ELSEVIER

Static Magnetic Field Therapy for Pain in the Abdomen and Genitals

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Two adolescents with debilitating, medication-resistant, chronic pain of the low back and abdomen with intermittent pain of the genitalia were diagnosed with intervertebral disk disease at spinal cord levels that correlated with their signs. Both patients had undergone multiple evaluations by physicians of different specialties and both underwent appendectomy without relief of their pain. The history of the onset of pain was important in determining the affected levels. The pain of both individuals was mimicked and localized by percussion of the vertebral spines at the level of disk protrusion. This maneuver and careful review of the history were important in making the correct diagnosis in each case. In both patients, treatment with novel magnetic devices provided rapid relief that was sustained for more than 2 years. These cases highlight the need for careful evaluation and correct diagnosis of abdominal and genital pain in young patients to avoid costly and unnecessary medical intervention and the stigma of painful debility.

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Introduction

How often neurologic etiologies are overlooked as possible explanations for abdominal and genital pain in adolescent patients is unknown. We present the cases of two adolescents with such pain that illustrate both the diagnostic dilemma and the issues related to the cost of diagnosis and treatment. Both individuals went to multiple physicians before a definitive diagnosis. The neurologic examination was able to localize the abnormality to the spinal canal and nerve roots in both cases, and noninvasive, cost-effective treatment with investigational magnetic devices was instituted. The magnetic devices consisted of four permanent magnets of alternating polarity housed in a hypoallergenic plastic case (Magna Bloc), which were taped to the skin over areas involved with the pain.

Case Reports

Patient 1. A 17-year-old white female was admitted to the Vanderbilt University Medical Center for further evaluation of chronic pain of 3 years' duration that had begun suddenly in the low back and radiated around the right flank. She could not attend school and relied on homebound teaching while she lay in bed.

Over the years, her many physicians uniformly described her complaint of constant right lower quadrant abdominal pain of variable intensity with intermittent radiation into the vulva. Community-based physicians, including pediatricians, emergency service personnel, an anesthesiologist, an obstetric-gynecologic specialist, a cardiologist, and a neurologist, had assessed her. Laparoscopic examination and appendectomy had been performed in the course of the evaluations. Pediatric specialty consultations in neurology, general surgery, infectious diseases, rheumatology, and gastroenterology at a university center led to a diagnosis of gastrointestinal migraine. The patient's pain continued without amelioration despite multiple medications, including narcotics.

The patient was referred to the pediatric general surgery service at the Vanderbilt University Medical. She was bedridden and unable to walk because of severe opiate-resistant pain. The laboratory and radiologic tests, including liver and pancreatic enzymes and abdominal radiographs were normal. Symptomatic treatment with saline enemas, intravenous fluids, and intramuscular and intravenous medications failed to relieve the pain. A pediatric gastroenterologist found no etiology for the patient's pain. A psychiatric consultant identified no underlying psychopathology and recommended relaxation and stress reduction training. The neurologic consultant obtained a history of intermittent lancinating pain of burning quality that radiated from the right posterior lumbar region into the right lower quadrant of the abdomen ventrally. This pain was superimposed on a constant aching pain. Burning lancinating pain also occurred from the right posterior lumbar region into the right hip, buttocks, leg, and heel. Intense burning pain of the vulva was also present intermittently. Percussion over the L5-S1 lumbar spinous processes

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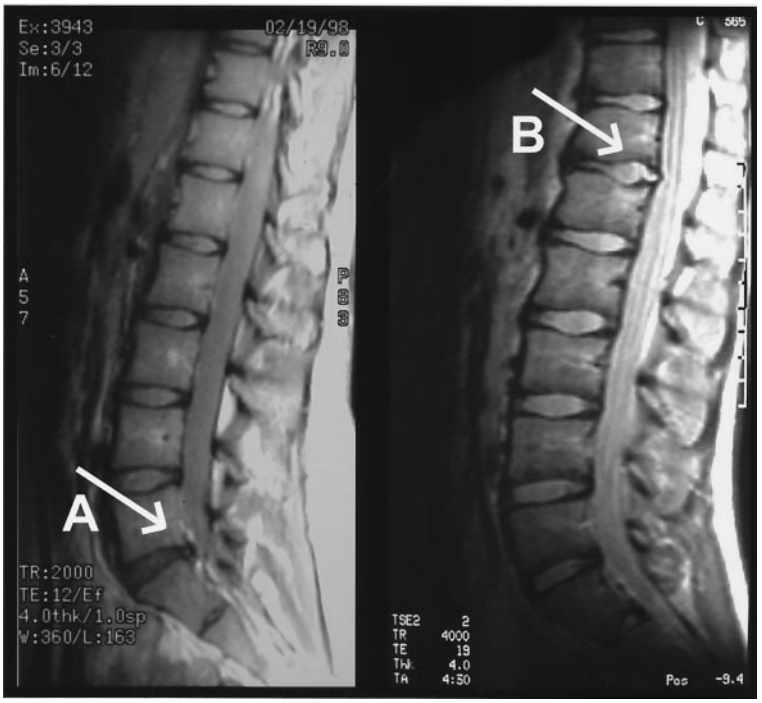

