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Overuse or underuse of MRI scanners in private radiology centers in Tehran

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Objectives: The semiprivate health system in Iran has created an opportunity for unnecessary uses of advanced medical equipments including magnetic resonance imaging (MRI). This study aimed to evaluate the evidence for MRI overuse in private diagnostic imaging centers in Tehran, Iran. The objectives of this study were to determine the frequency of use of MRI scans for different complaints and to explore frequency of normal MRI findings as a function of unnecessary MRI use.
Methods: We conducted a survey among private MRI centers in Tehran, Iran, to study the proportion of MRI scans that may result in significant clinical finding. All MRI reports at a specific point in time at selected MRI centers were reviewed by a physician and the findings were recorded as normal, abnormal, or substantial changes.
Results: Of all the MRI reports, 17.2 percent had resulted in normal findings; 9.8 percent ordered for examination of headache, and 4.8 percent for lower back pain.
Conclusion: Unnecessary MRIs are most likely to result in normal finding; although not all the MRI with normal results could be identified as unnecessary. Negative findings from MRI scans may be reassuring to both clinicians and patients. The proportion of normal findings in MRI scans did not provide evidence of MRI overuse in Iran. The results of this study warrant formation of guidelines for the use of MRIs for headache and low back pain disorders.

Keywords: Magnetic resonance imaging, Health expenditures, Health policy, Utilization, Iran

Healthcare expenditure is affected by the size of a population as well its demographics, medical care price, medical utilization rate, and high-tech medical utilization (5). Among the preceding factors advanced medical equipment utilization may be one of the most important factors that may influence healthcare expenditure (6). Magnetic resonance imaging (MRI) is a high technology medical imaging equipment that has been widely used in the medical field since the 1980s. MRI has become a popular diagnostic tool because of its

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accuracy and low radiation emission. The public's increasing access to health information and their exposure to private health facilities that offer MRI technology, has also contributed to their increase in use.

Hospitals in the private sector have incentives to purchase expensive high-tech equipments to attract more patients and, thus, generate more revenues (9). MRI scanners became available in the early 1990s in Iran. Initially the scanners were only available in tertiary level and university teaching hospitals. Gradually, private health facilities started acquiring this technology and made it available to the general public.

The Health Care system in Iran is a combination of both public and private systems in urban areas and a referral system in rural areas. The private system allows patients to choose their healthcare provider and even allows them to receive medical care from several providers at the same time. As such, some private healthcare providers may readily offer MRI technology without restrictions.

Patients' demand for medical services may be influenced by the cost of the services. On the other hand, patients' demand for medical services is less likely to be influenced by the cost of service when a patient is faced with low user fees (5). Most insurance providers in Iran cover MRI related expenses leaving approximately 25–30 percent of the expenses to the patients. As a result, most patients find MRIs as both accessible and affordable medical intervention.

Because private healthcare providers expect a substantial and speedy return on their equipment investment and also reduce the probability of medical malpractice, there is potential space for "supplier induced demand" situations that increases utilization of MRIs. In the United States (US) the break even volume, defined as the number of examinations needed to meet costs of an MRI facility, is estimated to be approximately 1,400 examinations (1). This value is much higher in Iran; the average cost of a single noncontrast MRI in Iran is approximately $78 (US) and its direct expenses for imaging center are estimates to be approximately 24 USD. On the other hand, the cost of a MRI scanner in Iran is similar to that in the United States (i.e., $1–1.5 million), depending on the type and brand of the MRI. Consequently, this might encourage private radiology centers to perform a higher number of MRIs to break even faster and make profit.

Healthcare expenditure is influenced by the number of health providers in a particular setting. It has been shown in the United States that when the number of practicing physicians increases a higher number of healthcare resources are used (2). Similarly, it has been demonstrated that factors such as hospital physicians to population ratio, MRI units to population ratio and family income, all affect MRI utilization (5). In Iran, the number of medical practitioners has been steadily increasing in the past 20 years. According to the Iranian medical council, roughly 94,000 medical doctors are registered as medical practitioners in Iran. Given Iran's population of 70,472,846 (8) (as of 2006) the doctor to population ratio is approximately 1:750 indicating a significant increase in the past 15 years.

From 1993 to 2003, there has been a twenty-fold increase in the number of MRI units per million inhabitants in Iran (7) and 67 percent of them are installed in private health facilities (7). We, therefore, sought to explore the prevalence of MRI overuse in private clinics in Tehran, Iran.

