REVIEW ARTICLE

LOW BACK PAIN IN ADOLESCENTS WITH AN OSTEOPATHIC COMPONENT

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ABSTRACT

Low back pain (LBP) is a common complaint in adolescents and has been increasingly reported in recent years. Affecting roughly 40% of adolescents, it leads to negative overall health, higher incidence of LBP in adulthood, and greater utilization of health care resources over one's lifetime. LBP in adolescents differs from adult populations due to variations in structural anatomy, which contribute to differing approaches in diagnosis and treatment of this condition. The differential diagnosis of LBP in this population is extremely broad and can be attributed to many underlying etiologic factors. Clinicians must conduct a thorough history and physical examination and consider the appropriate diagnostic testing to accurately diagnose adolescents early on in their conditions to provide the most effective treatment. Treatment for this condition ranges from rest and rehabilitation, to oral medications, OMT, bracing, and rarely, surgery. Physicians must also be able to recognize clear risk factors and symptoms for serious underlying pathology that can be causing LBP. This article will focus on diagnosis and treatment of the most common causes of LBP in adolescents

BACKGROUND

Low back pain (LBP) has become one of the most common chief complaints by patients but has been frequently underappreciated. Currently, more than 10% of all appointments made with primary care physicians are for complaints regarding back or neck pain, leading to roughly $86 billion in health care spending.[1–3] LBP in adolescents has been increasing in recent years, yet only 24% of adolescents who report LBP seek medical attention.[4] The prevalence of LBP generally rises with age, as an estimate of 1% of 7-year-olds experience LBP, while 6% of 10-year-olds, and 18% of 16-year-olds are found to have LBP.[5]

According to the World Health Organization, an adolescent is defined as those between the ages of 10–19 years old.4 LBP can have both short- and long-term implications for adolescents. Short-term effects can lead to restriction of daily activities, such as attending school and participating in sports.[6] In addition, studies have shown that adolescents with LBP are more likely to develop chronic LBP as adults, have impaired quality of life, and use a greater amount of health care resources throughout their lifetime.[7]

Many potential risk factors have been identified and can aid in early diagnosis and treatment of adolescent LBP. Nonmodifiable risk factors include sex, age, and ethnicity.[8] Conversely, modifiable risk factors include childhood obesity, psychosocial and socioeconomic factors, and sports specialization.[9–11] Additionally, some causes of LBP may correlate with participation in specific sports, as well as level of competition.[6,12–14]

The most common diagnosis among adolescents with LBP is muscular or nonspecific LBP. However, it is important for physicians to be able to detect other causes of LBP in adolescents.[13,15] Some of the more serious conditions are infection, masses (malignant and benign), spondylolysis, spondylolisthesis, lumbar disc herniation, degenerative disk disease, scoliosis, and ankylosing spondylitis.[13,15,16] Additionally, our institution recently began conducting a 3-year retrospective chart review regarding low back pain in adolescents seem to be suggesting similar gender breakdowns and prevalences of these conditions to the current literature (Tables 1 and 2). The pain and functional impairment these patients undergo can result from somatic dysfunction throughout the body, especially in the area of the lower back. An osteopathic structural examination assessing for TART findings (Tissue texture changes, Asymmetry, Restricted range of motion,

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Tenderness) may help physicians detect somatic dysfunction. This article will discuss these conditions to improve early detection and treatment and have provided a detailed summary of everything discussed at the end (Table 3).

RISK FACTORS

It is critical for physicians to know certain risk factors for LBP, as this will greatly aid them in their initial diagnostic interview with adolescents. During this initial encounter, the physician must note gender; past medical history; hours, type, and intensity of activity; and family history of LBP. Gender plays a large role, as females are more predisposed to have LBP than males.[11] As noted in Table 2, females are more likely to have pain that is discogenic in origin, and males are more likely to have spondylolysis when compared with females. There are many plausible explanations for this, from females starting puberty before males leading to girls reporting LBP earlier, to fat masses increasing at the end stage of pubertal development and replacing active muscle fibers, which can result in back problems.[17] Hours and intensity of activity are vital to note, as studies have shown that when both of these factors increase, adolescents are more likely to report LBP.[18] Additionally, adolescent athletes have a higher 1-year prevalence rate of LBP relative to nonathletes of the same age.[10]

