Preview of the Medifocus Guidebook on: Spondylolisthesis

Updated January 26, 2023

This document is only a SHORT PREVIEW of the **Medifocus Guidebook on Spondylolisthesis**. It is intended primarily to give you a general overview of the **format and structure** of the Guidebook as well as select pages from each major Guidebook section listed in the Table of Contents.

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1 - Background Information

Introduction

Chronic or life-threatening illnesses can have a devastating impact on both the patient and the family. In today's new world of medicine, many consumers have come to realize that they are the ones who are primarily responsible for their own health care as well as for the health care of their loved ones.

When facing a chronic or life-threatening illness, you need to become an educated consumer in order to make an informed health care decision. Essentially that means finding out everything about the illness - the treatment options, the doctors, and the hospitals - so that you can become an educated health care consumer and make the tough decisions. In the past, consumers would go to a library and read everything available about a particular illness or medical condition. In today's world, many turn to the Internet for their medical information needs.

The first sites visited are usually the well known health "portals" or disease organizations and support groups which contain a general overview of the condition for the layperson. That's a good start but soon all of the basic information is exhausted and the need for more advanced information still exists. What are the latest "cutting-edge" treatment options? What are the results of the most up-to-date clinical trials? Who are the most notable experts? Where are the top-ranked medical institutions and hospitals?

The best source for authoritative medical information in the United States is the National Library of Medicine's medical database called PubMed®, that indexes citations and abstracts (brief summaries) of over 7 million articles from more than 3,800 medical journals published worldwide. PubMed® was developed for medical professionals and is the primary source utilized by health care providers for keeping up with the latest advances in clinical medicine.

A typical PubMed® search for a specific disease or condition, however, usually retrieves hundreds or even thousands of "hits" of journal article citations. That's an avalanche of information that needs to be evaluated and transformed into truly useful knowledge. What are the most relevant journal articles? Which ones apply to your specific situation? Which articles are considered to be the most authoritative - the ones your physician would rely on in making clinical decisions? This is where *Medifocus.com* provides an effective solution.

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high quality, up- to-date digest of "professional-level" medical information consisting of the most relevant citations and abstracts of journal articles published in authoritative, trustworthy medical journals. This information represents the latest advances known to modern medicine for the treatment and management of the condition, including published results from clinical trials. Each *Guidebook* also includes a valuable index of leading authors and medical institutions as well as a directory of disease organizations and support groups. *MediFocus Guidebooks* are reviewed, revised and updated every 4-months to ensure that you receive the latest and most up-to-date information about the specific condition.

About Your MediFocus Guidebook

Introduction

Your *MediFocus Guidebook* is a valuable resource that represents a comprehensive synthesis of the most up-to-date, advanced medical information published about the condition in well-respected, trustworthy medical journals. It is the same type of professional-level information used by physicians and other health-care professionals to keep abreast of the latest developments in biomedical research and clinical medicine. The *Guidebook* is intended for patients who have a need for more advanced, in-depth medical information than is generally available to consumers from a variety of other resources. The primary goal of a *MediFocus Guidebook* is to educate patients and their families about their treatment options so that they can make informed health-care decisions and become active participants in the medical decision making process.

The *Guidebook* production process involves a team of experienced medical research professionals with vast experience in researching the published medical literature. This team approach to the development and production of the *MediFocus Guidebooks* is designed to ensure the accuracy, completeness, and clinical relevance of the information. The *Guidebook* is intended to serve as a basis for a more meaningful discussion between patients and their health-care providers in a joint effort to seek the most appropriate course of treatment for the disease.

Guidebook Organization and Content

Section 1 - Background Information

This section provides detailed information about the organization and content of the *Guidebook* including tips and suggestions for conducting additional research about the condition.

Section 2 - The Intelligent Patient Overview

This section of your *MediFocus Guidebook* represents a detailed overview of the disease or condition specifically written from the patient's perspective. It is designed to satisfy the basic informational needs of consumers and their families who are confronted with the illness and are facing difficult choices. Important aspects which are addressed in "The Intelligent Patient" section include:

- The etiology or cause of the disease
- Signs and symptoms
- How the condition is diagnosed
- The current standard of care for the disease
- Treatment options

- New developments
- Important questions to ask your health care provider

Section 3 - Guide to the Medical Literature

This is a roadmap to important and up-to-date medical literature published about the condition from authoritative, trustworthy medical journals. This is the same information that is used by physicians and researchers to keep up with the latest developments and breakthroughs in clinical medicine and biomedical research. A broad spectrum of articles is included in each *MediFocus Guidebook* to provide information about standard treatments, treatment options, new clinical developments, and advances in research. To facilitate your review and analysis of this information, the articles are grouped by specific categories. A typical *MediFocus Guidebook* usually contains one or more of the following article groupings:

- *Review Articles:* Articles included in this category are broad in scope and are intended to provide the reader with a detailed overview of the condition including such important aspects as its cause, diagnosis, treatment, and new advances.

