Today or tomorrow? A retrospective analysis of the clinical indications used to request urgent magnetic resonance imaging of the spine

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ABSTRACT

INTRODUCTION The finite resources available to National Health Service institutions require clinicians to order investigations that are not readily available appropriately. This is particularly true for the radiological assessment of patients presenting with features pertaining to acute spinal cord dysfunction. Such cases conventionally require urgent magnetic resonance imaging (MRI) which is sometimes performed 'out-of-hours'. There is evidence to suggest, however, that a high proportion of patients do not have a structural abnormality on MRI to account for their clinical findings, and consequently the majority of scans that are requested urgently are normal. The primary aim of this study was to determine whether any clinical feature(s) could accurately predict the presence of a structural abnormality on MRI. As a secondary objective, the ability of such features to predict the need for spinal surgery was assessed.

PATIENTS AND METHODS A retrospective analysis of consecutive patients who warranted urgent MRI was conducted. Eighty-one patients were eligible for study. The Fisher's test was used for statistical analysis of all data. A *P*-value of less than 0.05 was considered to be significant.

RESULTS MRI was performed within 24 h of admission in 16 patients, and of these, seven had surgery within 24–48 h. Only two patients were found to have significant neurological compromise. Despite both a history and examination suggesting otherwise, MRI was normal in 10 patients (12%).

CONCLUSIONS We were unable to elucidate any clinical features that were able to predict the presence of an abnormal MRI. We did find, however, that patients with a combination of both subjective neurological findings and positive neurological signs (*P* = 0.02), saddle anaesthesia and/or decreased anal tone (*P* = 0.03) or sciatica (*P* = 0.02) had pathology on MRI that warranted surgical intervention. The authors recommend that the aforementioned features formulate the basis of guidelines used to request and/or perform MRI urgently since they are highly suggestive of surgical intervention. Conversely, patients who do not exhibit the above examination findings might not require either an urgent or 'out-of-hours' scan, but could potentially be investigated less expediently and/or wait until 'normal working hours'.

KEYWORDS

Magnetic resonance imaging – Spine – Surgical procedures

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The finite resources available to National Health Service institutions require clinicians to order investigations that are not readily available appropriately. This not only minimises the strain placed upon the provision of essential services, but also facilitates the performance of urgent investigations. This is particularly true for the radiological assessment of patients that present with features pertaining to apparent acute spinal cord dysfunction. Such cases normally mandate magnetic resonance imaging (MRI); however, the timing of the scan remains a contentious issue,

particularly since many are requested and/or performed 'out-of-hours'.

The urgency with which spinal MRI is requested and subsequently performed is dictated solely by clinical assessment. That being said, the group of patients in question can present with a variety of symptoms and examination findings that represent different degrees of severity and pathological significance. Accordingly, several clinical indicators requiring urgent investigation have been recognised.¹ These include neurological dysfunction, sensory distur-

bance in the saddle area and loss of bladder or bowel function.² There is evidence to suggest, however, that a high proportion of patients do not have a structural abnormality to account for their clinical findings and thus the majority of scans requested urgently are, in fact, normal.²⁻⁴ Consequently, radiological services are placed under unnecessary pressure to perform urgent scans due to the possibility of permanent loss of function associated with delayed diagnosis.⁵⁻⁷ Since existing services are already under considerable financial constraints, the pressure to perform seemingly urgent scans, some during 'out-of-hours', may compound issues even further.

Due to the vast quantity of urgent spinal MR scans that are requested, it is important to identify patients that are likely to have a structural abnormality responsible for their clinical findings so that they may be prioritised. There are few studies though that scrutinise the clinical indications for requesting urgent MRI of the spine with the intent of determining features associated with a structural abnormality.^{2,3} Furthermore, there have been none to date that have examined whether any of the individual features themselves are predictive of surgery. The early identification of patients likely to undergo operative intervention based on clinical examination would not only justify performing an immediate MRI, but also permit earlier pre-operative planning and minimise the delay to surgery.

The primary aim of this study was to review retrospectively the clinical indications for all spinal MR imaging that was requested urgently and determine whether any clinical features could accurately predict the presence of a structural abnormality. This would provide guidance as to when such imaging should be requested and/or performed urgently, particularly during 'out-of-hours'. In doing so, resources may be used in a more prudent manner. A secondary objective was to measure the ability of such features to predict the need for spinal surgery.

