Evidence in Action

A patient brings her 11-year old son to your clinic with mid-thoracic back pain

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Children are not supposed to have pain, let alone back pain of unknown etiology. When a child comes to a chiropractic office, the doctor must ensure that all possibilities are ruled out and that care is appropriately managed.

An 11-year-old boy had mid-thoracic pain and a palpable and visible left thoracic scoliosis. The presence of non-traumatic back pain in a child may be a red flag for a more life-threatening underlying cause—even more than a simple spinal segmental dysfunction with associated myofasciitis. A simple search of "back pain in teenage boy" or with the key words "back pain child" in the layman's favorite search engine, Google, reinforced this point.[1] The fact that this was an atypical scoliosis (left convex side instead of right) also raised a red flag.[2,3] But before scaring the parents and child, let's consider heading to the online research "stacks" available just a few keystrokes away.

Using a simple search approach starting with Google, I entered "left painful scoliosis child" and immediately found the "lesson of the week" in a 1986 *British Medical Journal* article that was headlined "Painful scoliosis: a need for further investigation." The article described 10 scoliosis patients ages 11 to 19, half of whom were male. Of these 10 thoracic and thoracolumbar scoliosis patients, 6 had left scoliosis. The causes included osteoid osteoma, grade III or IV spondylolisthesis, central cord astrocytoma, and neurilemmoma.[4]

I deepened my academic search by entering similar search terms into PubMed: "scoliosis AND left AND child AND pain" and discovered more resources. One 1997 article further discussed the prevalence of back pain in children with idiopathic scoliosis.[5] This study retroactively evaluated a decade's worth of records at scoliosis clinics and yielded 2,442 diagnosed idiopathic scoliosis cases, 560 of which (23 percent) presented with pain and 210 (9 percent) of which demonstrated pain on further evaluation.

There was a significant difference in pain presence based on age and skeletal maturity: Ages 15 and up showed 32 percent prevalence of pain, while 21 percent in the 11-to-14 group and 15 percent in the 6-to-10-year-olds did so. This indicates that younger patients are less likely to have pain.

So, which of these 2 articles has more statistical, and therefore evidence-based, heft? The 1986 article is essentially a case series, and the 1997 article is a retrospective study of over 2,000 patient records. The higher number cohort (number of patients studied) should be considered the better evidence.

However, one might consider, "What if my child turned out to be 1 of the 10 cases? And what if there is an osteoid osteoma lurking in my child's spinal pedicle?" A 2009 article in the open-access online *Scoliosis Journal* discussed a 6-year-long mismanagement of a 15-year-old girl with a diffuse painful 25-degree thoracolumbar scoliosis. After 6 years of bracing treatment and unrelenting pain, a bone scan was done. It found that a large osteoid osteoma had destroyed the left pedicle of T12. Surgical reconstruction of the vertebra was necessary at this point.[6] Case studies and case series are important because they report unusual findings and lead us to consider new diagnostic possibilities. They can also inadvertently lead us to seek the unusual, however, rather than the common.

What non-idiopathic causes could be behind this scoliosis? If the boy had an osteoid osteoma, a

generally benign lesion with an affinity for the pedicle in the thoracolumbar region, he would also have had the characteristic nocturnal back pain relieved by NSAIDs accompanying his scoliosis.[7] Scheuermann's disease should be considered as a concomitant problem since it is seen in teens, generally male, and leads to increased kyphosis (>45 degrees), with back pain worse in the afternoon and relieved by rest. However, in our case, the patient was slightly younger than the expected initial age of Scheuermann's disease, which is seen usually at ages 13 to 17,[7] and his kyphosis on physical examination appeared to be within normal limits. A syrinx, or fluid-filled sac in the center of the spinal cord such as is seen in syringomyelia, is more likely to be found in the upper-thoracic region and have other neurologic findings, such as the classic "cloak and gloves" paresthesias and later motor weakness. Other serious diagnoses that have been listed as associated with painful and/or atypical thoracic scoliosis include neoplasm and infection.

Commonly accepted risk factors for underlying pathology in scoliosis for which MRI should be ordered have classically been as follows:

1. Scoliosis diagnosed before age 10
2. Single left thoracic curve or other atypical curve presentations
3. Larger curve size in a skeletally immature patient
4. Rapid curve progression
5. Abnormal neurologic findings
6. Chronic, unrelenting, function-disturbing back pain or headache or nocturnal pain[3]

Which physical examination procedures would determine if further diagnostic imaging is necessary? A literature search using "physical examination AND thoracic spine" provides guidance and direction. There are few orthopedic or neurologic tests for the thoracic spine; however, important tests include Adam's flexion and lateral flexion tests to establish the flexibility or non-structural component of the scoliosis, as well as the superficial abdominal reflex (a diagonal swipe on the skin to cause a normal movement of the umbilicus toward the stimulus, also known as SAR).

In one retrospective study of 93 scoliosis patients,[8] there was a 22 percent prevalence of abnormal SAR, which was therefore seen as a predictor of non-idiopathic scoliosis. An abnormal SAR as a predictor of non-idiopathic scoliosis in all patients was calculated to have a 90 percent PPV (positive predictive value, or number of true positives out of all positives) and a 60 percent NPV (negative predictive value, or number of true negatives out of all negatives). The sensitivity was 38 percent, and the specificity was 96 percent, signifying a strong test for determining the presence of the diagnosis but not supporting that a negative test could fully rule it out.