Nonspecific or muscular LBP

As noted, one of the most common causes of LBP is acute or subacute muscle strain, or nonspecific LBP.[15] According to a previous study, 24% of adolescents who complained of LBP in an emergency department were experiencing muscle strain injury.[19] Table 2 shows that in our retrospective chart review, roughly 47.5% of all the adolescents who reported back pain had muscular or nonspecific LBP. Previous studies have suggested that specific sports that involve pushing and pulling heavy weights, such as football and weightlifting, can lead to a higher risk of acute muscle strains.[20] Conversely, other sports can cause chronic strains from repetitive overuse of the muscles, such as rowing or tennis.[20] Initial treatment involves a brief period of rest and oral analgesics, such as acetaminophen or nonsteroidal anti-inflammatory drugs (NSAIDs). Additional modalities, including manual therapies can also be considered. An osteopathic structural examination at the time of initial presentation can alert physicians to the presence of somatic dysfunction, especially involving the lumbar spine, pelvis, and sacrum. Osteopathic manipulation treatment (OMT) can then be incorporated to correct these somatic dysfunctions, resulting in decreased pain, decreased use of medication, and improved functional ability. If no improvement is noted in 2–4 weeks, radiographs of the lumbar spine and structured physiotherapy are reasonable considerations.

TABLE 1:

Shows slightly more females than males presented with a complaint of LBP in a 3-year retrospective chart review at our institution[70]

Male	922 (47.7%)
Female	1,010 (52.3%)
Total	**1,932**

TABLE 2:

Prevalence of specific diagnoses in adolescents presenting to our institution

[1]Includes disc herniation, disc degeneration, and radiculopathy caused by disc herniation.

[2]Includes coccydynia, sacroiliac pain, and facet cysts.[70]

	NONSPECIFIC OR MUSCULAR LBP	DISCOGENIC CAUSES OF LBP[1]	SPONDYLOLYSIS (WITH OR WITHOUT SPONDYLOLISTHESIS)	SCOLIOSIS	OTHER[2]	TOTAL
Male	423 (45.9%)	230 (24.9%)	192 (20.8%)	46 (5.0%)	31 (3.4%)	1,010 (52.3%)
Female	494	304 (30.1%)	89 (8.8%)	92 (8.8%)	31 (3.1%)	922 (47.7%)
Total	**917 (47.5%)**	**534 (27.6%)**	**281 (14.6%)**	**138 (7.1%)**	**62 (3.2%)**	**1,932**

TABLE 3:

Summary of common causes of LBP in adolescents including diagnosis and treatment options[70]

DIAGNOSIS	DEFINING CHARACTERISTICS	COMMON HISTORY AND EXAMINATION FINDINGS	DIAGNOSTIC TOOLS	TREATMENT
Nonspecific or muscular LBP	Acute reproducible muscle tenderness	Often seen in sports with pushing/pulling components	Osteopathic structural examination TART findings	Rest Oral analgesics Physical therapy OMT
Degenerative disc disease/ lumbar disc herniation	Protrusion or rupture of a disc Radiculopathy can also be present	Largely seen in obese patients and patients participating in high-impact sports	Straight leg raise test Advanced imaging to include MRI	Rest NSAIDs Extension-based physical therapy OMT for associated somatic dysfunction Epidural steroid injections (ESIs)
Spondylolysis/ spondylolisthesis	Stress fracture in the pars interarticularis of the vertebral arch Spondylolisthesis displacement or forward shift of one vertebra with respect to another	Most commonly seen in athletes with repetitive extension or twisting	Stork test Radiographs are often normal Advance imaging can include SPECT scan, MRI, and CT scans	Rest from activity Bracing Flexion-based therapy
Scoliosis	Lateral curvature of the spine Often minimal or no pain Can progress rapidly during adolescent growth spurt	Often seen in females and patients who have a strong family history of scoliosis	Adam forward bend test Radiographs to include anteroposterior and lateral standing views of the thoracic and lumbar spine and measurement of the Cobb angle	Monitoring curve progression Bracing Surgical intervention
Ankylosing spondylitis	Inflammatory arthropathy that affects the spine	More often seen in males than females. Patients will complain of night pain Pain improves with exercise and worsens with rest	Schober test Gaenslen test Posterior superior iliac spine (PSIS) distraction test	Promote exercise and activity to maintain spinal flexibility NSAIDs Rheumatologic evaluation