- *General Interest Articles:* These articles are broad in scope and contain supplementary information about the condition that may be of interest to select groups of patients.

- *Drug Therapy:* Articles that provide information about the effectiveness of specific drugs or other biological agents for the treatment of the condition.

- *Surgical Therapy:* Articles that provide information about specific surgical treatments for the condition.

- *Clinical Trials:* Articles in this category summarize studies which compare the safety and efficacy of a new, experimental treatment modality to currently available standard treatments for the condition. In many cases, clinical trials represent the latest advances in the field and may be considered as being on the "cutting edge" of medicine. Some of these experimental treatments may have already been incorporated into clinical practice.

The following information is provided for each of the articles referenced in this section of your *MediFocus Guidebook:*

- Article title
- Author Name(s)
- Institution where the study was done
- Journal reference (Volume, page numbers, year of publication)

- Link to Abstract (brief summary of the actual article)

Linking to Abstracts: Most of the medical journal articles referenced in this section of your *MediFocus Guidebook* include an abstract (brief summary of the actual article) that can be accessed online via the National Library of Medicine's PubMed® database. You can easily access the individual abstracts online via PubMed® from the "electronic" format of your *MediFocus Guidebook* by clicking on the corresponding URL address that is provided for each cited article. If you purchased a printed copy of a *MediFocus Guidebook*, you can still access the article abstracts online by entering the individual URL address for a particular article into your web browser.

Section 4 - Centers of Research

We've compiled a unique directory of doctors, researchers, medical centers, and research institutions with specialized research interest, and in many cases, clinical expertise in the management of the specific medical condition. The "Centers of Research" directory is a valuable resource for quickly identifying and locating leading medical authorities and medical institutions within the United States and other countries that are considered to be at the forefront in clinical research and treatment of the condition.

Inclusion of the names of specific doctors, researchers, hospitals, medical centers, or research institutions in this *Guidebook* does not imply endorsement by Medifocus.com, Inc. or any of its affiliates. Consumers are encouraged to conduct additional research to identify health-care professionals, hospitals, and medical institutions with expertise in providing specific medical advice, guidance, and treatment for this condition.

Section 5 - Tips on Finding and Choosing a Doctor

One of the most important decisions confronting patients who have been diagnosed with a serious medical condition is finding and choosing a qualified physician who will deliver high-level, quality medical care in accordance with curently accepted guidelines and standards of care. Finding the "best" doctor to manage your condition, however, can be a frustrating and time-consuming experience unless you know what you are looking for and how to go about finding it. This section of your Guidebook offers important tips for how to find physicians as well as suggestions for how to make informed choices about choosing a doctor who is right for you.

Section 6 - Directory of Organizations

This section of your *Guidebook* is a directory of select disease organizations and support groups that are in the business of helping patients and their families by providing access to information, resources, and services. Many of these organizations can answer your questions, enable you to network with other patients, and help you find a doctor in your geographical area who specializes in managing your condition.

2 - The Intelligent Patient Overview

SPONDYLOLISTHESIS

Introduction to Spondylolisthesis

Spondylolisthesis is an uncommon spinal condition that develops when one spinal vertebra slips over the one immediately below it. In order to understand this condition, and a related condition called *spondylolysis*, which is a precursor for some types of spondylolisthesis, it is important to review the components of the spine and how they function.

The Spine

The spine is made up of a series of interconnecting bones called *vertebrae* (an individual unit is called a *vertebra*). The *vertebral column* (spine) is the main support structure for the body and keeps it upright and balanced. Other functions of the spine include:

- Providing platforms for attachments of many muscles and ligaments that traverse the skull, the thorax, and the pelvis
- Permitting the trunk of the body to have appreciable flexibility of movement, such as twisting, bending, or arching the back
- Protecting the spinal cord while providing openings between adjacent vertebrae for the passage of spinal nerves

The spinal column consists of 33 bones and is divided into:

- 7 *cervical* vertebrae ("C1-C7") which form the upper part of the spine between the skull and the chest
- 12 *thoracic* vertebrae ("T1-T12") which are found between the upper chest and lower back
- 5 *lumbar* vertebrae ("L1-L5") which form the lower back and are the largest and strongest of the vertebrae
- 5 vertebrae ("S1-S5") fused together form the *sacrum*, a triangular-shaped promontory that connects the spine to the pelvis and provides support for the spine
- 4 fused vertebrae that form the *coccyx* ("tail bone"), which has little known function

The vertebrae are connected much like the links of a chain. Although there are differences of function among the vertebrae of the various regions of the spinal column, there is a basic design common to all of them.