Syringomyelia was found in 9 of the 93, cases and further data evaluation showed that an abnormal SAR had an 80 percent PPV for syringomyelia and a normal SAR had a 98 percent NPV (sensitivity 89 percent and specificity 95 percent). Therefore, it seems important to perform an SAR on our patient to help confirm our diagnostic findings. We note that flexibility has also been listed as an indicator of underlying pathology in scoliosis.

Posterior/anterior and traction or weighted lateral bending radiographs are also used to determine the flexibility of scoliosis. Flexibility is calculated as the difference between the pre- and post-lateral bend Cobb's Angle. In the above study, greater than 50 percent flexibility showed a PPV of 26 percent and an NPV of 100 percent.[8] Curve flexibility was significantly greater with syringomyelia than with idiopathic scoliosis ($P = 0.02$). This goes opposite to what has been taught in chiropractic and medical schools, suggesting that the flexibility indicates a more "functional" than "structural" scoliosis.

The last factor is to determine if being male increases the risk that the scoliosis is non-idiopathic. In the above retrospective study, of the 9 syringomyelia patients, 4 were male in contrast to only 2 males out of 46 idiopathic

scoliosis patients. The calculated relative risk for a male patient to have syringomyelia was 6.5 (CI 2.4-18).[8] The confidence interval (CI) is generally calculated as a 95 percent CI, meaning that 95 percent of the time, the mean will fall within the interval listed. The interval in this case is 2.4 to 18. When there are only a few patients in a study, it is intuitively not as good or robust a study as one with many patients. In this case, the increased risk of having syringomyelia for a male patient may be as low as 2.4 but perhaps as much as 18 times higher. This is a statistically significant result because if a 95 percent CI runs from a negative number to a positive number, it would indicate that the results are not significant.

What should we recommend to the parents? According to current studies, the chance of a more serious underlying cause of scoliosis is not likely. However, if certain factors are combined, the importance of performing tests to rule out an underlying pathology increases. A 2010 article found that further investigation with MRI should be used to rule out neural axis abnormality (e.g., syringomyelia or Arnold-Chiari 1 malformation) if the scoliosis doesn't fit the norm.[9]

In this case, there were 3 factors: left scoliosis, male, and pain. This study also stated that the larger the curve of Cobb's angle, the greater the chance the scoliosis would be secondary to a neural axis abnormality. A second article attempted to establish a prognostic model to answer the question whether to MRI or not by reviewing the medical records of 1,206 patients diagnosed with idiopathic scoliosis to determine the presence of risk factors for underlying pathologies.

The study found 72 of the 1,206 patients had one or more of the risk factors. Of these 72 patients, 11 (15 percent) had abnormal MRIs and 16 (22 percent) had left curves and 4 had abnormal MRI. Pain was reported in 13 (18 percent), all of which had normal MRI findings. The most clinically significant of all were the 11 of the 72 patients (15 percent) with an abnormal superficial abdominal reflex (SAR). Of those, 5 had abnormal MRIs. The authors concluded that physical examination should evaluate neurologic abnormalities (SAR, cranial reflexes [e.g., gag reflex], and spinal reflexes). Pain, left thoracic curve (or other atypical curve), initial diagnosis at a young age, and rapid curve progression alone are not as much of a concern as when in combination. And neurologic abnormalities along with large curve size showed the highest chance that MRI would detect an underlying pathology.[3]

In our patient, I recommended further work-up of the scoliosis. I considered a full-spine x-ray, preferably digital, to allow me to focus on the image as well as to invert the image to a "negative" image, offering a second view to help reveal hidden findings. Radiographs are best at viewing structures containing minerals (bone, calcium deposits) but are less effective for viewing pathologies of soft tissue. This suggests that even with a seemingly normal or negative x-ray, the search should not stop.

Scintigraphy (bone scan) is the suggested imaging method to reveal osteoid osteomas because they are richly vascularized, causing a better radionuclide uptake. The more metabolically active the areas (as in fractures, infections, and blastic tumors), the higher the accumulation of the radionuclide on the bone scan.[10] Scintigraphy is therefore more sensitive than it is specific in that if a lesion showed up directly where the boy's complaint was, it truly does suggest a non-idiopathic scoliosis cause, which would require further evaluation. A bone scan does not give a clear view of the lesion but simply proves the existence of a metabolically active lesion.

In an ideal world with endless funding and medical facility availability, an MRI would be the ideal follow-up imaging technique because of its ability to reveal not only soft tissue but also many bony lesions displayed in 3 dimensions (sagittal, coronal, and horizontal planes). One may ask first, though, what is the chance that an MRI will reveal an abnormality in an otherwise asymptomatic thoracic spine?

Searching "MRI thoracic spine AND thoracic spine" brings up an article showing that there are many false negatives in this imaging technique.[11] That suggests using this diagnostic test for the thoracic spine may yield too many findings not related to the cause of the pain. That being said, as far as diagnostic imaging goes, MRI would be the best choice because it is more likely to be able to pick up most of the red flags associated with a painful left thoracic scoliosis.

For this child, plain radiographs were recommended. If they revealed nothing of diagnostic caution, it would be appropriate to provide a short therapeutic trial of conservative care (chiropractic manipulation and myofascial work). However, if the treatment did not relieve the pain combined with the fact that he is male and has a left scoliosis, I would suggest that an MRI be done.

Important Terms

Relative risk: the probability of a disease or condition in an exposed group divided by the probability of a disease or condition in an unexposed group. The larger this number, the more likely it is that there would be a relationship between the exposure and the disease or condition.

Confidence interval: the range of values within which a population parameter, such as a mean, is expected to lie. Usually set at 95 percent, it provides boundaries for the mean value in 95 percent of cases.

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