The use of magnetic resonance imaging in the assessment of intervertebral disc disease and low back dysfunction

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Abstract: Low back pain and pain derived from the lumbar structures are common causes of disability. An accurate diagnosis of the etiology of the dysfunction is often not possible. The advent of magnetic resonance imaging led to an expectation that it was a non-invasive mechanism for the detection of pain. However, it appears that only limited information can be derived from magnetic resonance imaging in this context, and its use should be confined in most cases to pre-operative assessment in the diagnosis of mechanical pain.

This paper deals with the assessment of 'low back dysfunction' when fusion is being considered. In doing so, the literature in regard to the use of magnetic resonance imaging in the diagnosis of somatic origin low back pain and low back dysfunction is reviewed. Magnetic resonance imaging has a very limited role in the management of lower back disorders.

Index terms: Magnetic Resonance Imaging, MRI, back pain, diagnosis, spinal surgery, fusion.

Introduction

Disorders of the musculoskeletal system are extremely common, and frequently cause impairment and disability. The prevalence of musculoskeletal disease in Australia is high. Twenty nine per cent of Australians have one or more musculoskeletal conditions, and long term back problems are present in 10 per cent of the population, occurring most frequently in the ages 45 to 59. There is no evidence that the prevalence of low back dysfunction (LBD) is decreasing.

There are three possible explanations for the persistence of LBD in the community:

1. Psychosocial factors

It is recognised that compensation and other social and psychological factors play a role in the persistence of LBD. However, it is possible that this point is overstated.

One paper that is used to demonstrate that compensation itself plays a large factor in ongoing disability was a retrospective controlled cohort study demonstrating that pain, disability, psychological disturbance, unemployment and time off work was greater in a group of compensation patients compared to a control group matched for age, type of injury and follow up period. However, this study was unmatched for socio-economic status as well as the nature of the work undertaken by the injured worker prior to his or her work related low back injury.

It has been established that vibration as well as combined lifting and twisting are risk factors for the development of LBD. It is possible that patients with LBD that did not respond to conservative treatment may be subject to those occupational factors. Consequently, the conclusions reached in this paper are questionable.

It is not easy to establish the contribution of compensation or other psychosocial factors to a person's LBD. Waddell has devised tests to assess the contribution of psychosocial factors, however, the inter-observer reliability of some of the signs is modest under the best circumstances.

2. Inadequate Technology

Although it is often possible to reproduce the patient's pain and to block such pain with local anaesthesia, radiological investigations often do not show the lesion responsible for the patient's pain. Myelography, CT scanning and MRI have an established role in the detection of postero-lateral disc prolapse, but their role in the detection of the cause of pain in LBD is unclear.

3. Inadequate Treatment

Even if the cause of LBD can be determined, it seems that the optimal method of treatment is yet to be discovered. Prospective, randomised, long-term studies have not been performed to determine if surgery or other treatments are useful for LBD. Other conservative treatments such as exercises and physical therapy, and more invasive treatments such as zygapophysial joint injections, radiofrequency denervation, 'rhizotomy' and epidural injections are in need of validation.
DEFINITIONS

1. Low Back Dysfunction (LBD)

LBD could be taken to include any abnormality in the function of the back, whether or not it was painful, but for the purposes of this paper, it is a term used to describe pain derived from any innervated structure of the lumbar spine. This definition excludes pain due to nerve root irritation. In this respect, a useful method for classifying pain is to consider it as either radicular or somatic.

Radicular (or neurogenic) pain, is characterised by sharp, at times severe, lancinating leg pain, often unaccompanied by back pain, and usually concentrating distally. (21) Sciatica is a term that is best applied to radicular pain derived from nerve root irritation, or any other problem involving one of the appropriate lumbar nerve roots. Postero-lateral disc prolapse, a common example of a cause of sciatica, is generally well recognised on history and examination, and confirmed by investigations such as myelogram, CT scan, MRI and electromyogram. (22) Sciatica is generally easily managed, either by conservative measures, or by surgery. However, in the total setting of pain derived from the back, sciatica is uncommon, with one recent study suggesting that it accounts for only one per cent of low back problems. (23) Studies on the use of MRI in low back origin pain have mainly concentrated on radicular pain due to nerve root compression by lesions such as disc prolapse and canal stenosis.