A typical vertebra is comprised of several components, including:

- *Vertebral body* - main anterior bony part of the vertebra. It faces the front (anterior) of the

body and is the weight-bearing segment of the vertebra. It is cylindrical in shape.
- *Centrum* - the thick anterior portion of the vertebra. It is the largest part of the vertebra.
- *Pedicles* - two short stalks that project off of the right and left sides of each vertebral body and function as attachment sites for muscles and ligaments of the spine. They also make up the sides of the *neural arch*.
- *Laminae*- flat bones that arise from the posterior part of the vertebra. They form the roof of the spinal canal and protect the spinal cord.
- *Vertebral (neural) arch* - arises from the posterior surface of the centrum and forms a circle of bone around the canal through which the spinal cord passes. A vertebral arch is composed of a floor at the back of the vertebra, walls (the pedicles), and a roof where two *laminae* join.
- *Vertebral foramen* (also called the *spinal canal*) - opening formed by the (anterior) centrum, and the (posterior) vertebral arch. It is an enclosed space through which the spinal cord passes.
- *Processes* - bony projections from the back of the vertebra that function as important attachment sites for spinal muscles and ligaments. There are three processes, namely:

    - *spinous process* - a projection from the posterior, midline region of the neural arch (these projections are the bumps that can be felt when moving a hand down the spine)
    - *superior* and *inferior articulating processes* - there is a pair of each of these processes on each side of the neural arch. The superior processes project upward and the inferior project downward. Each articulating process has a smooth surface that interlocks and forms a *facet joint* between the vertebra above and below it which facilitates movement of the spine and also increases the rigidity of the vertebral column.
    - *transverse processes* - processes that project outward from each side of the vertebra and are located between the superior and inferior processes.

- *Facet joints* - a joint formed by the two inferior articulating processes interconnecting with the superior process of the vertebra below, like the link of a chain. Each vertebra has two facet joints. The joints provide stability while allowing movement. They are almost always in constant motion and tend to wear out or degenerate.

- *Pars interarticularis* (also called just *the pars*) - a thin isthmus of bone that forms a bridge and connects the upper and lower facet joints of contiguous vertebrae. The pars is very thin with poor blood supply which makes it vulnerable to stress fractures.
- *Intervertebral disk* - a flat cartilaginous disk that sits between the vertebrae and acts as a shock absorber for any movement of the spine, thereby enabling the spine to bend, stretch, and twist.

What is Spondylolisthesis?

Spondylolisthesis occurs when one vertebra slips over the vertebra just below it. Though it can occur at the level of cervical vertebrae, it occurs most often at the level of the lumbar vertebrae. Symptoms can range from none at all to severe symptoms with pain and weakness in the legs. Slippage may result in *lordosis* ("swayback") or *kyphosis* ("roundback"), a backward curve of the spine at the lower back where L5 (the fifth lumbar vertebra) slips over the sacral promontory. Most cases of spondylolisthesis are not severe and do not involve high levels of slippage.

Spondylolisthesis can be caused by various conditions, but the symptoms are basically similar and include:

- Lower back pain
- Stiffness in the back
- Localized pain or tenderness in the back just above the pelvis
- Tight hamstrings
- Pain in the thighs and legs (*radiculopathy*)
- Pain in the buttocks

Classification of Slippage in Spondylolisthesis

The severity of spondylolisthesis is determined by the degree of slippage observed on X-rays. The Meyerding's Grading System is most commonly used by clinicians to measure the degrees of slippage which include:

- Grade I = 1% to 25%
- Grade II = 26% to 50%
- Grade III = 51% to 75%
- Grade IV = 76% to 100%
- Grade V is called *spondyloptosis* and occurs when the L5 vertebra completely slides over the top of the sacrum.

Grades I and II (below 50% slip) indicate "low grade slippage" are considered as *stable spondylolisthesis*, and Grade III and higher as *unstable spondylolisthesis*. Slippage grade in most cases of spondylolisthesis is low-grade (75% at Grade I and 20-25% at Grade II). Grade III and above are considered to be *high-grade slippage*.