MATERIALS AND METHODS

This study was a survey among private MRI centers in Tehran. Data were gathered using a two-step random sampling method.

The first step was a cluster random sampling among MRI reports in private MRI centers in Tehran; five MRI centers were randomly selected. The second step involved systematic random sampling over time. We systematically selected 1 month (July to November 2005) for every center. When we gathered the reports of 1 specific month at a specific center, we omitted that month's reports from all other centers.

All MRI reports were reviewed by a physician and findings were recoded as normal, abnormal, or substantial changes identified. MRI reports indicating no anatomical or physiological abnormality were recoded as "normal." Reports indicating abnormal findings that emerged either medical or surgical treatment were recoded as "abnormal." Minimal abnormalities which were deemed clinically insignificant and required no further interventions were recorded as "substantial changes identified."

Data were entered by two different investigators. Any discrepancies were resolved by looking at the original MRI reports. For categorical data analysis, Chi-squared statistics and Fisher's exact test were used. Other descriptive statistics were also performed using STATA (version 8). Charts were generated by SPSS 13. The Study protocol was approved by the Ethics Committee at The Ministry of Health and Medical Education.

RESULTS

All the MRI centers agreed to participate in this study and provided data. In total, 1,650 MRI reports were collected through five private radiology centers. Each center contributed 17.5 percent to 22.5 percent of the total sample size. The mean age of the men, who constituted 47 percent of the total patient population, was 40 $\pm$ 17 years. Women constituted 53 percent of the studied cases, and their mean age was 44 $\pm$ 16 years. Approximately, 94.4 percent of the MRI scans were of the spine, brain, or the extremities (Table 1).

Low back pain was the most frequent patient complaint that led to MRI scan of the spine (94.7 percent), followed by paresthesia (4.4 percent) and trauma (0.7 percent).

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Table 1. Distribution of Body Regions among Studied MRI Reports

Body region	Frequency	Percent
Abdomen	36	2.2
Brain	459	27.8
Head (other than brain)	11	0.7
Limbs	263	15.9
Pelvis	3	0.2
Spine	836	50.7
Thorax	5	0.3
Other	37	2.2
Total	**1650**	**100**

Table 2. Distribution of MRI Use in Brain Region by Disorder

Sign or symptom	Relative frequency (%)	Cumulative frequency (%)
Headache	61.1	61.1
Vertigo	15.4	76.5
Mass	9.3	85.8
Stroke	7.4	93.2
Paresthesia	4.9	98.1
Visual impairment	.6	98.7
Trauma	.6	99.3
Ataxia	.6	99.9

Headache was the most frequent symptom that was evaluated by a MRI scan of the brain region. Table 2 illustrates the different reasons for which MRIs were used in brain region.

Evaluation of pain was the most common reason for which a MRI scan was ordered for the upper and lower limbs (93.9 percent), followed by trauma (4 percent) and paresthesia (2 percent).

Of all the MRI reports, 17.2 percent had normal findings while 54.6 percent of the reports had abnormal findings. Approximately 28 percent of the reports had indicated substantial changes (Table 3). MRI reports from the spine, limbs, and abdomen showed more frequent abnormal findings than MRI scans of other regions (Table 3). Among the three regions most commonly examined by MRI, abnormal findings in the spine were the most common, whereas in brain were the least common ($p < .05$). Among the MRIs that were ordered for the brain, patients who were referred for evaluation of trauma represented the most frequent abnormal findings followed by stroke and paresthesia (Table 4). Normal reports in patients complaining from headaches, constituted 9.8 percent of total demand for MRI scans. This number was computed by multiplying the percentage of Brain MRIs (27.8 percent) of which 61.1 percent were ordered for headaches. Among those ordered for headaches 57.7 percent had normal findings (27.8 percent × 61.1 percent × 57.7 percent = 9.8 percent).

Table 4. MRI Results in the Brain Region by Disorder Type

Reason for MRI prescription	Findings in MRI of brain		
	Normal	Substantial changes	Abnormal
Trauma	0%	0%	100%
Stroke	18%	0.2%	81.8%
Paresthesia	37.5%	12.5%	50%
Suspected mass	53%	0.3%	46.7%
Vertigo	32%	32%	36%
Headache	57.7%	9.3%	33%
Ataxia	1%	98.9%	0.1%
Visual impairment	99.6%	0.3%	0.1%

Indeed, 59 percent of all of the normal MRI reports (which constitutes 17 percent of all scans) were from the brain region MRI in view of the fact that 27.8 percent of all the studied MRI reports belonged to brain region (Table 1) and 35.8 percent of these reports had resulted in normal report (Table 3).