In contrast, somatic low back pain with or without referred leg pain is common. (21) Most patients presenting with LBD have either low back pain or a combination of low back and somatic referred pain, rather than true radicular sciatica. (24) Any of the innervated structures of the back can produce pain of somatic origin. Such structures include the annulus fibrosus, (25) zygapophysial joints, dura, ligaments and muscles. Characteristic somatic pain is a deep aching type of pain, spreading at times from the back down the leg, rarely reaching the foot. (21) The pain tends to concentrate proximally, particularly in the back. The physical examination in somatic pain is generally not accompanied by signs of nerve root irritation, such as prominent restriction of the straight leg raising test, or by neurological deficit.

True sciatica (caused by nerve root compression) and referred pain are almost universally confused in the literature. Generally sciatica is defined as any pain in the leg, and no attempt is made to differentiate true radicular pain from the somatic type of pain. (26) Thus, any conclusions about the origins of the more common referred type of pain are flawed. For example, in one study (26) progressive local anaesthesia was used to establish the cause of pain in cases of true sciatica. The involved nerve root and the exposed anterior annulus fibrosus were found to be painful, and most other structures were not. The erroneous conclusion was that zygapophysial joints and other structures were not responsible for low back pain.

Disc prolapse is often erroneously blamed as the cause of pain. In one series 60 per cent of patients attended an orthopaedic clinic with a diagnosis of disc prolapse, although only 11 per cent were shown to have nerve root pain or dysfunction. (27)

2. Disc Degeneration (DD)

DD is the process of alteration of structure and function in the intervertebral disc, characterised by loss of protein, dehydration, and deformation of the annulus fibrosus. (28)(29) In some instances it appears to be a normal ageing process, and age related intervertebral disc degeneration has been demonstrated from the second decade of life. (30) Tears within the annulus fibrosus may also play a significant role in the process of DD, (31) as well as disc degradation in which there is chemical breakdown of nuclear matrix, particularly proteoglycan. (32)

Plain X-ray can detect the subsequent mechanical changes that arise from the process of DD, and the typical changes of osteophyte formation along the edges of the vertebral bodies are called spondylosis and considered to represent DD. (33) MRI can detect DD at an earlier stage, but there is no correlation between pain and degenerative changes.

TECHNIQUES USED TO DETECT LBD

The problem for the clinician attempting to help a patient with disabling LBD is to decide what tests if any should be ordered and how the tests should be interpreted. It is generally accepted that plain X-rays are necessary in spontaneous onset conditions after a period of about 4 weeks, presumably to exclude any radiologically demonstrable conditions such as bone cancer, infection, and fracture. (34)

The role of CT, (35) MRI (36) and myelogram (37) is accepted in the assessment of sciatica. Their high sensitivity seems responsible for this consideration as disc herniation is demonstrated in 90-98 per cent of patients with sciatica, but notice needs to be taken of the low specificity of these tests in the diagnosis of disc herniation as disc herniation is shown in 28-35 per cent of asymptomatic people. (38) It has yet to be established if these investigations have a role in the
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Detection of the cause of somatic LBD. Thus, it seems unlikely that they have a role in the detection of the source of LBD.

1. Plain X-Ray

It is fallacious to assume that plain X-ray changes such as spondylosis, spondylitis, spondylolysis, spondylolisthesis, osteophytosis, zygapophysial joint degeneration and disc space narrowing implicates the disc, or indeed the lumbar spine, as a source of pain. X-ray does not provide satisfactory information about the lumbar spinal components as a cause of LBD at the time of X-ray or at some time in the future.(39-48)

Plain X-rays should be ordered largely to detect fractures and other bony pathology that might be a cause of pain.

2. MRI

An MRI is a reconstruction of a signal that is emitted from a patient after introduction of a radio wave.(49)

The physical basis for MRI involves the interaction of hydrogen bonding, which may be a part of many molecules in many human cells, with an external magnetic field and with an oscillating (radiofrequency) electromagnetic field that is changing as a function of time at a particular frequency.(50) MRI is a useful imaging technique for the lumbar spine as it demonstrates the morphology of the intervertebral disc, which is high in water content in the younger healthy disc, and lower as aging occurs.

MRI can detect DD by a decrease in the signal intensity on some MRI sequences, as DD is accompanied by dehydration.(51-59) DD is best seen on heavily T2-weighted images (TR > 2000m sec, TE 60-90 m sec) using a spin echo technique.(53)(60)

Under these circumstances the pathological areas are shown up as a dark spot. A normal intervertebral disc shows up as white on a T2 weighted spin echo sequence.(61) This is due to the high water content of the normal nucleus pulposus and annulus fibrosus.(62)

A disc with low water content may be represented by a dark signal on a T2 weighted image.