Types of Spondylolisthesis

The standard accepted classification system for spondylolisthesis is that of Newman, Wiltse, and McNab that was published in 1976 in *Clinical Orthopaedics and Related Research* (vol.117:pp.23-29). This system describes the etiology of five types of spondylolisthesis and also highlights the anatomic lesion responsible for the slip. The five types of spondylolisthesis are:

- Dysplastic or congenital
- Isthmic
- Degenerative
- Traumatic
- Pathologic
- Iatrogenic (post-operative) spondylolisthesis

The most common forms of spondylolisthesis are isthmic, degenerative and dysplastic.

Dysplastic or Congenital Spondylolisthesis

This type of spondylolisthesis accounts for up to 20% of treated cases. Slippage is related to a

congenital malformation of spinal structures, usually a neural arch defect of L5 or the upper sacrum or dysplastic sacral facet joint. *Spina bifida* (incomplete closure of the embryonic neural tube) is frequently present (seen in up to 94% of cases of congenital spondylolisthesis) and scoliosis (spinal curvature) at the level of the slip is noted in up to 50% of cases of congenital spondylolisthesis. There is a high rate of nerve root involvement, such as compression, associated with dysplastic spondylolisthesis. Dysplastic spondylolisthesis usually causes pain during adolescence but not during childhood.

Isthmic Spondylolisthesis

This is the main focus of the Medifocus Guidebook on Spondylolisthesis and is discussed at length below.

Degenerative Spondylolisthesis

This type of spondylolisthesis is due to chronic degeneration of the vertebral facets and is considered in most cases to be secondary to osteoarthritis. It usually occurs later in life (after the age of 50), and is one of the causes of *spinal stenosis* (narrowing of the spinal canal). The location of degeneration is most frequently at the level of L4-L5 (six to ten times more frequent than other locations), though it can also be present at the L3-L4 level. More infrequently, it may occur at the L5-S1 level. It is diagnosed in females approximately five times more frequently than males. Degenerative spondylolisthesis is the most common type of spondylolisthesis in adults. In some people, there may be a combination of disk degeneration and/or pars injury that causes the slippage. The degree of listhesis (slippage) usually does not progress beyond Grade I (mild).

Traumatic Spondylolisthesis

The cause of this type of spondylolisthesis is an acute fracture of some part of the spinal process, such as the neural arch or the pars, which causes destabilization of the vertebral segments. It can occur at any age.

Pathologic Spondylolisthesis

This type of spondylolisthesis results from diseases that affect the bones and cause destabilization of the spinal structures.

Postoperative/Iatrogenic Spondylolisthesis

An additional type of spondylolisthesis is gaining increasing recognition and is called *postoperative* or *iatrogenic spondylolisthesis* and it results from complications of surgical intervention. This classification was recently added and results from excessive removal of the posterior elements of the pars or other spinal supporting structures after *laminectomy* (spinal surgery usually performed to correct disk herniation or nerve compression caused by spinal stenosis). The incidence of iatrogenic spondylolisthesis is thought to be approximately 3-5% of cases of treated spondylolisthesis.

Isthmic Spondylolisthesis

This type of spondylolisthesis is due to progression of *spondylolysis* (the presence of a defect or fracture of the pars) that becomes unstable and causes slippage of one vertebra (usually L5) over the one below it (S1). There are three subtypes of isthmic spondylolisthesis:

- Subtype IIA - a defect due to a fatigue fracture of the articulating segment and associated with complete bony separation. This is more common in individuals under 50 years of age.
- Subtype IIB - elongation of the articulating segment due to repeated microfractures, but no separation. Bony areas may form around the improperly healed microfractures. The result is an elongated pars which may eventually break and over time may transform to Type IIA.
- Subtype IIC - acute fracture of the articulating segment.

In order to understand spondylolisthesis, it is important to understand a condition called "spondylolysis" which, as noted above, is typically the precursor to the development of spondylolisthesis.

Spondylolysis was first described in the medical literature in the mid-1800s. As noted above, it involves the degeneration, defective development, or fracture of the *pars interarticularis* typically at the level of L5. The most common known cause of spondylolysis is a stress fracture, often related to physical activity such as sports, but sometimes the cause is unknown. If the defect of the pars, regardless of the origin, weakens the bone (vertebra) to the point where it is unable to maintain its position, the affected vertebra may then shift out of place and slip over the vertebra below it. Normally, posterior facets, ligaments, and intervertebral disks provide resistance to forward displacement of the vertebrae. When there is a defect, fracture, or elongation of the pars, however, the posterior elements may no longer be strong enough to hold the vertebra in its correct anatomical position. This also increases the stress on the intervertebral disk and may cause it to stretch. If the posterior elements also slide forward, stenosis (narrowing of the spinal canal) and compression on nearby nerves occurs. If the defect in the pars is unilateral (occurring only on one side), there may be no slippage and no progression to spondylolisthesis.

