	0.66-3.27	0.34	3.25	0.92-11.45	0.07
Health insurance	Yes	195	182	1	-	-	1	-	-
	No	10	13	1.40	0.60-3.25	0.44	0.50	0.18-1.40	0.19
Complementary health insurance	Yes	28	19	1	-	-	1	-	-
	No	177	176	1.47	0.80-2.72	0.22	1.46	0.64-3.34	0.37
Hospital ownership	Private	30	70	1	-	-	1	-	-
	Public	175	125	0.31	0.19-0.50	<0.001	0.48	0.26-0.90	0.02
Physician specialty	Neurologist	63	86	1	-	-	1	-	-
	Neurosurgeon	53	24	0.33	0.18-0.59	<0.001	0.34	0.16-0.72	0.005
	Physiatrist	5	5	0.73	0.20-2.64	0.63	1.52	0.21-10.71	0.67
	Orthopedist	65	67	0.67	0.41-1.09	0.11	0.80	0.41-1.51	0.48
	Other specialist physicians	19	13	0.50	0.23-1.09	0.08	0.45	0.18-1.14	0.09
Treatment before MRI	Yes	111	6	1	-	-	1	-	-
	No	94	189	37.20	15.78-87.72	<0.001	28.68	11.29-72.86	<0.001
Previous MRI	Yes	60	11	1	-	-	1	-	-
	No	145	184	6.92	3.51-13.65	<0.001	2.91	1.21-6.97	0.02
Consulting with a specialist in rehabilitation medicine	Yes	37	10	1	-	-	1	-	-
	No	168	185	4.07	1.97-8.45	<0.001	1.25	0.39-3.95	0.71

*A *P* value less than 0.05 is statistically significant, MRI=Magnetic resonance imaging, CI=Confidence interval, OR=Odds ratio

previous MRI and specialty of a physician who prescribed MRI with having appropriate use of MRI ($P < 0.05$). The risk of inappropriate use of MRI in the private hospitals was about 2 times more than in public hospitals. Also the risk of inappropriate use of MRI in patients who did not receive treatment before MRI was about 29 times more than in people who received treatment. The risk of performing MRI without indication in people who did not have a history of previous MRI was 3 times more than in people with previous MRI. The risks of inappropriate use of MRI in patients who refer by neurosurgeons are one-third of patients who refer by neurologists. The last two cases may be as a result of the severity of LBP.

Factors contributing to having contraindication for MRI are shown in Table 5.

Table 5 shows that there was a significant relationship between factors such as gender, age and receiving treatment prior to MRI with having contraindication for MRI ($P < 0.05$). The risk of not having contraindication for MRI in women was 3 times more than in men. Also in patients who did not receive treatment before MRI is 3 times more than people who received treatment. The risk of performing MRI without contraindication in people aged less than 40 is about 6 times more than in people over 50.

A further point is that we used 2 models for Logistic regression analysis. In the first model all

Table 5: Determination of the effective factors on contraindication of performing MRI by using Logistic regression method

Variable	Condition	Contraindication		OR	CI (95%)	*P* value	Logistic regression		
		Yes *n*=27	No *n*=373				OR	CI (95%)	*P* value
Gender	Man	16	151	1	-	-	1	-	-
	Woman	11	222	2.14	0.97-4.74	0.06	3.11	1.81-8.21	0.02
Age	≤40	3	144	7.14	2.05-24.82	<0.001	5.71	1.42-22.95	0.01
	41-50	6	108	2.86	1.03-7.00	0.04	1.40	0.45-4.28	0.56
	51≤	18	121	1	-	-	1	-	-
Education level	Illiterate	7	48	1	-	-	1	-	-
	Primary and secondary school	9	119	1.93	0.68-5.47	0.21	1.86	0.53-6.51	0.33
	Diploma	8	163	2.97	1.02-8.61	0.04	3.73	0.95-14.61	0.06
	Academic degree	3	43	2.09	0.51-8.60	0.30	2.06	0.37-11.38	0.41
Health insurance	Yes	27	350	1	-	-	1	-	-
	No**	0	23	-	-	0.19	-	-	-
Complementary health insurance	Yes	4	43	1	-	-	1	-	-
	No	23	330	1.35	0.44-4.04	0.61	1.14	0.32-3.98	0.83
Hospital ownership	Private**	0	100	1	-	-	1	-	-
	Public	27	273	-	-	0.002	-	-	-
Physician specialty	Neurologist	10	139	1	-	-	1	-	-
	Neurosurgeon	8	69	0.62	0.23-1.64	0.33	0.62	0.20-1.90	0.40
	Physiatrist	1	9	0.65	0.07-5.63	0.70	1.30	0.06-25.97	0.86
	Orthopedist	7	125	1.11	0.41-3.01	0.84	1.34	0.44-4.05	0.61
	Other specialist physicians	1	31	2.23	0.27-18.07	0.44	4.71	0.51-43.94	0.17
Treatment before MRI	Yes	17	100	1	-	-	1	-	-
	No	10	173	4.64	2.06-10.47	<0.001	3.11	1.16-8.29	0.02
Previous MRI	Yes	5	66	1	-	-	1	-	-
	No	22	307	1.06	0.39-2.90	0.91	0.41	0.12-1.36	0.15
consulting with a specialist in rehabilitation medicine	Yes	6	41	1	-	-	1	-	-
	No	21	332	2.31	0.88-6.06	0.08	1.81	0.51-6.40	0.36