Patients and Methods

We undertook retrospective analysis of consecutive patients for whom urgent spinal MRI was requested over a 12-month period between March 2006 and March 2007. All scans were performed within the radiology department of a large university teaching hospital. Participants were identified using a computerised image register at our institution. Criteria for inclusion into the study were the presence of complete medical charts and images that had been reported by a radiologist. Medical charts were then reviewed to identify duration of symptoms, clinical features in the history, clinical features on examination, result of the scan and the urgency and type of treatment provided. Standard demographic information was also collected. Initial recording of the data onto medical charts was performed by several medical

teams whereas the retrospective analysis was performed solely by the authors.

Upon hospital admission, all patients were assessed by the duty medical team. On the basis of clinical findings, MR imaging was requested. Clinical features were subdivided for analysis. Urinary symptoms were classified as acute incontinence, retention, frequency and other. Bowel symptoms were divided into acute incontinence and change in bowel habit. Abnormalities in neurology were categorised as either subjective neurological findings or positive neurological signs. The former included those symptoms that the patient would present with such as weakness or sensory dysaesthesia, as opposed to those that could be elicited on clinical examination. Findings of peri-anal/per rectal examination were divided into saddle anaesthesia, decreased anal tone or the presence of both. Finally, the presence of unilateral and bilateral sciatica was also recorded. All MR images were reviewed by a radiologist and classified into six categories: normal, disc prolapse with significant neurological compromise, disc prolapse without significant neurological compromise, degenerative disease, neoplastic and other.

The Fisher's exact test was used for statistical analysis of all data. A *P*-value of less than 0.05 was considered to be significant.

Results

Based on the inclusion criteria, 81 patients were eligible for study. The cohort consisted of 43 women and 38 men with a mean age of 55 years (range, 17–86 years; median, 58 years). Eighteen patients presented to hospital on the day that their symptoms began; however, the median duration of symptoms prior to hospitalisation was 11 days (range, 0–5113 days; mean, 160 days). MR imaging was performed within 24 h of admission in 16 patients; of these, seven had surgery within 24–48 h. The remaining scans were performed within a median of 4 days (range, 0–187 days; mean, 10 days) after hospital presentation.

A focal neurological deficit was noted in 56 patients making it the most frequently encountered abnormality. Of these, 10 patients had positive neurological signs, 17 had subjective neurological findings and 29 had both. Those individuals that had positive neurological signs displayed abnormalities in tone, power and reflexes whereas those who had only subjective neurological findings exhibited sensory dysaesthesia and weakness. Urinary symptoms were second most prevalent and were found in 28 patients. Within this group, nine patients had acute incontinence, five patients had retention, four patients had urinary frequency and 10 patients had other non-specific complaints such as hesitancy, dysuria, dribbling and infective symptoms. The remaining parameters studied were anal/peri-anal

abnormalities, sciatica, back pain and bowel dysfunction. Thirteen patients had anal/peri-anal abnormalities including six that had saddle anaesthesia, four that had decreased anal tone and three that had both. Sciatica was bilateral in six patients and unilateral in 20. Back pain was a predominant symptom in 53 patients. Bowel complaints were least frequently reported with four patients having acute incontinence and six patients describing an alteration in bowel habit.

Despite both a history and clinical examination suggesting otherwise, MRI was still normal in 10 patients. Disc prolapse without significant neurological compromise was the most common pathology being noted in 22 cases. Of these, six occurred at L4/5 and 16 at L5/S1. Although many patients exhibited clinical features suggestive of significant thecal compression, there were no cases of cauda equina syndrome, something that most likely reflects the rarity of the condition.² In two patients there was significant neurological compromise, both of which were due to burst fractures of L1 vertebrae. One such patient underwent urgent posterior stabilisation whereas the other was managed non-operatively in a brace. The scans of 15 patients were characterised by degenerative changes including osteoarthritis, spinal stenosis and osteoporosis. Neoplastic disease was found in nine patients of whom six had known primary lesions. A further 11 patients also had primary neoplastic lesions but had no evidence of spinal metastases. Fifteen patients had other abnormalities comprising of nine cases of trauma, three infections and three intrinsic spinal cord abnormalities. The latter included syringomyelia, vascular compression of the spinal cord and features of multiple sclerosis.