3. Discography

Discography is used to determine the integrity of the intervertebral disc, and to determine if the disc is likely to be the source of a patient's pain.(63)(64) It is particularly useful in the detection of painful annular tears if the tears communicate with the nucleus pulposus.(65)(66)

Discography involves firstly the insertion of a needle under X-ray control into the nucleus pulposus. The insertion of the needle can be painful, and it is often performed under some sedation. Once the needle is in place, dye is injected. The patient is counselled prior to the procedure on the importance of this part of the examination, as he or she needs to identify the site and nature of the pain produced by this injection. The response can include exact reproduction of pain, or degrees of pain from severe to none that ranges in similarity to the pain from partial to no similarity. The questioning should be done at the time of the procedure.

The morphology of the disc is then studied. Sometimes disc material can be seen to leak into the epidural space, suggesting a communication from the within the disc to this area. The disc is then studied on plain AP and lateral X-ray views, and sometimes CT scan views are taken.

Pain reproduction can occur if there are painful abnormalities in the disc, and if the injection of dye causes a pressure effect in the disc. Thus, symptomatic tears that spread from the nucleus pulposus and are confined within the disc are able to be demonstrated on discogram by elicitation of pain reproduction and demonstration of abnormal morphology. Tears that reach the outer part of the annulus fibrosus and communicate with the epidural space are able to be demonstrated by discogram, but pain reproduction is difficult to detect as there is no pressure effect.

Discography can be very painful, and runs the risk of discitis.(67) It seems that the insertion of antibiotic with the injected contrast protects the disc from discitis.(68)

THE CAUSES OF LBD

The intervertebral disc is considered by some the most frequent source of somatic pain.(24)(69) In chronic LBD, the possible origins of pain in chronic LBD can include the zygapophysial joints,(70)(71) sacro-iliac ligaments and joints,(72) dura,(73) muscles,(74) interspinous ligaments,(75) entheses and bone. This section only deals with the disc as a cause of pain, as the discussion concerns the use of MRI and discography in the detection of a painful disc.

The nature of the tissue damage that can cause chronic LBD is disputed: some consider that there is no proven organic cause in chronic LBD.(76) However, clinical and pathological studies seem to indicate that the disc can be a source of chronic LBD.(24)(31)(77) Pain in LBD occurs via the usual nociceptive mechanisms. Chemically induced nociception occurs when the receptors in the peripheral part of the disc are stimulated by released chemicals, and mechanically induced nociception occurs as the small nerve fibres undergo distortion in response to load.(32)
The methods of assessment of patients presenting with LBD include a thorough musculoskeletal history and physical examination and other specialised investigations including plain radiography, CT scan and Magnetic Resonance Imaging (MRI). MRI has advantages over plain radiography and CT scanning in that it does not involve irradiation, and it provides more information about the anatomy, pathology and biochemistry of the spine, and in particular intervertebral disc degeneration.(55)

The disc undergoes degenerative changes throughout life, and the process of degeneration itself does not appear to be painful. Some of these changes reflect normal ageing,(79)(80) and other changes may be related to increased mechanical stress or trauma. DD in asymptomatic people increases with ageing.(52) Using MRI, about 5 per cent of lumbar discs in people under 20 show signs of degeneration, which increases with age so that by 70 most discs are degenerate.(80) Not only does DD increase with age, but the proportion of severely degenerated but painless discs increases with age, as does the proportion of discs with dissimilar pain induced by provocative discography.(81)

MRI has the advantage over myelogram and CT in that it can detect the qualitative and quantitative degree of hydration of the disc. The change in disc morphology that is detectable on MRI largely relates to the changing state of hydration of the intervertebral disc. This state of hydration can be correlated with the level of intact protein within the nucleus pulposus: with ageing the protein in the disc degrades and as a consequence the disc dehydrates. The MRI is able to register this change. The problem with the finding of DD on MRI is that there is no correlation between DD and symptoms.(79)(80)(82)

Another investigation that measures the changing morphology of the intervertebral disc is the discogram. Degeneration is detected on discogram by the demonstration of tears or clefts in the intervertebral disc. The morphology is demonstrated after dye has been placed in the disc and x-rays (or better CT scan) are taken to demonstrate these abnormalities.