*A *P* value less than 0.05 is statistically significant, **Because the cell count in the table was zero, the calculation of OR was not possible, MRI=Magnetic resonance imaging, CI=Confidence interval, OR=Odds ratio

variables were entered in Logistic regression and in the second model just the variables with a $P < 0.2$ were entered in regression. Whereas, the results of two models were approximately the same, we reported the first model results in Tables 4 and 5.

DISCUSSION

Lehnert and Bree found that 26% of medical images ordered by physicians were inappropriate. They also found that 35% of patients with LBP perform MRI without indication and without any conservative therapy before MRI.[20]

We found that about 7% of the patients undergoing MRI for LBP had contraindications for MRI. The Canadian Radiology Association has set standards for MRI and all contraindication items are asked of the patient using the standard form.[7]

We found that more than 70% of patients have been referring for MRI had no prior treatments such as medication, rest and physical therapy. This is against many of MRI guidelines.[15,18,21]

A recent study showed that a health system that places physical therapists as first providers for back pain has the ability to decrease over usage of limited and valuable resources. In addition, physical therapists have an important role in educating the patient and medical staff on appropriate use of imaging technologies.[15]

The experience of the Virginia Mason Medical Centre in Seattle, WA in refinement the care procedures for patients with LBP in the year 2004

showed that implementing an evidence-based guideline with physical therapy at the first stage led to reduction in the number of people with LBP who receiving an MRI from 15 to 10% in a year. Moreover, the cost of an episode of care was reduced from the $2100-$2200 to the $900-$1000 range.[22]

In our study, the specialties of the physicians ordering an MRI for LBP contained neurologists order 37.2% of all MRI scans, orthopedists 33%, neurosurgeons 19.2%, physical medicine and rehabilitation specialists 2.5% and emergency physicians 2%.

The primary analysis of MRI scans in Ontario showed that the specialties of the physicians ordering an MRI for LBP contained neurologists order 22.2% of all MRI scans, family physicians 24.2%, orthopedic surgeons 15.2%, neurosurgeons 13.5%, physical medicine and rehabilitation specialists 6.1%.[23] So most MRI tests prescribed by family physicians who know about patient history of LBP.

The primary analysis of MRI scans in Ontario showed that the frequency of repeat MRI scans was about 15% within 2 years.[23]

Our results show that about 18% of patients had a previous MRI for LBP within the last 2 years and 20% of these MRIs have been normal (14 cases). Access to complementary insurance had significant correlation with a number of MRI performed.

Applying clinical practice guidelines (CPGs) in the decision making process can help to improve the appropriate use of these diagnostic technologies. To the best of our knowledge, there are no national guidelines for referring patients with LBP to perform an MRI. A study in Iran on barriers of CPGs development and implementation illustrated that the lack of an evidence-based health-care system and a political macro support are the key barriers to produce and implement the CPGs.[24]

CONCLUSIONS

According to the results, about half of the patients referring to radiographic centers with LBP for MRI, had no indication for this test.

The results of this study might help the health policy makers to develop national guidelines toward appropriate use of health technologies and pay more attention to cost-effectiveness and cost-benefits of health technologies. Health insurance organizations could play a major role toward more appropriate use of health technologies and reducing health expenditures.

Increase number of advanced medical equipments in the public and private sectors also generates induced demand in the patients and increases inappropriate use of such costly equipments greatly.

The use of best practice guidelines to manage the flow of patients who need an MRI will help improve proper access to this diagnostic technology and decrease health-care costs. Culture building and education in the community can also play an important role in reducing the demand for unnecessary diagnostic services.

Study limitations

Our study has some limitations that restrict the generalizability of the results. The majority of patients was urban and had insurance coverage and the results are based on hospitals and imaging centers of Tehran city, so other studies must be managed in other parts of the country to increase the generalizability of results of this study. Moreover, it is possible that we have excluded some indications for which we could not make the consensus in the expert panel and this might has leads to a slight overestimation of the inappropriate use of MRI and thus, results must be used with cautions.

Ethical concerns

This study was approved by the Institutional Review Board, Tehran University of Medical Sciences. Administrative approval was also granted for conducting the study at the hospitals and imaging centers. Verbal consent was obtained from participants after providing adequate information about the significance and aim of the study. Participants were assured that their participation was voluntary and their responses would be treated with confidentiality.

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