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CASE REPORT

Vertebroplasty in the treatment of recalcitrant lower back pain attributed to Modic 1 changes

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ABSTRACT

Vertebroplasty is a recognised treatment for osteoporotic and pathological compression fractures. We present the case of TF, a 70-year-old male patient with a history of poor left ventricular function presenting with refractory lower back pain, thought to be secondary to Modic Type1 changes in the L2 and L3 vertebrae, accompanying L2–L3 degenerative disc disease. He was treated conservatively for approximately 9 months without success. Following recent suggestions that vertebroplasty may provide pain relief in patients with degenerative disc change and coexistent Modic 1 changes not responding to conservative treatment, we proceeded to vertebroplasty of the affected levels. This resulted in rapid resolution of pain and return to his pre low back pain level of activity. At 1-year follow-up the patient remains pain free. We review the causes of Modic 1 change, its relationship to low back pain and a rarely used but highly effective treatment option, percutaneous cement vertebroplasty, when it is unresponsive to traditional treatment options.

BACKGROUND

Lower back pain (LBP) is a source of considerable morbidity in the Western world and most people who experience an episode of back pain go on to have recurrent problems.[1] In the USA it is estimated that 80% of the population will experience LBP at some stage.[2] Causes of LBP include intervertebral disc, vertebral body and facet joint pathology, and are generally the result of either degeneration or trauma.

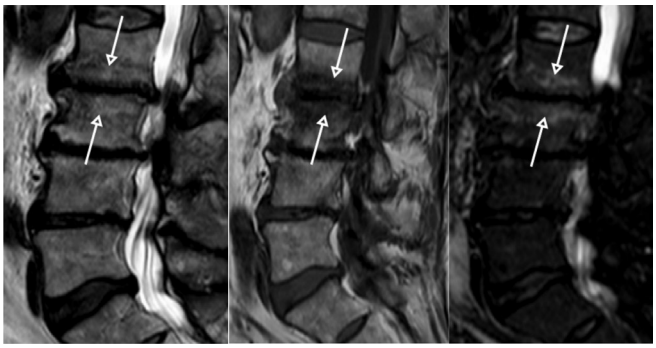
Degenerative vertebral endplate changes usually occur adjacent to degenerate or protruded intervertebral discs, and were first described on MR imaging in 1987,[3] and subsequently classified by Modic et al in 1998.[4] Modic Type 1 changes appear as hypointense on T_1 and hyperintense on T_2 weighted imaging, secondary to a combination of bone marrow oedema and inflammation, and represent the acute phase of degeneration. Modic Type 2 changes are hyperintense on T_1 and isointense to mildly hyperintense on T_2, secondary to ischaemia with subsequent conversion of red marrow into fatty marrow. Modic Type 3 changes are hypointense on both T_1 and T_2 as a result of sclerosis. Modic changes are associated with ageing[5] and are seen mostly at L4–L5 and L5–S1.[6] The prevalence of Modic change or vertebral endplate signal change (VESC) is found to be a common finding in those with non-specific lower back pain (LBP) with a median prevalence of 43%.[7] There is also a positive association between LBP and Modic changes[8] with Type 1 changes being strongly associated with LBP.[9]

Vertebroplasty is a minimally invasive procedure developed in France in 1984[10] for the treatment of symptomatic vertebral angioma, and was subsequently used in the treatment of osteoporotic vertebral fractures and pathological fractures not responding to conservative treatment. We present a case of intractable lower back pain attributed to Modic 1 change, with complete resolution of symptoms following vertebroplasty, and in doing so emphasise its role as an effective and underused treatment option, for poor surgical candidates in whom conservative treatment fails.