The remaining eight patients had no structural abnormalities of the lumbosacral spine despite having clinical features suggesting otherwise. They did, however, have lesions in other regions of the spinal cord. Three patients were noted to have spinal metastases in the thoracic spine with the remaining five cases consisting of vertebral collapse at T1, degenerative disease in the cervical spine, an epidural abscess at C7/T1, spondylolisthesis at C3/4 and cervical disc prolapse at C3/4 and C4/5.

Sixty-three patients were managed non-operatively of whom 40 received no treatment. The remaining patients received specific oncological therapy, palliative care, medical management, nerve root block or immobilisation with a brace. Spinal surgery was performed in 18 out of 81 patients within the cohort. It was undertaken within 24 h in five cases and after 48 h in the remaining 13 cases. Indications for surgery included 12 cases of lumbosacral disc prolapse without significant neural compression, four vertebral fractures, one case of C3/C4 spondylolisthesis and one case of thoracic vertebral collapse. The most common procedure was a decompression which was carried out on

14 patients. One further patient had a stabilisation and three patients had combined decompression and stabilisation.

Using the Fisher's exact test, we found that patients with both subjective neurological findings and positive neurological signs ($P = 0.02$), saddle anaesthesia and/or decreased anal tone ($P = 0.03$) or sciatica ($P = 0.02$) were likely to undergo surgery. No association could be found between a positive radiological diagnosis and saddle anaesthesia, decreased anal tone, abnormal neurology or urinary/bowel dysfunction. Further details of all variables examined with their corresponding P -values can be found in Tables 1 and 2.

To establish further the accuracy of the aforementioned variables in correctly identifying either a structural abnormality on MR imaging or the need for operative intervention, both

Table 1 The relationship between clinical features and a structural abnormality seen on magnetic resonance imaging

Variable	<i>P</i> -value
Positive neurological signs	1
Subjective neurological findings	1
Positive neurological signs and subjective neurological findings	1
Sciatica	0.72
Saddle anaesthesia ± decreased anal tone	1
Faecal incontinence	1
Change in bowel habit	0.56
Urinary incontinence	1
Urinary retention	0.50
Urinary frequency	1

Table 2 The relationship between clinical features and surgical intervention

Variable	<i>P</i> -value
Positive neurological signs	0.44
Subjective neurological findings	0.75
Positive neurological signs and subjective neurological findings	0.02
Sciatica	0.02
Saddle anaesthesia ± decreased anal tone	0.03
Faecal incontinence	1
Change in bowel habit	1
Urinary incontinence	1
Urinary retention	1
Urinary frequency	1

Table 3 Positive and negative predictive values for clinical features predicting a structural abnormality on magnetic resonance imaging

Variable	Positive PV (%)	Negative PV (%)
Positive neurological signs	12.7	9
Subjective neurological findings	88.2	80
Positive neurological signs and subjective neurological findings	36.6	70
Sciatica	31	60
Saddle anaesthesia ± decreased anal tone	16.9	90
Faecal incontinence	5.6	100
Change in bowel habit	7	90
Urinary incontinence	11.3	90
Urinary retention	5.6	90
Urinary frequency	5.6	100

PV, predictive value

positive and negative predictive values were also calculated (Tables 3 and 4). These illustrate that patients who do not present with either saddle anaesthesia/decreased anal tone, positive neurological signs or acute disturbances in bladder or bowel function are unlikely to have a positive MRI or undergo operative intervention.

Discussion

Clinical assessment formulates the basis upon which MRI of the spine is requested and performed urgently. Nevertheless, given the high proportion of scans that are either normal or do not require operative intervention, it is plausible that an unnecessary strain is placed upon both radiological and spinal surgical services. A rationalisation in the number of these urgent requests would allow for greater attention to be given to other more urgent cases thereby permitting a more economical use of our already strained resources.

