Review Article

Management of degenerative disc diseases: A review

Abstract:

The degenerative disease of the intervertebral disc and back pain are chronic conditions that are caused by several factors and represent an important cause of morbidity and mortality in everyday clinical practice. The study aims to summarize the updated evidence regards epidemiology, pathophysiology, clinical manifestation, diagnosis, and management of degenerative disc diseases. The incidence of low back pain, which is the main symptom in IVD disease, varies widely among different reports. It is the fifth most common cause for the visit to the doctor and affects 7.6 to 37% of patients. IVD degeneration is attributed to a complex interplay between environmental and genetic factors. DDD is a process that includes a progressive decrease in disk nutrient supply and changes in extracellular matrix (ECM) composition, which weakens the tissue strength and alters the cell metabolism. Degenerative lumber disc disease patients typically present with mechanical lower back pain, which is worse on forward flexion and when carrying heavy load. The pain is relieved with rest. Diagnosis of DDD is done by various methods, computed tomography (CT) scan, magnetic resonance imaging (MRI), and provocative discography. These methods should be used in conjunction with the patient history, physical examination and specific biomarker to monitor the response to treatment. There are three major lines of management of DDD; Treatment Options for Relief of Pain in Conservative Therapy.Treatment with Aims of Restoration, Repair, and Regeneration of Intervertebral Disc Diseases: Molecular Therapy.Reconstructive

Strategies: Percutaneous Intervertebral Disc Techniques. Definitive Treatment for Intervertebral Disc Diseases :(surgical management).

Key words: lumbar degeneration, lumbar disc diseases, management, lower back pain.

Introduction:

The degenerative disease of the intervertebral disc and back pain are chronic conditions that are caused by several factors and represent an important cause of morbidity and mortality in everyday clinical practice. (1) It is a common condition characterized by the breakdown (degeneration) of one or more of the discs that separate the bones of the vertebrae, causing pain in the back or neck as a consequence of the cell-mediated response to multifactorial contributions, such as genetics, micro/macro trauma, accelerated age-related changes, inflammation, local nutritional deficiency, and vascular factors, leading to excess catabolic over anabolic responses. The intervertebral discs IVD, provide cushioning between vertebrae and absorb pressure put on the spine. (2). IVD disorders can affect both the young and old population. Treatment strategies need to consider age of presentation, comorbidities, severity of IVD, neural elements compression and stability of the spinal column, many of the restorative and reconstructive management strategies are still at the early stages of laboratory experimental and animal trials, with clinical efficacy yet to be proven. . (3). Degenerative disc disease (DDD) and prolapsed intervertebral disc (PID) are the two commonest forms of IVD diseases. They have a close cause and effect relationship as a prolapsed intervertebral disc is a risk factor of degenerative disc disease while advanced degenerative disc often presents with disc prolapse with annular fissure due to degeneration leading to a fragmented disc being prolapsed into the spinal canal (4).

Objective:

The study aims to summarize the updated evidence regards epidemiology, pathophysiology, clinical manifestation, diagnosis, and management of degenerative disc diseases

Epidemiology:

The incidence of low back pain, which is the main symptom in IVD disease, varies widely among different reports. It is the fifth most common cause for the visit to the doctor and affects 7.6 to 37% of patients. There is a proportional increase in the prevalence of intervertebral disc diseases and the age of the patient. Long lasting pain and movement difficulties are experienced by 10% of patients (5). Up to 84% of the population have back pain at some point in their lives. The degeneration of intervertebral disc tissue starts sooner than the degeneration of other muscular and skeletal tissues and many cases are asymptomatic. (6).