Degenerative disc disease/lumbar disc herniation

Both degenerative disc disease and lumbar disc herniation can cause LBP in adolescents.[21] This most commonly occurs at the L4-L5, and L5-S1 levels.[22] Some notable symptoms of the condition are radiating pain ("sciatica"), and pain worsening with flexion or the Valsalva maneuver.[22] According to our data, 27.6% of our adolescent population had discogenic causes of LBP.[23]

For early detection of degenerative disc disease or lumbar disc herniation, clinicians must monitor a patient's anthropometrics, as rapid changes in height or weight can predispose individuals to discogenic issues.[23] Obesity and participation in high-impact sports can play large roles in developing a herniation, as these place added stress on a patient's discs, causing injury.[24,25] A common physical examination done to test for the condition is a straight leg raise test, which has a high sensitivity and specificity rate.[26] Diagnostic imaging might also be necessary to confirm the condition, with magnetic resonance imaging (MRI) being a commonly used modality.[27,28]

The goal of treatment of adolescent lumbar disc herniation is to relieve symptoms and allow early return to routine life. The most common treatment plan for adolescents is a conservative approach with a mix of rest, physical therapy, and NSAIDs. If there is no improvement, then epidural steroid injections can be considered.[23] OMT to correct somatic dysfunction can be beneficial. Additionally, if conservative treatment fails, there is more aggressive surgical treatment that consists of surgical discectomy. Borgesen and Vang conducted a study that reviewed 158 adolescent patients who had all undergone surgery. According to the study, 93.7% of the patients reported good to excellent results after surgery. [29]

Spondylolysis/spondylolisthesis

Spondylolysis is a condition in which there is a bony defect within the pars interarticularis of the vertebral arch.[30] This can occur due to repetitive overuse, especially in extension; it can also be congenital. This injury most commonly occurs at the L5 level.[30] Spondylolisthesis is a displacement or forward shift of one vertebra with respect to another.[30] This typically occurs due to trauma and is categorized by different grade based on the percentage of slip of the superior body relative to the one inferior.[30] This typically occurs at the L5-S1 region of the vertebra.[30] Patients will complain of exertional LBP usually relieved by rest. Pain tends to worsen when patients extend at the lumbar spine. Adolescent athletes are at a higher risk for this condition than nonathletes.[31] Interestingly, according to our data, more adolescent males experience spondylosis than females. Of adolescents diagnosed with spondylolysis, roughly 70% were males and 30% females. While our data showed that this condition was most prevalent in adolescents who participated in gymnastics and weightlifting, it should be considered in any adolescent who engages in increased extension-based activities.

Studies have shown that there is no clear identifying physical examination maneuver that detects spondylosis; however, a positive Stork test is more often indicative of spondylolysis.[32] A positive Stork test must be paired with other distinctive indications of spondylosis to warrant further diagnostic imaging.[33] Common diagnostic imaging that can be used to detect this condition are anterior-posterior (AP) and lateral radiographs (72%−78% sensitivity), single-photon emission computed tomography (SPECT) scan (84% sensitivity), MRI (92% sensitivity), and computed tomography (CT) scans (90% sensitivity).[34]

For this condition, there are many treatment options that can be combined. Some of the options include rest from activity, bracing, and flexion-based therapy.[32,35] Rest from activity is generally recommended for anywhere from 4−12 weeks.[35] Bracing can also be incorporated for 4–12 weeks.[35] Braces used include soft lumbar corset brace and hard or soft thoracic lumbar sacral orthosis, with or without thigh extension.[35] Bracing is prescribed for many adults with LBP, but it is much more controversial for treatment of adolescents. A recent meta-analysis has found that most adolescents have a clinically successful outcome after undergoing conservative management, whether bracing was used or not.[36] Additionally, physical therapy is recommended with focus on flexion-based movement, which is prescribed for roughly 4–10 weeks.[35]

