

## Patient Backpack Injuries: A Retrospective Analysis of 132 Patients

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### Abstract

**Purpose:** 132 cases of back pain associated with the use of backpacks from a Midwestern U.S. Rheumatology practice were evaluated by history, physical exam, and radiographically.

**Methods:** This was a retrospective study of 132 patients with back pain who used backpacks for carrying book, electronic, and other related equipment. History, physical examination, HLA-B27, and either spine CT or MRI were available on all patients.

**Results:** Back pain in the thoracic spine area was found in almost all. No evidence of other causes was identified and of the 11 patients with a positive HLA-B27 study were not felt to have a spondyloarthropathy. Disc changes included disc deformity and annular tears in all 132 patients some with more than one disc level affected. Weight of the backpack or age was not associated with the number of disc levels affected. Treatment was elimination of the backpack, time, and analgesics as needed.

**Conclusion:** Back pain associated with inappropriately loaded backpacks can be a source of significant discomfort. The select group of individuals with radiographic studies also demonstrated the presence of discogenic changes that may contribute to the underlying pain. Backpack associated spine pain needs to be considered in any young person who presents with back pain.

**Keywords:** Backpack Injury; Spine; Back Pain

## Introduction

Use of backpacks to carry books or related equipment is a world-wide phenomenon. There is a concern that the use of backpacks, especially if heavy, might cause musculoskeletal symptoms or even injury [1]. A study of school-aged children from Italy found that school backpacks were felt to too heavy in 79.1% of children studied and was a source of fatigue in 65.7% and low back pain in 46.1%. (Negrini 2002). A similar study from Greece found that up to 50-80% of girls in the fifth and sixth grades reported back pain related to use of a low back pain compared to 10-20% of boys of the same age. The prevalence of low back pain as well as the gender differences decreased with age but still was as in the 30% range for both genders in the ninth grade (Korovessis 2005).

With this in mind, we report the experience of backpack-associated musculoskeletal symptoms from a single large Midwestern U.S. Rheumatology practice from 1985 to 2021 including radiographic studies.

## Methods

This was a retrospective study gathered from the records of a Midwestern US Rheumatology practice. The practice receives referrals for elementary, high school, or college patients with thoracic or lumbar back pain, or young enlisted military personnel. This report details the findings in 132 patients who used backpacks and had advanced radiographic studies available, namely CT scan or MRI of the spine. All were referred for a concern about underlying Rheumatologic illness such as ankylosing spondylitis, developmental or degenerative disc disease, reactive arthritis or fibromyalgia. Back pain and the apprehension of a serious underlying disease marked the initial concerns of the patient.

All patients underwent a thorough Rheumatologic physical examination and HLA-B27 determination. Their backpacks were also examined for loading characteristics and weighed along with the weight and height of the patient.

## Results

### Patients

The patients range in age from 13 to 23 years. There were 72 (54.5%) girls are young women and 47 (45.5%) boys or young men. Backpack weight ranged from as low as 8 pounds to heavy as 154 pounds.

### Spine Pain

The discomfort was the predominant feature and the presenting complaint. In this series, it was typically localized to the thoracic region. Nine patients described non-inflammatory stiffness. Others stated their spine was “tired” without being more descriptive. Unilateral neuropathic symptoms were rare.

Each patient described their symptoms as daily, promptly worse as they donned their backpack, with little relief at night. There was very rare diurnal or nocturnal variation of the pain. Indeed, many patients stated that bedrest actually made their pain worse, or at least was no help at all.

Thirty-two patients described intermittent mild leg numbness without abnormalities found on neurologic examination.

### Physical Exam Findings

Patients were examined gowned on the exam table, free of their load. Interestingly their pain returned after they redressed and put on their backpack to leave. This lent credence to the backpack as the cause of their pain. Typically, when a patient presented with pain, they winced as they removed it. Doctors suspected the heavy weight of the backpack was related to the pain. This began the interest in the backpack as the putative cause of their symptoms; the first patient in the series presented 38 years ago (K. Margules 1983).

Pain was rarely at more than one level of the spine and was reproducible with percussion by grouping several fingers together and striking the spine level deftly, diligently keeping track of the level that was tender. Frequently, the presenting complaint was pain felt lateral to the spine and was reminiscent of a tender point seen in fibromyalgia, hence confusion with the latter in the differential diagnosis. There was never any tenderness in the sacroiliac joints, never multiple tender points, and never any peripheral joint findings.

Coughing or Valsalva maneuvers were inconsistent in provoking pain but did in 23 patients (22%) and generally caused local rather than radicular pain.

### Backpacks

The lightest backpack that was thought to be responsible for the back pain was eight pounds in a female patient who was 81 pounds, 14 years of age. The female patient with the heaviest backpack was 105 pounds who carried a backpack which itself

was 105 pounds. The male patient with the heaviest backpack was 150 pounds and carried a backpack of 154 pounds.