Pathophysiology of degenerative disc disease DDD:

IVD degeneration is attributed to a complex interplay between environmental and genetic factors. DDD is a process that includes a progressive decrease in disk nutrient supply and changes in extracellular matrix (ECM) composition, which weakens the tissue strength and alters the cell metabolism. A decrease in nutrient supply has been shown to negatively impact the IVD in its function to maintain the ECM. Nutrient supply has been found to be altered in the degenerative disk leading to decreased oxygen concentration and lower pH (7). Calcification of the endplates has also been shown to lead to a decreased blood supply. Inadequate nutrition inhibits the ability of the IVD to respond to increased load or injury. Structural damage is accrued over time further propagating the degenerative cycle. However, genetics may play a larger role in DDD than both inadequate nutrition and mechanical damage (8).

Clinical manifestation:

Degenerative disc disease patients typically present with mechanical lower back pain, which is worse on forward flexion and when carrying heavy load. The pain is relieved with rest and lying supine with calves supported on a pillow (9). Advanced degenerative disc disease can present with morphological changes in the spine, such as intervertebral disc bulge, disc herniation, facet hypertrophy, and thickening of the ligamentum flavum, which in turn can lead to spinal stenosis and neural compression. The presentation of symptomatic spinal stenosis is neurogenic claudication where the patient presents with radicular pain, which is distance and time limited, and the pain is relieved by sitting or flexing the hip and knee at rest as these actions widen the spinal canal and relieve the compression on the neural elements. (10).

Diagnosis:

Various diagnostic studies can help in the diagnosis of degenerative disc disease and the exclusion of other diagnoses. Common studies used to aid in the diagnosis of patients with axial back pain include lumbar radiographs, computed tomography (CT) scan, magnetic resonance imaging (MRI), and provocative discography. These studies should be used in conjunction with the patient history, physical examination and specific biomarker to monitor the response to treatments. (11). X-rays should include a full series with standing or weight-bearing views, these weight-bearing can help identify many diagnoses which may otherwise be overlooked by a pure supine or non-weight-bearing X-ray. A CT scan by itself is of limited value in the correct diagnosis of degenerative disc disease, it is used to help exclude other diagnoses. A CT scan is performed in a non-weight-bearing position. (12).MRI scanning, like CT scanning, can be used to evaluate the spinal canal and space available for neural structures. It can evaluate the overall bony alignment and the lumbar facets, but it has the additional benefit of allowing the direct assessment of the neural structures as well as the disc structures. This direct evaluation of neural and disc structures is not possible by CT scan (13).An MRI is capable of evaluating the hydration within the discs.Discography, particularly provocative discography, is the single most important diagnostic tool of

degenerative disc disease. Lumbar discography is a test that would be appropriately performed in symptomatic patients who have failed non-operative conservative treatment and whose X-rays and MRI studies suggest no other obvious pathology leading toward their diagnosis. Since the patient's chief complaint is pain and since no imaging studies actually see pain, lumbar discography can be used to potentially provoke and reproduce the patient pain (14).

Management and treatment of DDD:

1. Treatment Options for Relief of Pain in Conservative Therapy,

A trial of conservative management, such as physiotherapy, oral analgesia, and supplements with or without alternative medicine, would help in some patients with DDD. Physical exercise is clinically recommended in several guidelines to help in alleviating pain (15).Physical exercise helps in IVD cell proliferation in animal model studies, particularly in moderate to high volume low repetition and frequency exercises. It has an effect on paraspinal muscle strength and aids in reducing pain and disability. Up to 80% of patients with a prolapsed and/or degenerated intervertebral disc respond to conservative therapy in an average of 4 to 6 weeks .Oral medications such as paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs), opioids, and muscle relaxants are given to patients who present with symptomatic DDD with no contraindications to these drugs (16). Pain- relieving injections, are used in decreasing inflammation around symptomatic nerves, providing temporary anesthesia in the specific target area where the irritated nerve is involved, and adhesiolysis between the neural elements concerned and the degenerated or prolapsed disc through the hydrostatic pressure effect of introducing a volume of fluid in the region of concern.(17)