Discogram has another role to play, however. Provocative or analgesic discography can reveal whether or not a disc is likely to be responsible for a person's LBD. A strong correlation exists between the extent of annular disruption and pain reproduction using provocative discography, and over 70 per cent of tears or clefts in the outer one third of the annulus are associated with pain reproduction using provocative discography.(69)(83)

LITERATURE REVIEW

Early reports on the efficacy of MRI in relationship to determining the origin of LBD were encouraging. However, these earlier studies only compared discography, demonstrating the morphology of discs, with MRI, and did not consider the correlation between the morphology of the discs seen on MRI and discography, and the provocation of typical pain in discography.(56) There is no doubt that MRI seems to be a sensitive and a specific imaging modality for detecting pathologic biochemical disc changes in the spine of a young adult.(84) There is a high correlation in the identification of the degenerative disc between MRI and discography.(85)

The role of MRI in early identification of DD lead to a school of thought that discography should be abandoned.(86)(87) However, recent information has shown that MRI and discography have different roles in the determination of the origin of back pain, and that for a pre-operative work up for discogenic pain, both tests may be required.(88)

It is known that asymptomatic discs may be abnormal on MRI.(79)(80)(82) One study looked at the correlation between awake discography findings and MRI in the evaluation of symptomatic lumbar disc disease.(88) This study, based on 164 consecutive patients and performed in 1991, produced the following figures:

1. 76% of the abnormal discs reproduced symptoms (by discogram).
2. In 13%, MRI showed abnormal findings and discogram normal findings.
3. 37% of the discs classified as abnormal on MRI were asymptomatic.
4. MRI showed normal findings and discogram abnormal findings in 7%, of which 5% recreated exact symptoms, and 2% caused no pain.

The conclusion from this study was "MRI and discography are necessary components for adequate evaluation of back pain of discogenic origin. Dependence on MRI interpretation of disc integrity may result in significant error both in overtreatment of clinically asymptomatic dessicated discs and undertreatment of clinically significant pathology. Awake discography is a more reliable study for determining the symptomatic disc. Correlation of the patient's history and clinical examination with laboratory studies will result in appropriate treatment for the patient (88)."
A recent study on the usefulness of MRI in the diagnosis of painful lumbar discs has demonstrated a previously unreported correlation between the high-intensity zone (HIZ) in the annulus fibrosus seen on T2 weighted images and discography findings. This finding is of significance because it establishes the first non-invasive method of predicting with a reasonable degree of certainty the presence of a painful internal disc disruption. However, the finding has not as yet been corroborated by other studies.

The HIZ is defined as 'a high-intensity zone (bright white) located in the substance of the posterior annulus fibrosus, clearly disassociated from the signal of the nucleus pulposus in that it is surrounded superiorly, inferiorly, posteriorly and anteriorly by the low-intensity (black) signal of the annulus fibrosus and is appreciably brighter than that of the nucleus pulposus'. It is suggested that the contrast can be best seen 'by viewing the image at arm's length against bright sunlight'.

This study concluded ...'(the HIZ) occurred in 28 per cent of 500 patients undergoing MRI for back pain. The presence of a HIZ correlated significantly with the presence of Grade 4 annular disruption and with reproduction of the patient's pain. Its sensitivity as a sign of either annular disruption or pain was modest but its specificity was high, and its positive predictive value for a severely disrupted, symptomatic disc was 86 per cent. This sign is diagnostic of painful internal disc disruption.'

Another study compared provocative discography with MRI, but no comment was made in respect of HIZ. This may be because it was not recognised as a significant feature, or the MRI machine or settings were insufficient for the detection of the HIZ. All discs shown as abnormal on MRI were degenerate on discography, but of those with a normal MRI, 10 per cent had marked degenerative changes on discogram, and a further 45 per cent had either an inner or outer annular tear.

Although it is considered that the disc is a major cause of LBD, it may be that a substantial cause of LBD is unable to be detected on both MRI and discography. Pathological studies have demonstrated circumferential tears in the annulus fibrosus that do not communicate with the nucleus pulposus. As discography can only demonstrate morphological abnormality if the injected material can reach the abnormal part of the disc, these lesions may be undetectable by conventional tests that attempt to demonstrate pain reproduction and abnormal morphology.