Spondylolysis is the most common cause of low back pain in children and adolescents. In the majority of young children vertebral development is normal, but around the age of six to eight, some children experience abnormal growth and development of this particular area of the vertebra making it vulnerable to injury from participating in certain sports. The bony defect is virtually nonexistent among newborns, but exists in 5% of six year olds and in approximately 6% of adults.

Most children and adults with spondylolysis are asymptomatic (have no symptoms) and may discover its existence only incidentally when they seek medical advice for back pain that may not be related to the condition. Although spondylolysis develops in childhood, it remains unclear why for some people no symptoms ever appear and for others, symptoms may develop many years later. Some studies suggest that only 20% of adult patients with spondylolysis are symptomatic before the age of 20.

Spondylolysis is common in people who participate is sports such as diving, weight lifting, wrestling, bobsledding, and gymnastics - activities that require repetitive hyperextension (stretching) of the lumbar portion of the spine. But repetitive stress over time, or an acute extension injury to the lumbar spine, may also cause the condition in susceptible adults who did not experience spondylolysis as children or young adults.

There are two stages of injury of the pars (spondylolysis) that may ultimately result in vertebral slippage (spondylolisthesis):

- Stress reaction - this occurs from excessive wear and tear due to either activities of daily living, lifestyle, sports, or trauma (e.g., falling). Nothing unusual appears on X-ray images, but a bone scan may show increased activity in the region of the pars. Stress on the pars is the initiating factor in the development of spondylolysis. Symptoms associated with this stage include:

    - low back pain
    - low back stiffness
    - tightness of the hamstring muscle - a group of large, powerful muscles that passes along the back of the thigh, from the lower pelvis to the back of the shin bone

- Fracture - fracture or crack (stress fracture) in the pars that can be seen on X-ray. It may occur due to repetitive extension or rotation of the lower back where the pars cannot absorb the constant shock and, consequently, develops a stress fracture that weakens the bone over time. Once the pars is injured and the defect is created, healing of the fracture is often prevented by anatomic and/or biomechanical forces, leading to instability at the level of the fracture. If the stress fracture weakens the bone to the point where it is unable to maintain its position, the vertebra may then shift out of place and slide forward over the vertebra below it (spondylolisthesis).

Spondylolisthesis develops when the gap caused by the fracture widens and, as a result, the L5 vertebra shifts forward over the sacrum. Slippage typically results from bilateral fracture of the pars which prevents the posterior articulating facets from providing adequate stability. Because the vertebral motion is abnormal and is chronic, the pars cannot heal properly. As new bone forms around the fracture, it may compress nearby nerves.

Natural History of Spondylolisthesis

Most patients with low-grade spondylolisthesis are asymptomatic. The clinical course of the condition is generally benign regardless of age. Slip progression is rare even during adolescent growth spurts and is thought to occur in up to 4% of cases of children with low-grade spondylolisthesis. Although the pars defect usually occurs before skeletal maturity, typically symptoms (if they occur) appear only in adulthood and, at that point, individuals may seek treatment for ongoing back pain.

High-grade spondylolisthesis is thought to occur in 5-10% of cases of spondylolisthesis. It typically develops during childhood or adolescence and is associated with a high risk of progression. Symptomatic high-grade spondylolisthesis is more likely to cause pain and is less likely to respond to treatment than symptomatic low-grade spondylolisthesis. Adults who are diagnosed with high-grade slippage are typically stable and rarely experience further progression of slippage. The time for highest risk of progression of slip in spondylolisthesis is before skeletal maturity; progression rarely occurs later. Progressive slip in high-grade spondylolisthesis raises the risk of *lumbosacral kyphosis*, an outward curvature at the lower back, which can cause imbalance that affects posture and gait.