In the current study, only 16 patients received an MRI scan within 24 h of hospital admission. The remaining 65 patients, despite having an urgent request for MRI, were only scanned within a mean of 10 days, during which time the majority remained as in-patients. Although it may seem favourable to have discharged these patients whilst they waited for a scan, 11 still underwent surgery and constituted the majority of cases that received operative intervention (11 out of 18). This highlights the limitations of clinical assessment given that patients who were initially thought to

Table 4 Positive and negative predictive values for clinical features predicting surgical intervention

Variable	Positive PV (%)	Negative PV (%)
Positive neurological signs	5.5	85.7
Subjective neurological findings	16.6	77.8
Positive neurological signs and subjective neurological findings	61.1	71.4
Sciatica	55.6	83.1
Saddle anaesthesia ± decreased anal tone	33.3	88.9
Faecal incontinence	5.6	95.2
Change in bowel habit	5.6	92
Urinary incontinence	11.1	88.9
Urinary retention	5.6	93.7
Urinary frequency	5.6	95.2

PV, predictive value

have warranted MRI less urgently than others still underwent surgery as an in-patient. Nonetheless, the high negative predictive values associated with saddle anaesthesia/decreased anal tone and acute disturbances in either bladder or bowel function suggest that their absence confers a low probability of a structural abnormality being found on MR imaging.

Beattie *et al.*⁸ compared the self-reported symptoms of 408 patients undergoing lumbar MRI against the results of the scans. Two hundred and fifty six patients did not show any signs of nerve compression; however, 151 (58%) reported lower limb symptoms suggesting otherwise. It was, therefore, concluded that neither sensory dysaesthesia nor weakness were significantly predictive of any lumbar impairment. To explain the disparity between self-reported symptoms and normal imaging, Rooney *et al.*⁵ postulated that an abnormally persistent physiological response to acute back pain may lead to apparent neurological symptoms in the absence of an organic cause. Visceral dysfunction too may occur as a result of acute back pain and may, therefore, be regarded as a functional symptom. Functional symptoms cannot be explained by disease and are present in up to one-third of new neurology out-patients. Functional paralysis, for instance, has an incidence of 3–5 per 100,000 and has been known to mimic cauda equina syndrome.⁵ This hypothesis may account for no cases of cauda equina syndrome being found in the current cohort despite many patients having examination findings suggesting otherwise. This is in concordance with the existing literature, however, which states that cauda equina syndrome is an uncommon

entity. In one study, it was found that only 22% of patients referred to a tertiary neurosurgical unit with a suspected diagnosis of cauda equina syndrome were confirmed to have it.²

As a secondary objective, we examined whether any single clinical feature could predict the need for spinal surgery. We found that patients with a combination of both subjective neurological findings and positive neurological signs, saddle anaesthesia and/or decreased anal tone or sciatica had pathology on MRI that warranted surgical intervention. Moreover, the high negative predictive values associated with positive neurological signs, saddle anaesthesia and/or decreased anal tone and acute disturbances in either bladder or bowel function imply that their absence confers a low probability of operative intervention.

This is the first study to the authors' knowledge that has investigated any potential association between specific clinical features and operative intervention. Since the same clinical features were not found to be predictive of a structural lesion on MR imaging, this is an unusual result. Nevertheless, such findings do have important ramifications for clinical practice as they should alert the clinician to the possibility of surgery and, therefore, necessary measures should be taken to minimise subsequent delays. This may entail organising immediate MR imaging and informing senior surgeons and relevant theatre personnel earlier than would have been otherwise possible. These findings also emphasise the importance of accurately assessing perianal sensation and anal tone. Anorectal physiological testing, for instance, has been advocated for objectively assessing sphincter function.⁹

Due to the small sample size, it is beyond the scope of the current study to provide a greater in-depth analysis of individual symptoms or combinations of symptoms. This is the main limitation of the results we have presented. Other weaknesses are predominantly due to the method of data collection and study design. Due to the retrospective nature of this study, it is conceivable that data may not have been recorded as diligently as would have been done in a prospective study and thus important findings may have been omitted. Although decisions to perform MRI were made by senior clinicians, these may have been influenced

by the clinical assessments conducted by more junior members of the medical team. Furthermore, with several radiologists interpreting the images there may be a degree of interobserver variability.

Conclusions

Based upon our analysis, clinical assessment is unreliable in determining the presence of a structural abnormality on MRI. However, the combination of both subjective neurological findings and positive neurological signs, sciatica and saddle anaesthesia and/or decreased anal tone was found to be predictive of spinal surgery. The authors recommend that the aforementioned features should formulate the basis of guidelines used to request and/or perform MRI urgently since they are highly suggestive of surgical intervention. Conversely, patients who do not exhibit the above examination findings might not require either an urgent or 'out-of-hours' scan, but could potentially be investigated less expediently and/or wait until 'normal working hours'.

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