**REASONS FOR APPARENT DISCREPANCIES BETWEEN MRI, DISCOGRAPHY AND PATHOLOGY**

A variety of possible investigation results and clinico-pathological correlations can exist. Some of the MRI and discography findings do represent the exact clinical state, but sometimes the results of either can be falsely positive or negative. Some possible combinations are:

1. **Normal MRI, Normal Discogram, Painless Disc**

   This combination occurs in most healthy young discs. The findings represent normal discs. At some stage in the life of a nucleus pulposus degeneration occurs. There will be a time when some nuclear protein degradation occurs but the disc shows as being of normal signal intensity on MRI. The degree of degradation that is necessary for detection on MRI is unknown. The discogram is normal if the nucleus pulposus is intact, and from which there are no radiating tears or clefts. The disc should be painless as long as there are no clefts or tears in the innervated part of the disc, (usually the outer third of the annulus fibrosus), and if the internal structure of the nucleus pulposus is sufficiently intact to prevent excess load being borne by an even normal innervated part of the annulus fibrosus.

   If a person complains of LBD and there is no tear in the disc (and this is not able to be stated with any certainty using current assessment methods), the pain may come from structures including the zygapophysial joints, the sacro-iliac joints, the muscles and ligaments, or from other as yet unidentified structures.

2. **Normal MRI, Normal Discogram, Painful Disc**

   This is an example of false negative MRI and discogram. Consider a twisting incident leading to a circumferential tear in the peripheral part of the annulus fibrosus without extension from or to the nucleus pulposus. This tear could produce pain. MRI would be normal if the nucleus pulposus had not undergone sufficient degradation, and discography would be normal as the injected dye could not pass into the tear from the intact nucleus pulposus. It is possible that this discogram might reproduce some similar pain, due to the pressure transmission from the nucleus pulposus to the annulus fibrosus and its tear, but the pain reproduction would be mild.

3. **Normal MRI, Abnormal Discogram, Painless Disc**

   This could occur if the disc had undergone little or no protein degradation and a small tear or cleft had opened up in continuity from the nucleus pulposus, but...
it either had not reached the innervated part of the annulus fibrosus or, if it had, it was painfree. If the tear was of insufficient dimension to stimulate the nociceptive system for either local or central reasons, or if the nucleus pulposus was efficient enough to take excess load from the annulus fibrosus, then the MRI would be normal, the discogram mildly morphologically abnormal but painless, in the presence of a painless disc.

4. Abnormal MRI, Normal Discogram, Painless Disc

Protein degradation shows as a darkened image on T2-weighted signal. If this has occurred in a disc that has no tear or cleft radiating from the nucleus pulposus, the discogram will be normal and painfree, and the disc will be painless as long as there is no tear of significant dimension in the annulus fibrosus, and if the alteration of function of the nucleus pulposus is of insignificant dimension to abnormally load the annulus fibrosus.

5. Abnormal MRI, Relatively Abnormal Discogram

This disc has a degraded nucleus pulposus with tears extending from the nucleus pulposus through the annulus fibrosus to the epidural space. The disc may or may not be responsible for the patient's pain. The discogram will show as degenerate, but there may be no pain on the provocative testing due to the inability of the disc to build pressure because the injected material leaks rapidly into the epidural space. The passage of the needle into this disc may be very painful. This disc could also be totally painfree despite its abnormal morphology.

6. Other Permutations

Any combination of findings on MRI and discography is possible, and all diagnostic formulation must take these possibilities into account. If the relevance of the HIZ is validated by other studies, these additional factors will need to be considered when evaluating MRI, provocative discogram and the patient's LBD.

RAMIFICATIONS OF MRI FINDINGS ON TREATMENT

There is no consensus about how to manage the patient with somatic pain of lumbar origin that has not responded to time and conservative management. No treatment method for this type of condition has been scientifically validated.

Spinal fusion is one method used in the management of LBD. One rationale for fusion is that relative stabilisation of a painful disc will affect pain control. For fusion to be successful, the painful disc must be identified, and the offending part must either be resected or totally immobilised. Immobilisation is usually performed via internal fixation using metal and/or bone applied to the posterior elements or the vertebral bodies. It is considered that fusion is best applied only to the painful spinal segment. However, in some circumstances fusion is applied to other non-painful spinal segments, because adjacent segments are seen to be at risk to becoming sources of pain.