Slip progression after skeletal maturity is usually related to disk degeneration (secondary to arthritis) at the slip level. This is likely to develop during the fourth and fifth decades of life with the onset of degenerative spondylolisthesis. As the disk loses its structural and functional integrity, the lumbosacral junction (L5-S1) becomes unstable and the slip progresses and can cause severe, incapacitating back and leg pain. This concurrent occurrence of disk degeneration and adult slip progression explains how asymptomatic spondylolisthesis can be present for at least two or three decades before becoming symptomatic. It is associated with signs of mechanical instability and spinal stenosis resulting in significant low back pain and possibly radicular (radiating) pain in the back of the legs. The magnitude of symptoms is not necessarily related to the grade of slippage, since symptoms may be related to nerve compression, which can happen with any grade.

In 1955, a large long-term study of 500 first graders was initiated with the intention of tracking the natural progression of spondylolysis and development to spondylolisthesis. A 45-year follow up study was published in 2003 in *Spine* (vol.28(10):pp.1027-1035). At the outset of the study, each child underwent an X-ray of the spine to determine the presence of spondylolysis. The 45-year follow up consisted of a spinal magnetic resonance imaging scan (MRI), a questionnaire regarding back pain, and a health-related quality of life survey filled out by each subject who was available from the original study. Some of the findings included:

- Thirty children were identified to have a defect of the pars - approximately 22 (4.4%) of the children had either unilateral or bilateral pars defect (spondylolysis) and eight developed a defect later in early adulthood, indicating that the incidence of spondylolysis is 4.4% at six years old and 6% in adulthood.
- No subjects with a unilateral pars defect had developed slippage at follow-up.
- Progression of slippage was associated with disc degeneration.
- Among those with bilateral pars defects who progressed, progression was slow and occurred mostly in the first and second decade of life.
- When contacted again in their 60s, only five of the 19 subjects with spondylolisthesis had progressed to a Grade II slip.
- Progression of spondylolisthesis slowed with each decade.
- There was no association between slip progression and low back pain.
- Health-related quality of life scores of the entire group at follow-up did not differ from those of the general population.
- At follow-up, no subjects reported disability.

Further information can be found by following this link:
http://www.ncbi.nlm.nih.gov/pubmed/12768144

A survey of 4,151 adults was conducted in Denmark to identify the distribution and risk factors for lumbar spondylolysis and published in 2007 in *European Spine Journal* (v.16(6):pp.821-828). The age range of subjects was 22-93. Spinal X-rays identified subjects with pars defects and slippage. Results indicated that:

- There were 52 cases of spondylolysis at L4 and at follow-up, 42 of those individuals (80%) progressed to Meyerding slips Grade I-II.
- There were 123 cases of spondylolysis at L5 and at follow-up, 85 of those individuals (69%)

progressed to Meyerding slips Grade I-III.
- In women, L5 slip progression was related to aging, while L5 slip progression in men was significantly associated with body mass index (BMI - a measure of obesity) at the time of the original radiographs.
- L4 slip progression was significantly related to BMI for both men and women.
- Neither occupational activities, such as repeated lifting, or smoking were related to slip progression in either gender.
- There was no significant relationship between low back pain and spondylolysis, though women complained of low back pain more than men.
- Other risk factors associated with spondylolysis in men and women included lordotic angle (degree of spinal swayback curve) and pelvic inclination (angle of the pelvic tilt).

The authors of this study concluded that in contrast with conventional wisdom that spondylolysis and progression to spondylolisthesis is mostly restricted to children and adolescents, spondylolysis does indeed progress in adults in the majority of cases and for some individuals, slippage may continue slowly throughout life. In addition, they found that women are affected by spondylolysis more often than previously thought. To read more about this article, please click on the following link: http://www.ncbi.nlm.gov/pubmed/17120072

Nerve Root Compression in Spondylolisthesis

The spinal cord ends at the lower thoracic vertebrae and, at that point, the lumbar and sacral nerves come off the bottom of the spinal cord and exit through the lumbar vertebrae and the sacrum. Nerve root compression in spondylolisthesis can be caused by:

- Anterior slippage of L5 over S1, which may lead to a narrowing of the opening through which the nerve passes (*foramen*)
- Degeneration of vertebral discs, which can lead narrowing of the disc space in adult
- A disc that is degenerating which may also bulge anteriorly and cause pressure on the nerve root
- A pars defect, which may stimulate fibrous growth around the injury which compromises the opening of the foramen

What Causes Spondylolisthesis?