Figure 1. Lateral magnetic resonance images exhibiting lesions (white arrows) at (A) L5-S1 in Patient 1 and (B) T12-L1 in Patient 2. Imaging parameters appear in the lower left of the panels.

reproduced many of the components of the patient's pain, including intense lumbosacral muscle spasm and burning lancinating pain around the right flank into the lower abdomen and vulva. These complaints suggested S1 radiculopathy or lumbosacral plexopathy (or both). Magnetic resonance imaging revealed protrusion of the L5-S1 disk with impingement on the right S1 root (Fig 1A).

After a neurosurgical consultant did not recommend surgical intervention, the patient was offered treatment with investigational magnetic devices (Magna Bloc; see schematic insert in Fig 2). After informed consent was obtained, the devices were taped over the lumbosacral spine (Fig 2A). Within minutes, the patient reported a 90% reduction in the pain and was able to walk without complaint. She was discharged from the hospital with instructions to keep the devices taped to her body and to increase her activity gradually as tolerated. She returned to school and resumed her prior activities during the next few days.

Her follow-up care consisted of telephone calls with instructions for optimizing her care. She was examined intermittently during the follow-up period for episodes of pain in the abdomen. The recurrent pain was controllable by adjusting the placement of the magnetic devices.

Patient 2. A 15-year-old white male developed acute pain while wrestling with his brother. The pain consisted of aching in the right posterior thoracolumbar region, right groin, and right lower abdominal quadrant, with intermittent radiation into the testes. The initial evaluation at a local hospital emergency room led to a diagnosis of nephrolithiasis. After multiple laboratory and radiologic evaluations failed to demonstrate an etiology for the persistent pain, an appendectomy was performed within 48 hours of admission. The patient's pain did not abate postoperatively, and he was discharged with a prescription for narcotics. Frequent emergency room visits ensued during the following months. After evaluation by a pediatric urologist, he was admitted to the pediatric surgery service of a regional tertiary referral center. Functional constipation resulting from use of narcotic analgesics was diagnosed on the basis of abdominal plain films.

With narcotic-resistant pain of 3 months' duration, the patient was admitted to a second pediatric tertiary care hospital, where another pediatric urologist performed cystoscopy under anesthesia. The study was normal. A review of all outside radiologic studies failed to reveal a structural lesion. A neurosurgical consultant also found no abnormality. A consulting psychiatrist diagnosed psychosomatic pain disorder and prescribed outpatient psychotherapy. However, this treatment was not pursued because the patient and his family could not afford it.

The psychiatric diagnosis made it difficult to find a primary care physician who was willing to manage the problem longitudinally. Frequent visits to the emergency room continued for intermittent exac-

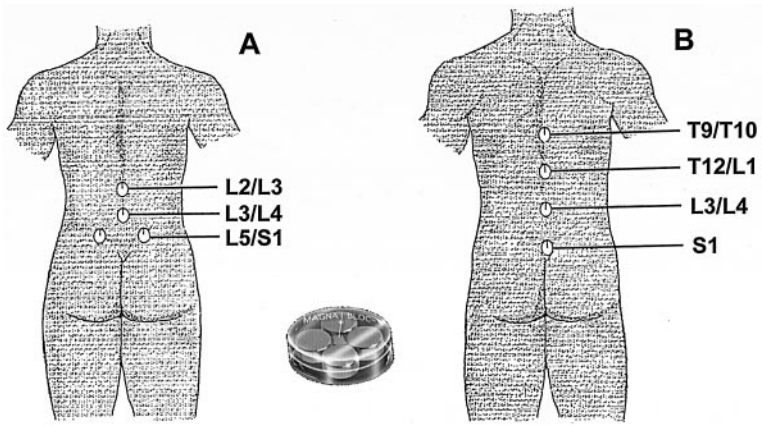

Figure 2. Placement of magnetic (Magna Bloc) treatment devices. (A) Patient 1 and (B) Patient 2. (Insert) Schematic drawing of the devices.