The most predictive features of backpain were the duration of backpack use and misloading of the backpack. No patient came for evaluation after brief usage of merely a few days. Rather, these were patients who had been using heavy backpacks, loaded with textbooks and, much later, computers, or both, for at least one month and more often longer.

Attempts to formalize the data into a ratio of weight of the backpack divided by weight of the patient or other such formulae were not successful predictors of pain. We never found that a threshold of a certain weight or height of the patient, or some ratio of the two, predicted symptoms or predicted the radiographic changes to be discussed below.

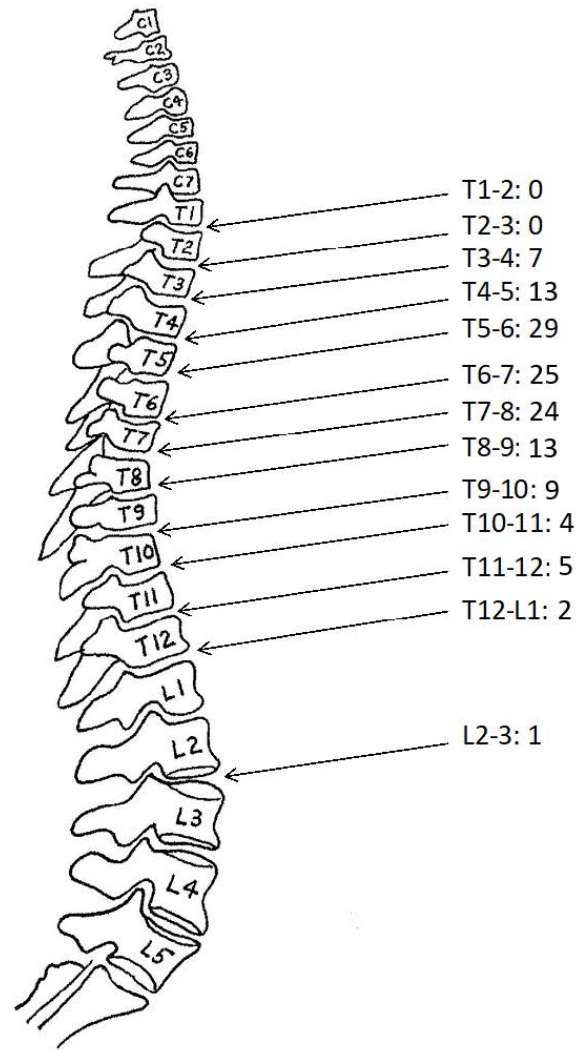
**HLA B27**

HLA B-27 determinations were gathered in all patients to be included in this study, male or female. Eleven (10%) were positive, 7 males and 4 females. However, because of their history of backpack use, the description of the pain, the lack of typical morning gel, and the absence of sacroiliitis by exam or x-ray. They were not thought to have a spondyloarthropathy. Furthermore, all were well until they started using a backpack.

**Imaging Studies**

In this group of patients there were disc changes of the thoracic spine in all but one; the remaining patient had changes at the L 2-3 level. Disc deformities were either right or left posterolateral in location as the origin of pain and agrees with [3]. A search was made for vertebral end-plate or pedicle fractures; none were identified.

A disc herniation typical of the type seen in the study is given in Figure 2, "Patient Disc Herniation of T5." The number of levels involved per patient varied from one to four levels. 45%, 59 of 132 patients, occurred in one level, 39%, 53 of 132 patients, occurred in two levels, 14%, 19 of 132 patients, occurred in three levels, and 0.01%, 1 of 132 patients, occurred in four levels. See Table 1, "Disc Injury Data." Thoracic intradural disc herniations are rare, and were not seen in this series [3].



**Figure 1:** Levels and numbers of discogenic abnormalities seen on CT/MRI of the spine in 106 patients

**Table 1:** Disc Injury Data

Number of Disc Injuries	Number of Patients	Percentage of Patients
1	59	45
2	53	39
3	19	14
4	1	0.01



**Figure 2:** View of T<sub>6</sub>-T<sub>7</sub>, Herniated Nucleus Pulposus

## Treatment

Treatment is first eliminating the backpack, education regarding the problem, pain relievers, and time for the problem to resolve. We did not find that bedrest was useful. Physical activity such as jogging and running made the symptoms worse. Several patients had epidural cortisone injections or acupuncture (not prescribed by the authors) and these were not helpful. Pain persisted in some cases for eight to twelve months without return to the use of a backpack, but did eventually resolve as did the mild parathesiae that were reported by a few patients.

## Discussion

Backpack injury can be painful and debilitating. Affected patients were generally those who often carried misloaded large textbooks or equipment on a regular prolonged basis. This is actually the hallmark of their dilemma. Their behavior continued despite the discomfort in their back. In their defense, if a student complained that there wasn't enough time to go to lockers for their books between classes, either because the school build-

ing was large or they were required to walk from one building to a different one, they were offered no accommodation.