Normal reports in patients complaining from low back pain, constituted 4 percent of total demand for MRIs in view of the fact that 8.3 percent of MRIs ordered for spine region had resulted in normal findings (Table 3), while low back pain was the cause of MRI orders in 94.7 percent of the spine region which in turn constituted 50.7 percent of all MRI reports (8.3 percent × 94.7 percent × 50.7 percent = 3.99 percent).

DISCUSSION

The Health Care system in Iran has created an opportunity for MRI overuse. We studied the number of MRI scans resulting in Normal findings as an indicator of its overuse in Iranian capital, Tehran. Unnecessary MRI is most likely to result in normal findings rather than abnormal, although not all MRIs with normal result could be considered unnecessary.

We did not find strong evidence of vast overuse of MRI in our setting. Only a small fraction of MRI reports (17 percent)

Table 3. Distribution of Abnormal MRI Findings in Different Regions

MRI result	Region							
	Abdomen	Brain	Head	Limbs	Spine	Thorax	Pelvis	All
Normal	22.2%	35.8%	18.2%	12.2%	8.3%	20.0%	33.3%	**17.2%**
Substantial changes	27.8%	24.4%	54.5%	35.1%	27.3%	79.8%	66.6%	**28.2%**
Abnormal	50.0%	39.8%	27.3%	52.7%	64.4%	0.2%	0.1%	**54.6%**

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in our study yielded normal results. The most frequent MRIs with normal findings were observed in the brain region and the most common indication for brain MRIs were headaches (Table 2). In addition, the most frequent number of "normal finding" of MRIs in the brain region belonged to patients suffering from headaches. The percentage of normal findings for headaches in our study was deemed to be similar to findings from other studies. For example, Jordan et al. showed that 50 percent of MRI examinations that were ordered to work up adults' headache had resulted in normal findings. In the same study, only 1.5 percent of MRI scans resulted in a clinically significant finding (4). Cooney et al. showed that abnormal brain MRI findings were present in only 16 percent of patients with migraine. This value would be as low as 6 percent among those with no existing risk factors for migraine (3). A similar study by Tsushima and Endo indicated 55 percent normal findings and 44 percent minimal changes in patients with recurrent headache in Japan (10). These results are similar to our findings, although we found slightly higher percentage of normal findings among those diagnosed with headache compared with both the US and Japanese studies (8;10).

Controlling the use of MRI for all signs and symptoms is not practical. Demand management protocols should focus on specific signs or symptoms that are common and when worked up by means of MRI, a small percentage of patients represent abnormal findings. In this manner, implementation of a few clinical practice protocols would prevent majority of unnecessary MRI investigation. Development of clinical practice guidelines for prescription of MRI for headache appears to be necessary. Using suitable guidelines for this single symptom might reduce total demand for MRI use up to 9 percent. Moreover, development of effective guidelines to prescribe MRI for work up of low back pain might reduce total demands for MRI use by up to 4 percent.

Our study is subject to limitations. Due to the study design, we were not able to evaluate whether the MRI scan was necessary for every single patient. However, similar frequency of normal findings in MRI scans compared with other studies diminishes the concern about over use of MRI in general. Negative MRI scans may also be beneficial to clinicians and patients. Such findings may alleviate patients' concerns and prevent unnecessary follow-up interventions.

The ratio of MRI units to population in Tehran is the highest in the country (7); therefore, lack of evidence of overuse in this area makes it less likely to face MRI overuse in other provinces or regions in the country. There is a need for studies specifically designed to evaluate the suitability of MRIs for headache and low back pain in light of our findings that the majority of MRI reports for these conditions result in normal findings. There is also a need for management protocols to take different approaches in the case of abnormal MRI findings.

CONCLUSION

The proportion of MRI scans with normal findings was not critically high; therefore, we did not find evidence of MRI overuse in Tehran where the MRI units to population ratio is highest in the country. There is still need for specific studies evaluating indication of MRI for individual patients. Using effective clinical practice guidelines for prescription of MRI for headache and low back pain seems essential.

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