erbation of the pain. During these visits, he was treated with intramuscular narcotics and was given prescriptions for oral narcotics for long-term use. Homebound schooling was required because he had difficulty walking, and the pain decreased only when he was supine.

A pediatric neurology consultation was scheduled at the Vanderbilt University Medical Center to evaluate the pain further, when it was of 6 months' duration. The neurologic examination revealed an antalgic gait, with the patient flexed at the waist and complaining of severe pain. Percussion of the spinous processes at the thoracolumbar junction with a reflex hammer caused paraspinous muscle spasm and a burning pain that lancinated around the right flank into the testes. Lumbosacral radiculopathy was tentatively diagnosed. While in the clinic, the patient was offered treatment with the Magna Bloc devices. After informed consent was obtained, the devices were positioned as shown in Figure 2B. Ten minutes after placement of the devices, the patient reported a significant reduction in his pain. He was able to walk upright without complaint. The next day, he underwent magnetic resonance imaging, which revealed T12-L1 disk protrusion with anterior thecal effacement and a right posterior annular tear (Fig 1B). A neurosurgical consultant did not recommend surgical intervention.

The patient was sent home with the magnetic devices in place. He was instructed to wear them constantly and to increase his activity as tolerated. On one occasion when the pain recurred, he came to the emergency room for repositioning of the Magna Bloc devices. Otherwise, the patient remained virtually pain free for the past 24 months. He gradually increased the intervals between wearing the magnetic devices until finally he deemed them no longer necessary except on rare occasions. He played basketball during his senior year of high school and at last follow-up was an active college student. He rarely requires the devices but obtains relief whenever he uses them. No other hospitalizations, investigations, or medications were necessary.

Discussion

The two cases we described represent diagnostic dilemmas in which thoracolumbar and lumbosacral radiculopathy masqueraded as abdominal and genital pain. The pathophysiology of the pain is not completely understood. The leg and buttock signs of Patient 1 can be explained in large part by impingement on the right S1 root. However, her abdominal and vulvar pain suggest involvement of the lumbosacral plexus and its various contributions. Magnetic resonance imaging did not reveal any extravertebral abnormalities. Mixed and variable contributions to the plexus and indirect involvement of the sympathetic nervous system also may have contributed to her pain. Magnetic resonance imaging of Patient 2 revealed T12-L1 disk protrusions. Because the L1 and L2 roots contribute to branches of the lumbar plexus that innervate areas of the lower abdomen and genitalia [1], this protrusion could explain the findings in Patient 2. Neurosurgeons did not believe that surgical intervention was indicated in either patient. These two cases are unusual because the back pain began in adolescence and was disabling. Ultimately, careful attention to the descriptions of the pain onset and the maneuver of percussion over the spine resulted in correct localization and mimicking of the symptoms. These two cases accentuate the need for careful history taking and neurologic evaluation at the initial presentation of adolescents with a history of acute back pain. The possibility of radiculopathy or lumbosacral plexopathy should be included in the differential diagnosis of lower abdominal and genital pain.

Before establishing a correct diagnosis, multiple consultations, in-hospital evaluations, and laboratory tests were performed at great expense. The family of the second patient was bankrupted because they could not pay the deductible portion of their insurance expenses, emphasizing the cumulative cost of investigations that produced neither a correct diagnosis nor adequate treatment. The cost of caring for these two young patients pales in the context of the cost of caring for the problem of back pain in general. In 1989, the Liberty Mutual Insurance Company expended $991 million for back pain-related Workman's Compensation. Of this amount, 32.4% was for direct medical costs and roughly 66% was spent on indemnities [2]. The cost of caring for low back alone in the United States in 1989 was $11.4 billion [2]. Costs are undoubtedly higher now. Because the lifetime prevalence of low back pain in industrialized countries is 50-80% [2-4], these costs are likely to continue to increase. The current focus on medical economics has created an atmosphere ripe for the discovery of novel, cost-effective treatment modalities. The costs incurred for Magna Bloc therapy, including the physician's fees for the initial and follow-up visits and the nonrecurrent cost of the devices, amount to less than $500 for each of our two patients—less than 1% of the costs incurred before magnetotherapy.