CASE REPORT

Mr TF, a 70-year-old male with a history of left ventricular dysfunction, presented with a 9-month history of non-radiating LBP, which was localised to mid-lumbar spine. MRI revealed endplate degenerative Modic 1 changes in L2 and L3 vertebrae, without evidence of significant disc bulging or fissuring (Figure 1). Treatment options included the use of non-steroidal anti-inflammatory drugs (NSAIDs) that resulted in a slight exacerbation of heart failure symptoms, and following this a gastric ulcer. A 3-month course of co-amoxiclav was also trialled to no avail. Owing to poor left ventricular function, he was deemed a poor surgical candidate. His quality of life was severely affected

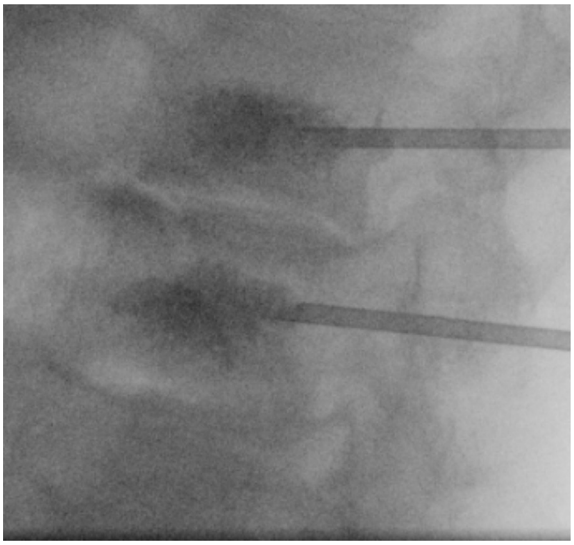
Figure 1. T_2, T_1 and short tau inversion recovery Sagittal MR images demonstrate Modic 1 change in the endplates of L2 and L3.



and having exhausted all conservative measures, a decision to proceed to vertebroplasty of the affected levels was made.

A fellowship-trained interventional musculoskeletal radiologist with over 20 years experience performed the procedure, using fluoroscopic guidance with the patient in the prone position. The skin was infiltrated with lignocaine 1%, and the periosteum with ropivicaine 10 mg ml^{-1}. A left pedicular approach was used and a 13 G straight injection cannula was advanced to the anterior vertebral body of L2, and polymethyl methacrylate (PMMA) cement, consisting of 60% synthetic calcium sulphate and 40% hydroxyapatite, was injected. Once absence of leakage outside the vertebral body was confirmed, the cannula was withdrawn slightly, and further injections were performed in the mid and posterior vertebral body. The process was then repeated for the level below (Figure 2). Following the procedure, the patient remained prone for 20 min and was then rolled onto a bed, and instructed to lie motionless for the next 3 h. The patient was followed up each month for 3 months, and 6 monthly thereafter. He remains pain free approximately 3 years later.

Figure 2. Lateral fluoroscopic image demonstrates vertebroplasty of vertebral bodies L2 and L3 using a left pedicular approach, 13 G cannulae and PMMA cement.



DISCUSSION

Vertebral endplates are composed of trabecular bone, with a layer of overlying hyaline cartilage measuring approximately 0.6 mm in thickness. Blood supply comes from the highly vascular bone marrow centrally, and to a lesser extent from the outer annulus capillaries. Endplates are richly innervated and endplate damage is felt to result in vertebrogenic pain.[11] The endplates contain tumour necrosis factor immunoreactive nerve cells, which are present in increased numbers in those with Modic 1 changes, and may result in pain.[12]

Modic changes may result from injury to the disc resulting in increased loading and shear forces on the subjacent endplate.[13] This causes endplate fissuring, with subsequent bone marrow depletion and degeneration and regeneration of bone. Bone marrow oedema is a result of increased intravascular pressure and local changes in the capillary wall, with subsequent capillary leakage, and is frequently associated with pain.[14] This pain is due to the irritation of sensory nerve fibres in the neurovascular bundles of marrow.[15]

Modic 1 changes comprise of granulation tissue that weakens the endplates, resulting in microscopic cracks extending to the overlying disc.[16] The granulation tissue and the damage to the disc and endplate lead to prostaglandin and inflammatory cell mediator production, resulting in nerve ending growth and pain. Increased tumour necrosis factor alpha and C-reactive protein levels are seen in Modic Type 1 changes suggesting an inflammatory process.[12] Raised C-reactive protein level is also associated with spondylodiscitis, which is a differential for signal change in the vertebral endplates; however, clinical presentation, endplate erosions, epidural enhancement and paraspinal collections will help differentiate in most cases.