Scoliosis

Scoliosis is a condition in which the spine has a lateral curvature causing a structural alteration. Although some adolescents with the condition may not experience LBP, pain is found to be twice as common in patients who have scoliosis.[37] Strong risk factors for this condition include being a female and having a family history of scoliosis.[31] Roughly 30% of adolescents with idiopathic scoliosis also have a family history of the condition.[31]

Early diagnosis and proper management are crucial for physicians to properly treat adolescents with this condition. This is critical, as idiopathic scoliosis in adolescents is predictive of adult back pain.[38] It is common practice for physicians to perform the Adams forward bend test at yearly examinations to test for scoliosis.[38] Although the test is very accurate in confirming scoliosis, it can be skewed if the patient is overweight or obese. This can occur due to overlying soft tissue and increasing double major curve.[38] Additionally, an osteopathic structural exam can be performed to assess a patient's posture, balance, and range of motion, while also palpating for any asymmetry or tenderness.[39] In addition to the physical examination, a physician may also order additional diagnostic imaging to confirm scoliosis in a patient.

A common diagnostic test for scoliosis is AP and lateral standing radiograph of the thoracic and lumbar spine.[40] Radiographs allow for the severity of lateral spinal curvature to be assessed.[40] A Cobb angle, which is a critical measurement for diagnosing scoliosis, can also be determined by using radiography.[41,42] When measuring a Cobb angle, an angle of trunk rotation that is less than 5° is insignificant and does not require follow-up; while a measure of 5°−9° warrants reexamination in 6 months.[43] However, a measurement of 10° or greater requires further radiologic evaluation for more thorough Cobb angle measurement.[43,44] Spinal curve can change over time and must be evaluated periodically. Most notably, during an adolescent's growth spurt, spinal curvature can change dramatically.[45,46]

Treatment options for scoliosis range from monitoring, to bracing, to surgical correction. The goal of all of these treatments is to keep curves under 50° at maturity.[47] Typically, observation is recommended for skeletally immature patients with curves of less than 25°.[47] Bracing is recommended for adolescent patients with curves between 25° and 50°.[48] There are many bracing options. The Milwaukee brace, Boston brace, and Charleston bending brace are all used. Bracing does not correct the scoliotic curve but instead tries to prevent it from worsening.

Another option is surgical correction, which is considered for curvatures of greater than 45° in adolescent patients, and for curves greater than 50° in mature patients.[48] Surgical treatment is done to prevent progression and improve spinal alignment and balance. Strategies include fusion with and without instrumentation. Surgical approaches can be from the anterior, posterior, or both. Surgical treatment is dependent on curve type, age of the patient, and surgeon preference.[47]

Given these treatment options, health care providers should refer any adolescent with a curve greater than 10° to a spine specialist.[47] Primary care physicians' roles are to monitor and assess their patient's spinal curvature. However, once spinal curvature exceeds a significant degree, the primary care physician must refer the patient to a spinal specialist who can properly treat the curvature. Since scoliosis rarely progresses faster than 1° per month, referral within 3–6 months is appropriate.

Ankylosing spondylitis

Ankylosing spondylitis is an inflammatory arthropathy that affects the spine.[49] Two types of ankylosing spondylitis are juvenile spondylarthritis (patients 16 years and younger) and ankylosing spondylitis (patients 17 years and older).[49] Both types are more

common in males than females.[48] Patients will report night pain that resolves with exercise but does not resolve with rest.[50]

On physical examination, patients may have limited lumbar flexion, limited spinal side-bending, and limited chest expansion. Therefore, the posterior superior iliac spine distraction test and Gaenslen test have been used to measure this condition. Each test has a sensitivity rate of 100% and 90%, respectively, and specificity rate of 89% and less than 35%, respectively.[51] The Schober test is also a common physical exam performed on patients with ankylosing spondylitis, as it assesses the restrictions in lumbar range of motion.[52] Additionally, diagnostic testing can be performed to confirm the condition, most notably plain radiographs, but also SPECT and CT scans can be helpful.[53] Adolescents with juvenile spondylarthritis are at greater risk for developing degenerative hip disease including joint space narrowing, osteophytes, erosions, and protrusio acetabuli.[54] Therefore, it is essential for physicians to know early risk factors and diagnostic tests to detect this condition in its onset and prevent progressive damage as the adolescent ages.[54]