The pathological causes of the various types of spondylolisthesis include:

- Congenitally dysplastic joints
- Hyperextension of the lumbar spine
- Degenerative joint disease (arthritis)
- Trauma
- Bone disease
- Genetics
- Sacral plate abnormality

Congenitally Dysplastic Joints

Children who are born with dysplastic (underdeveloped) facet joints, which affect the stability of the vertebrae, may develop slippage of one vertebra over another. The presence of dysplastic (abnormally developed) sacral facet joints is accompanied by forward movement of the L5 vertebra leading to stress on the pars, which may then fracture and result in slippage of the L5 over the sacrum. The neural arch typically compresses the nerve as it slips.

Hyperextension of the Lumbar Spine

Hyperextension of the lumbar spine is typically the cause of isthmic spondylolisthesis through several mechanisms, including:

- Trauma - Hyperextension of the lumbar spine is commonly found in children and adolescents who play impact sports and for whom repetitive impact causes stress fractures or fatigue of the pars. Up to 40% of athletes with spondylolysis recall having some type of back injury.
- Weak pars interarticularis - Researchers believe that most children with spondylolysis may be born with a weak pars that makes them more vulnerable to stress fractures that ultimately may evolve into spondylolisthesis. Biomechanical studies suggest that the pars is the weakest part of the posterior neural arch, which may predispose it to injury with certain repetitive motions.
- Abnormal bone healing - If normal bone healing does not follow stress microfractures, then the pars can become elongated and cause imbalance, setting the stage for slippage. Elongation of the pars can also be a congenital condition.

Degenerative Joint Disease

Chronic degenerative disk disease and arthritis (degenerative joint disease) cause instability between the affected vertebrae that leads to slippage, most commonly at the level of L4-L5. Nerve roots coming out of L5 are typically compressed due to stenosis (narrowing) of the spinal canal. Progression of slippage occurs in approximately 30% of cases, but it usually does not exceed Grade I. Degenerative spondylolisthesis is not related to spondylolysis and may be related to the pars only in terms of the overall degenerative process in the joints.

Some researchers theorize that degenerative spondylolisthesis may also be related to increased laxity of ligaments due to hormonal changes.

Trauma

Trauma can lead to spondylolisthesis by a variety of different mechanisms:

- Fracture of the neural arch
- Fracture of the pars interarticularis
- Fracture of the articulating processes of the vertebrae
- Fracture of the facet joints
- Traumatic subluxation or dislocation of the facet joints

Bone-Related Disease

Certain bone-related diseases can cause abnormal mineralization of the bone which results in remodeling (effort of the bone to repair itself) or attenuation (reduced density of bone). When the

vertebrae are affected, instability ensues that can lead to spondylolisthesis. Some examples of bone disease include:

- Syphilis - a sexually transmitted disease (STD) that in the late stage can cause bone damage
- Paget's disease - a disorder that results in enlarged and deformed bones caused by causes a malfunction in the normal process of bone breaking down (resorption) and rebuilding (regeneration)
- Albers-Schonberg's disease - an genetic disorder characterized by an increase in bone density
- Osteogenesis imperfecta - a genetic disorder characterized by bones that break easily, often from little or no apparent cause

Genetic Factors

Evidence of a genetic link to spondylolisthesis includes:

- Family history - there is an increased incidence of spondylolysis in up to 70% of first-degree relatives of individuals with either congenital or isthmic spondylolisthesis
- Gender - spondylolysis is two to three times more prevalent in males than females, while spondylolisthesis is two to three times more prevalent in females than males
- Race - the prevalence of spondylolysis in Caucasians (approximately 6%) is thought to be two to three times higher than in African Americans who have an incidence of only approximately 1.5%. Also, certain ethnic groups such as Eskimos have very high rates of spondylolysis (25-50%), indicating a strong genetic component.

Sacral Plate Abnormality

Recently, investigators studied radiographic and surgical reports of patients with spondylolisthesis and noted that patients with high-grade slips appear to have in common an abnormality of the growth plate on the sacrum. Another study of 27 patients with spondyloptosis (Stage V where L5 slides completely over the sacrum) indicated that all of them exhibited a rounding of one area of the sacral plate. This has led investigators to ponder whether some cases of spondylolysis and spondylolisthesis are caused by a defect in the pars interarticularis or by an abnormality of the sacral plate.