It is considered that a degenerate disc adjacent to a segment to be fused is at risk of becoming a source of LBD. Thus, in the work-up of a patient for spinal fusion, it is important to establish which discs are degenerate as well as which discs are responsible for the patient's pain. The results of such a work-up may mean that more than one segment may need to be fused even if only one segment is painful. It is possible that the work-up will establish that fusion is untenable. This occurs when multi-level disc degeneration is discovered.

For example, consider a patient who is sufficiently disabled and psycho-socially acceptable for surgery, and who has had an acceptable course of conservative therapy. If investigation reveals the L5/S1 disc as the source of LBD, and the disc above this to be painless and morphologically normal, then fusion of the L5/S1 disc is performed. However, if the L3/L4 disc was shown to be abnormal, then the surgeon would have to consider one of three options:

- fusing L5/S1 and running the risk of the L3/L4 disc becoming painful at an accelerated rate.
- fusing L3/S1 to decrease the chances of L3/L4 becoming painful at an increased rate.
- abandoning the procedure due to the problem associated with both leaving L3/L4 unfused and the extent of a triple level fusion.

The decision on what levels to fuse can only be made after determination of both the degree of DD in each disc and the source of a patient's LBD as it relates to pain reproduction.

It appears that the gold standard for the detection of internal disc pain is discography. DD can be detected by MRI or discography. However, even if the disc is shown to be the major cause of pain in a patient with LBD, fusion, with or without disc excision, does not always produce wonderful results. Mechanical causes of failed fusion include: complications of surgery such as wound infection, subsequent non-union, fatigue fracture of metal implants, biomechanical insufficiency with posterior fusion, other concomitant sources of pain (eg zygapophysial joints and epidural fibrosis) and pain at other levels.
The diagnosis of a probable cause of LBD should only be attempted if some form of treatment depends on this process. Investigation should only be performed if treatment is likely to lead to improved function. At present the only option when discography is positive is fusion. The first investigative step in the diagnosis of discogenic pain is MRI. Confirmation that the lesion is responsible for the patient's symptoms has to be obtained by discography.

The demonstration of the HIZ opens up a range of possible options for management of the painful annular tear. Although it appears that intra-discal steroids are not successful in the management of disc pain, at least in comparison to marcaine, and only over a 10 to 14 day period,(89) it is still possible that steroid or other anti-inflammatory agents injected into the HIZ, followed by an active period of mobilisation could lead to improvement. Other options for treatment of the HIZ include radiofrequency ablation, percutaneous resection and drug injection.

RECOMMENDATIONS FOR ORDERING MRI FOR LBD

A disc can be a potent source of LBD even if MRI is normal. However, an abnormal MRI is not indicative of a painful disc, unless the HIZ is considered a reliable sign. Further studies in this area are needed before MRI becomes a reliable marker of discogenic pain.

As the results of MRI do not lead to definitive treatment, the indications for MRI in the work-up of a patient with benign, somatic LBD are limited to two circumstances. There may be a place for MRI in a medico-legal setting if the HIZ is validated by other studies as indicative of a high chance of a person having a symptomatic disc. The other indication is as a screening tool in the work-up of a patient for operative intervention such as fusion.

Once a patient is classified as a fit and proper candidate for surgery, MRI is performed to evaluate whether the lumbar spine is suitable for surgery, and thus, to determine if discography is an appropriate investigation. If MRI demonstrates a degree of DD that makes fusion impossible, there is no need for discography. Thus, MRI can obviate the need for some patients undergoing the pain and morbidity associated with discography.

The indication for ordering MRI for LBD is simple. It should only be used in the management of LBD if surgical intervention is indicated.

In the future the role of MRI may change. If the HIZ will become the accepted and first line assessment tool for LBD.

A breakthrough in the management of LBD will occur if:

1. The psycho-social contributions to pain maintenance are minimised by such things as changes to the compensation systems.
2. Technology establishes the prime sources of LBD.
3. Scientifically proven management techniques are devised to specifically treat these causes of LBD.

Technologies such as MRI should probably not be introduced into the management of conditions such as LBD until such time as tests demonstrate that a particular protocol provides reliable information that leads to some effective treatment.

CONCLUSIONS

1. MRI has a limited role to play in the assessment of LBD, and probably should be confined to the patient scheduled for spinal fusion.
2. New approaches to MRI may make it the investigation of choice.
3. A normal MRI is of no clinical relevance in LBD.

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