Treatment for ankylosing spondylitis aims at reducing symptoms and maintaining spinal flexibility, while maintaining life function. The mainstay of treatment has been NSAIDs and exercise. Slow-acting antirheumatic drugs can be used, at which point rheumatologic referral is reasonable.[55]

RED FLAGS

When diagnosing and treating LBP, it is imperative for the physician to be knowledgeable and aware of different "red flags" that can present. These "red flags" indicate the need for further diagnostics and potentially referrals to more specialized physicians. These factors include[56]:

- Morning stiffness
- Numbness
- Night pain
- Unexplained weight loss
- Motor weakness
- Fever or chills
- Loss of bowel or bladder control
- History of malignancy
- History of immunosuppression
- Prolonged use of steroids
- Neurologic compromise
- Pain that is increased or unrelieved by rest

If any of these factors are present in a patient, it warrants further evaluation by a spine specialist.

OSTEOPATHIC CONSIDERATIONS

In the modern health care climate, patients are often seeking additional or alternative means of treating their pain. As physicians, our goal is to provide safe and cost-effective care while simultaneously minimizing risk of undue harm. Particularly, with concerns over the rise in opioid prescribing, the need for safe and effective nonpharmacologic low back treatment is even more pressing. Adolescents who seek medical care for their reports of back pain receive an opioid prescription 20%–40% of the time.[57] The side effects and addiction potential of these medications are well documented. As physicians, we constantly weigh the risks and benefits of any intervention, while following best practices, current guidelines, and utilizing evidence-based medicine. There is an abundance of evidence demonstrating the utility and benefit of manual therapy in adults with back pain, with many of those conclusions being extrapolated and applied to treatment of back pain in adolescents. Studies have demonstrated not only improvements in pain, but also decreased use of pain medications.[57–59] There are studies demonstrating benefit and utility of OMT in the pediatric population for a variety of ailments, but a scarce amount of quality data exists regarding use of OMT for back pain in adolescents.[59,60]

Generally regarded as both safe and effective, OMT is a nonpharmacologic option that utilizes various manual techniques in an effort to correct somatic dysfunction and associated pain. Somatic dysfunction is defined as "impaired or altered function of related components of the somatic (body framework) system: skeletal, arthrodial, and myofascial structures, and their related vascular, lymphatic, and neural elements."[58] Paramount to the ability to treat somatic dysfunction is the ability to make an accurate diagnosis, and to understand and incorporate the principles of osteopathic medicine: the body is one dynamic unit of function; the body is self-regulating and self-healing; structure and function are interrelated; a treatment regimen is designed and individualized to each patient based on the understanding and implementation of the first 3 principles.[60] Whereas other forms of spinal manipulation (as performed by chiropractors, physical therapists, massage therapists, and exercise therapists) focus primarily on axillary osteoarticular structures, OMT also addresses soft tissue structures surrounding spinal and appendicular articulations. With regard to back pain, this paradigm allows for careful assessment and treatment of the axial spine, sacrum, pelvis, extremities, rib cage, cranium, and viscera.

As individuals progress through adolescence, physical and skeletal maturity becomes less similar to that of a child, and closer to that of an adult. Additionally, movement patterns become more engrained, such that treatment may directly lead to use of new movement patterns after restoration of function versus having to unlearn certain movement patterns that have been adapted as a compensatory mechanism over time.[61] Also, as joint mechanics are influenced by maturation of primary and secondary ossification centers, care must be taken to ensure techniques are applied in a careful and gentle fashion to avoid potential harm, such as fracture, subluxation/dislocation, sprain/strain, or increased pain. Such techniques would include passive techniques with either direct or indirect force applied relative to the restrictive barrier (counterstrain, myofascial release).[60] As adolescents age, more active direct techniques, such as muscle energy, direct myofascial release, and high-velocity low-amplitude thrusts, can be incorporated as part of the treatment regimen.[58,59] Treating back pain before it becomes a more chronic issue can prevent activity avoidance, deconditioning, and poor core and lower-extremity endurance, while allowing adolescents to maintain prior levels of physical activity and sports participation.[62]