Risk Factors for Spondylolisthesis

- Age - progression is highly likely during adolescent growth spurts, i.e., the younger the age at onset of a pars defect, the higher the probability of slip progression
- Gender - females are four times more likely to develop spondylolisthesis than males
- Pregnancy may be a risk factor
- Osteoarthritis - can lead to degenerative spondylolisthesis in older people
- Diabetes - diabetics appear to be more prone to degenerative spondylolisthesis
- Traumatic injury - an injury that does not heal properly in an adolescent can progress to spondylolisthesis
- Activity in sports - certain types of sports appear to put some children and adolescents in a high-risk category for spondylolysis due to continued hyperextension of the lumbar spine. Damage to the pars is noted in 25-40% of sports-related lower back pain. High risk sports

include:

- gymnastics
- diving
- football
- pole-vaulting
- weight-lifting
- wrestling
- dancing
- high-jumping

- Back pain - investigation into generalized back pain may uncover existent but possibly asymptomatic spondylolysis or spondylolisthesis

Incidence of Spondylolisthesis

Spondylolysis is rarely seen before the age of four. It is present in approximately 4-6% of school children and increases to about 5.8% of adults. The most common periods in which spondylolysis develops is the ages of five to seven and then during the teenage years. By the age of 18, some estimate the incidence of spondylolysis to be approximately 7% with prevalence appearing in individuals who participate in sports that require repetitive hyperextension or flexion and extension the spine. Spondylolysis is twice as common in male children as female children but females are more likely to exhibit progressive slippage of the vertebra. It is estimated that up to 50% of cases of spondylolysis progress and develop into spondylolisthesis.

Approximately 2-4% of adults have isthmic spondylolisthesis. After the age of 16, the incidence of new spondylolisthesis falls and it rarely develops after the age of 20. Approximately 87% of cases occur at the level of L5-S1, while close to 10% occur at L4-L5, and up to 3% occur at the level of L3-L4.

The incidence of degenerative spondylolisthesis increases with age. The slip associated with degenerative spondylolisthesis occurs most commonly at the level of L4-L5 and is found more frequently in females (9.1%) than males (5.8%). African-American women are affected three times more commonly than Caucasian women. Degenerative spondylolisthesis is the most common form of spondylolisthesis in adults.

The **Intelligent Patient Overview** in the complete **Medifocus Guidebook on Spondylolisthesis** also includes the following additional sections:

- **Diagnosis of Spondylolisthesis**
- **Treatment Options for Spondylolisthesis**
- **Quality of Life and Psychosocial Considerations in Spondylolisthesis**
- **Questions to Ask Your Health Care Provider About Spondylolisthesis**

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3 - Guide to the Medical Literature

Introduction

This section of your *MediFocus Guidebook* is a comprehensive bibliography of important recent medical literature published about the condition from authoritative, trustworthy medical journals. This is the same information that is used by physicians and researchers to keep up with the latest advances in clinical medicine and biomedical research. A broad spectrum of articles is included in each *MediFocus Guidebook* to provide information about standard treatments, treatment options, new developments, and advances in research.

To facilitate your review and analysis of this information, the articles in this *MediFocus Guidebook* are grouped in the following categories:

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4 - Centers of Research

This section of your *MediFocus Guidebook* is a unique directory of doctors, researchers, medical centers, and research institutions with specialized research interest, and in many cases, clinical expertise in the management of this specific medical condition. The *Centers of Research* directory is a valuable resource for quickly identifying and locating leading medical authorities and medical institutions within the United States and other countries that are considered to be at the forefront in clinical research and treatment of this disorder.

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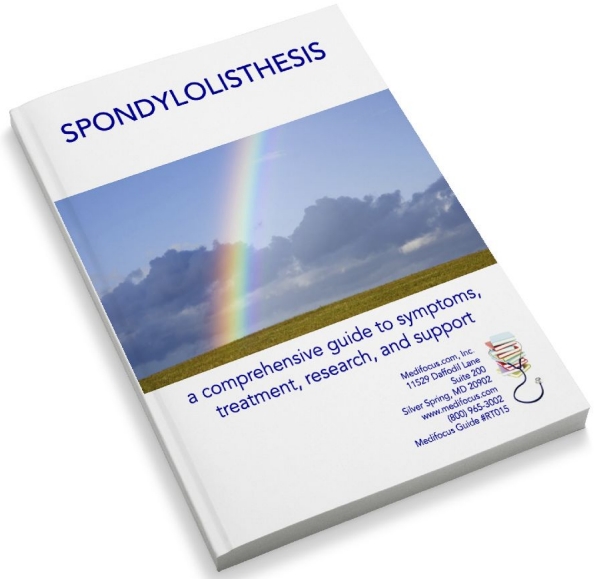

This document is only a SHORT PREVIEW of the **Medifocus Guidebook on Spondylolisthesis**. It is intended primarily to give you a general overview of the **format and structure** of the Guidebook as well as select pages from each major Guidebook section listed in the Table of Contents.

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