We found a predilection for discogenic changes by CT/MRI in the thoracic spine (99%), although a small percentage occurred in the lumbar spine (1%). Other studies have focused on either the lumbar level or included the spine in toto [4,1]. In our series the entire spine was open to investigation. The radiographic data is one of the strengths of this study but also may have selected a group of patients with more severe disease since it was felt that advanced imaging was necessary to further evaluate their pain.

Backpack associated spine pain is common. In an unselected cohort of patients, 46% were found to complain of backpack associated spine discomfort (Negrini 2002). In a study of 123 eighth-graders by [1], several factors were associated with back pain. Back pain was most commonly seen in girls, those with a backpack weight greater than 20% body weight and in those who walked to school with their backpacks. Overall, 82.9% reported spine pain during the year with 16.3% having a single episode, 57.7% recurrent pain, and 8.9% reporting chronic pain. In addition, 18.7% of the patients sought medical help for the pain and 14.6% avoided sports activities or missed school due to the pain. Not all of the pain may have been related to backpack use although this was certainly a contributing factor [1] Further evaluation on the topic is warranted.

A recent systemic review of back pain in children and adolescents did not find any association with weight of the backpack, design, or carriage method on prevalence of back pain. Our study also did not find any association of backpack weight compared to patient weight etc. We did find that asymmetry of loading and duration of use were associated with pain similar to the findings of Korvessis et al based on altered spine alignment (Korvessis 2005).

Load carrying injuries are reported in soldiers carrying heavy loads, with back injuries being the most common reported site of injury. General physical conditioning did not seem to prevent these injuries (Orr 2015).

The strengths of this study are the radiographic data. Weaknesses include the lack of a control group and the severity of this group based on the need for advanced imaging. Nevertheless, it is important for providers who see children and young adults with spine problems to inquire about the use of a backpack and characteristic of that use as part of the evaluation.

## Conclusion

Messenger bags, over-the-shoulder, or bags with a strap over one shoulder and the bag on the opposite hip, were not found in this series. For reasons beyond this author's ken they did not bother students. Backpacks with (any) frames and symmetry of weight on both the left and right sides caused the most pain. Furthermore, they were the most frequently employed by the patients. These backpacks tend to be expensive and well-engineered. We are at a loss to explain why there is a difference between these two types. This experience, however, supports the study Knapik of [5] in which they similarly observed that any framed backpack could prompt pain. Over-the-shoulder bags were also less likely to be painful and were not seen in our series of patients. Lack of presentation in this series may be due to these style bags typically being smaller, able to carry less weight, and can be easily shifted side-to-side.

Backpacks in this series were frequently loaded incorrectly. Books tend to be the heaviest article and should be in the lower section putting the load on level with the lumbar spine. This spares the otherwise well-encircled thoracic spine which resists fracture, but not disc compression. While backpacks are designed not to sway, swaying does not present threat to the thoracic spine. Today there are a number of adjustable metal, canvas, or nylon straps to custom fit the load. These have evolved since early days of study and generally can be easily fit to the carrier at home or in the field.

It is not wrong to think of backpack injuries as a repetitive injury to the disc [6]. This has been discussed by Ullrich et al. In their study, rat discs were stabbed at zero, three, and six-day intervals. A prolonged inflammatory response was detected in the injured discs. Non-steroidal drugs were administered as treatment. Our experience, however, failed to note any improvement with non-steroidal anti-inflammatory drugs. Steroids were not utilized in this series.

It is reassuring to note that thoracic spine injuries are frequently less dangerous than cervical or lumbar injuries. The thoracic spine is analogous to a cage and is somewhat stabilized from the ventral side by the ribs [7]. Our study did describe thirty-two patients who described numbness in the ipsilateral leg. With correction of their habits, these symptoms gradually resolved.

This brings us to our final point. Patients with backpack injuries generally had a good prognosis [8]. The pain however

persisted in some cases for eight to twelve months, without return to the use of the backpack. During this time, patients were supported with analgesics, physical therapy, braces, and avoidance of running or jogging. Generally, these measures were of little comfort. The pain gradually improved over time whether treatment included the above or simple abstinence of a backpack. There was no worthwhile procedural intervention to help the pain resolve. Waiting, analgesics, and avoidance of the backpack were an acceptable treatment approach given the fact there were no serious neurological deficits. Surgery was unnecessary in this series [9-13].

Implications of the manuscript are two-fold. Patients with back pack injuries are common and seen by physicians who should counsel the patients and their family about the diagnosis and treatment. A team approach including those involved including the diagnosing physician, practitioners of Physical Medicine and Rehabilitation, the patient, family and school is welcome.

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