Recently, *Proprionibacterium acnes*, a bacteria that secretes propionic acid, which may dissolve fatty marrow, resulting in marrow oedema and Modic change, has been proposed as a cause of LBP. In a double-blind randomised controlled trial in those with LBP and lumbar disc herniation with 1-year follow-up, those treated with amoxicillin/clavulanic acid for 3 months had considerable improvement in symptoms than the placebo group.[17]

Modic 1 change is associated with mechanical segmental hypermobility and instability. Surgical fusion results in increased segmental stability and accelerated evolution to Type 2 change.[18] Vertebral body inflammation and microfractures of the overlying endplates, resulting in "intrasegmental instability," was the basis for Masala et al treating Modic 1 changes with vertebroplasty.[19] They hypothesised that reduction or stabilisation of the instability might improve symptoms and convert Modic 1 to Modic 2 changes. Elevated intraosseous pressures will result in bone pain by excitation of nerve fibres, and this pain can be alleviated when the bone innervation is ablated by vertebroplasty.[20]

Type 2 changes are felt to represent stable lesions developing from Type 1 changes, and have a lesser association with pain than Modic 1 changes.[21] Type 2 lesions can occasionally reconvert to Type 1, via superimposed stress.

Percutaneous vertebroplasty has been predominantly used to treat refractory osteoporotic compression fractures and painful pathological vertebral fractures secondary to malignancy. Other less common indications include steroid-induced vertebral fracture, multiple myeloma and unstable fractures due to osteonecrosis.

It has been found to significantly reduce pain in cancer patients with vertebral compression fractures, decrease opiate requirements and have low complication rates.[22] In the treatment of osteoporotic fractures despite controversy triggered by two separate randomised control studies published in the New England Journal of Medicine (NEJM),[23] multiple publications and trials have confirmed similar efficacy.[24,25]

Contraindications include uncorrectable coagulopathy, allergy to contrast medium or cement, pregnancy and osteomyelitis.

Endplate thickness decreases with age, predominantly in the centre of the endplate with sclerosis occurring more peripherally. The strength of the endplate decreases as perfusion decreases, and the granulation tissue of Modic 1 change produces microscopic cracks that extend to the disc resulting in subsequent pain and a rise in inflammatory markers. Modic 1 change has been linked with segmental hypermobility, and surgical fusion results in improved pain scores and progression of Modic 1 change to Modic 2. Based on this theory, Masala et al propose that vertebral augmentation can stabilise endplate microfractures and underlying trabecular inflammation, by reducing "intrasegmental instability," and in doing so, reduce pain. In doing this they believe they could accelerate Modic 1 to Modic 2 change; however, this was not followed up. Following stringent selection criteria, they performed 218 vertebral augmentations in patients with LBP attributed to Modic 1 change and found that 79% had a rapid improvement in their symptoms in the first 4 weeks.[19]

The complications of vertebroplasty are not insignificant and include but are not limited to extravasation of cement into the dural, epidural or foraminal space, leakage into paravertebral veins and subsequent pulmonary embolus, infection, bleeding and even death. It is important therefore, to exhaust traditional and more conservative treatment options in the treatment of LBP secondary to Modic 1 change, prior to considering vertebroplasty as a treatment option. Supporting emerging data in this case suggest that when LBP is recalcitrant to standard treatments, and when it impacts severely on the quality of life of the patient as it did in our patient, it is not only a reasonable but also a potentially highly effective treatment option.

LEARNING POINTS

1. Modic 1 change is strongly associated with LBP, mechanical hypermobility and instability.
2. In poor surgical candidates who have significant LBP that can be attributed to Modic 1 change, and in whom conservative treatment fails, vertebroplasty can result in rapid relief of symptoms and an improved quality of life.
3. We emphasise the role of vertebroplasty as an underutilised but highly effective treatment option when conservative treatment options are exhausted in these patients.

ETHICS APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

CONSENT

Written informed consent for the case to be published (including images, case history and data) was obtained from the patient(s) for publication of this case report, including accompanying images.

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