A study conducted by Selhorst and Selhorst in 2015 looked at the benefit of lumbar manipulation in adolescents with acute (<90 days) LBP, measuring efficacy, when added to a dedicated exercise program. The treatments were performed by five manual therapists with no specific lumbar segmental vertebral or somatic dysfunction diagnosis, and utilized high-velocity thrust maneuvers in a "shotgun" approach.[62] The study did not find any serious adverse events, however, the patients in this trial did not have significant improvement in pain with addition of spinal manipulation. Two recent systematic reviews of OMT and chiropractic spinal manipulation for a variety of pediatric health conditions confirmed the safety of this treatment, noting only mild exacerbation of symptoms.[62,63] Another study, conducted by Evans et al in 2018, looked at spinal manipulation in adolescents with chronic back pain, again coupled with targeted exercises versus exercise alone. A 12-week course of treatment was provided to the experimental group, with outcomes measured at 12, 26, and 52 weeks. The treatment group demonstrated improvement in pain levels at all points, with statistically significant improvement at 26 and 52 weeks.[57] Secondary outcomes demonstrated 80% reduction in medication use, decreased disability, improved quality of life, and higher patient satisfaction.[57] No patients in either trial reported any adverse effects, beyond slightly increased symptoms that ultimately abated without need for further evaluation or intervention.[57,62] Additional studies are needed to look at the benefit of OMT in adolescent patients complaining of back pain with diagnosed somatic dysfunction.

At this time, there is a paucity of high-quality randomized controlled trials regarding the utilization of OMT for back pain in the adolescent population. The limited number of studies on LBP and systematic reviews for treatment of other pediatric conditions show significant improvements in pain, decreased utilization of pain medication, and a high degree of safety with only short-lived symptom aggravation. When performed by a provider skilled in OMT, it stands to reason that this modality is a useful adjunct for treatment of back pain in the adolescent population.

TREATMENT

Treatments for individual causes of LBP can vary widely. To have an effective treatment plan, there must first be accurate and early diagnosis of the cause of LBP. The most effective treatment for nonspecific LBP has been a conservative approach, emphasizing rest from offending activities and physical therapy.[14–16,63]

Rehabilitation is a multifaceted process that focuses on preserving and promoting range of motion and strength.[63] Exercises such as hip flexibility, core stabilization, and others are prescribed to strengthen the abdominal muscles, lumbar multifidi, erector spinae, as well as other paraspinal, pelvic, and cervicothoracic musculature.[27] When prescribing rehabilitation, providers must be specific with their diagnosis, as rehabilitation protocols vary based on diagnosis. For example, spondylolysis is treated through flexion-based therapy, while conditions like disc herniations and radiculopathy are treated with extension-based therapy.[63,64]

If conservative management has failed, clinicians should consider consultation with a spine specialist. Although surgery is not an option with regard to nonspecific LBP, in rare cases it may be the only option for treatment. Some examples of patients who might require surgical treatment are adolescents with high-grade spondylolisthesis or disc herniations with persistent radicular or neurologic symptoms.[65] Typically, adolescents respond much better to spine surgery relative to adults.[66]

PREVENTION

Adolescents will always be more vulnerable to trauma, as they are skeletally immature individuals, especially during periods of rapid growth.[67] Therefore, the best method to prevent LBP is for health care providers to properly educate their patients on the vulnerability of their backs, and the need for good overall health.[53] Studies have shown that strengthening of an adolescent's quadriceps, hamstrings, and core; increasing lumbar flexibility; and weight loss are all associated with reducing one's risk for developing LBP.[27] Additionally, patients should participate in regular physical activity and maintain a body mass index (BMI) below 30 kg/m^2.[24,68,69] If adolescents play in competitive sports, studies have shown that those who participate in preseason sports conditioning programs and neuromuscular training have reduced injury rates in their upcoming season.[67] Finally, adolescents should be aggressive in seeking treatment for LBP and recognize that they may need to see their primary care physician if their symptoms persist for longer than 2–3 weeks.[14]

CONCLUSION

LBP in adolescents is common and can be caused by a range of different musculoskeletal conditions. The most common causes of LBP in adolescents were discussed. A careful history, physical examination, and osteopathic structural exam can help the provider make a specific diagnosis. An appropriate treatment plan can then be instituted in an attempt to prevent acute back pain from persisting into adulthood. Therefore, clinicians must be vigilant in identifying key risk factors for certain causes of LBP in adolescents.

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