Both of our patients improved within minutes of the placement of the magnetic devices in the regions of the affected nerve roots. They have been functional and have had only intermittent pain for extended periods. The investigational devices consisted of four permanent magnets of alternating polarity encased in a hypoallergenic plastic case (Magna Bloc). The magnetic fields produced by these devices have regions of steep gradients that are thought to mediate the therapeutic effect [5-7]. The success of magnetotherapy in these two patients is a common experience for us; we have treated more than 2,000 people with the magnetic devices, alone or in combination with medication, for low back pain during the past 10 years under Institutional Review Board-approved protocols. About 80% achieved sufficient benefit that they chose to continue treatment chronically. Many became pain free within minutes to hours. Others became pain free within weeks to months or had acceptable, ongoing, mild-to-moderate pain. As did Patient 2, many of those who benefit increase the intervals between the applications of the devices gradually or stop wearing them because of a lack of need. To some extent, this occurrence may reflect the tendency for painful disk protrusion to resolve spontaneously with time. About 20% of patients experience no benefit. Failure to benefit from the devices is usually recognized rapidly, so that alternative approaches to pain management are not delayed inappropriately,

The Magna Bloc devices were superior to placebos ($P < 0.03$) in a double-blind, placebo-controlled, two-center, crossover study of 54 individuals with mechanical

low back and knee pain [8]. Medication use during treatment with the Magna Bloc devices declined. In a subsequent double-blind, placebo-controlled, crossover study of similar design, the per protocol analysis of 56 patients with mechanical low back pain again demonstrated the statistical superiority of the Magna Bloc devices to nonmagnetic placebos within 24 hours ($P = 0.037$; Holcomb et al., 1999, unpublished data). In a blinded pilot study, treatment with the Magna Bloc devices resulted in a significant reduction of knee pain in 18 patients with inflammatory arthritis at 1 hour ($P < 0.008$) and at 1 week ($P < 0.0002$) [9]. These pilot data are the basis for the design of a placebo-controlled trial. The combination of success in open use and the significant benefit in controlled studies suggests that the Magna Bloc magnetic treatment device is a cost-effective, noninvasive therapy for low back pain.

The precise molecular mechanisms by which the Magna Bloc devices relieve pain is not known. However, in studies of primary afferent neurons in cell culture, exposure to the field produced by the Magna Bloc array resulted in reversible blockade of sodium-dependent action potential firing [5,6] and calcium-dependent responses to the irritant capsaicin (Wamil et al., unpublished data). In addition, the gradient regions of the field produced by the Magna Bloc devices reduced or delayed the acute neuronal swelling induced by the excitotoxin kainic acid [10]. Taken together, these data suggest that gradient magnetic fields produced by the Magna Bloc reduce hyperexcitability and excitotoxic edema. These effects are probably mediated by multiple mechanisms, including alterations in the conformation of ion-channel proteins and the lipid bilayer in a manner that prevents inward movement of ions and water in response to voltage changes or chemical stimuli.

Other devices with different magnetic field strengths and topography have been reported to have significant clinical effects, including reduction of trigger point pain in patients with postpolio syndrome [11] and the foot pain of diabetic neuropathy [12]. Pulsed electromagnetic fields have also been reported to ameliorate migraine [13]. A homogeneous static magnetic field reduced calcium influx through voltage-activated calcium channels of a clone of pituitary cells [14]. However, similar spatially invariant fields and the field produced by the devices used in the study of patients with postpolio syndrome did not reduce excitotoxic neuronal edema in our laboratory model described above (McLean et al., unpublished observations). Thus, it is possible that many types of fields will prove to have beneficial effects. However, different magnetic fields may not be equivalent and may not share identical cellular actions. Additional laboratory and clinical studies are in progress to elucidate the molecular mechanisms of action of the magnetic field produced by the Magna Bloc and to determine the range of clinical utility of this magnetic device.

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