2. Treatment with Aims of Restoration, Repair, and Regeneration of Intervertebral Disc Diseases: Molecular Therapy,

Developments in molecular science have led to an effervescence of growth in the development of various experimental and clinical trials in the manipulation of cells, genes, and various growth factors in an attempt to produce end proteins that can repair and regenerate the degenerated disc. Cell therapy, the principle of cell therapy is the usage of de novo cells, which are nurtured in the laboratory environment to be introduced to the disease region through cell transplant. (18).These cells mediate paracrine signaling, which stimulates the endemic cells to produce favorable end products to rejuvenate the target degenerated disc, or de novo cells directlyparticipate in extracellular matrix (ECM) production and homeostasis . The cells generally used are notochordal cells, chondrocytes or mesenchymal stem cells. Growth factor therapy, involves the injection of biological factors directly into IVD to promote synthesis of the extracellular matrix, delay degeneration, and stop inflammation (19) Growth factors are peptides that target receptors to cause cellular actions, such as proliferation, differentiation, apoptosis, and synthesis of proteins. The most known growth factor in spine and orthopedic practice is bone morphogenic proteins (BMPs) and members of transforming growth factor beta TGF-β, stimulating osteogenesis and chondrogenesis (20).Gene therapy, which introduces genes to target cells by two ways: (1) In vivo gene therapy involves using viral or non-viral vectors to transfect candidate genes that can be incorporated into the target cells; and (2) the ex vivo method involves getting the target cells out into a culture medium, altering its target genes, and re-implanting them back into the target organs . Interest is growing in this area of development. The attractiveness of modulating the biological activities of IVD by delivering therapeutic genes has led to significant research in this area. Most of the studies are still based in laboratory settings. The advantage of gene therapy is that unlike growth factor therapy, its effect is potentially long term. (21).

3. Reconstructive Strategies: Percutaneous Intervertebral Disc Techniques:

Their common aim is separation of the neural elements from irritant pathology, reduction of the size of the disc protrusion in the spinal canal, and reconstruction of the function of the damaged IVD. The examples of percutaneous decompressions are mechanical decompression, thermal decompression, chemical decompression, and biomaterial implantation.Thermal decompression, involves applying thermal energy to IVD. Thermal energy can be introduced by different kinds of lasers and radiofrequency probes (22, 23). The primary goal is to decrease the inflammatory response, leading to shrinkage of the tissue, reducing its compression on the neural elements and destroying the nociceptive fibers in the periphery of the disc.Chemical decompression, using chymopapain which is a proteolytic enzyme injected intradiscally, is useful in the treatment of herniated lumbar discs. The average success rate is 73% for the elimination of backache and sciatica (24).Recently, a publication based on the result of 1991–2000 on chymopapain showed good results in chemical decompression, with no significant complications in their series. Currently, the use of chymopapain as a treatment option for a prolapsedintervertebral disc is rare as compared to previous years when it was very popular. Other chemical percutaneous decompression techniques based on the use of an oxygen–ozone mixture and radiopaque gel like ethanol were recently studied. The injection of this admixture of oxygen and ozone into the nucleus pulposus reduces intradiscal pressure and has immune-modulating effects (25) .Biomaterial implantation, several advantages in biomaterial implantation have been found such as ease of obtaining and manufacturing the biomaterial as compared to molecular techniques, stability in transport and storage, extensive laboratory testing can be done to find a matching compatible material, potential promotion of endogenous repair of the disc architecture (26,27).

4. Definitive Treatment for Intervertebral Disc Diseases :(surgical management)

Surgical management for IVD diseases has been a constant source of debate among surgeons, and scientific communities (28). Surgical treatment caters to two groups of

patients with different needs. The first group of patients are those with acute deterioration of neurology and/or cauda equina syndrome they have a strong indication for early surgical management, they are less frequent (29). The more common group including, patients with chronic lower back pain, with imaging showing a degenerative disc with or without disc herniation. The most common indication for surgery is failure to improve with conservative treatment as in disc herniation (30). The goals of surgery, are decompression, replacement, and fusion. (31).

Conclusion:

IVD degeneration is attributed to a complex interplay between environmental and genetic factors. DDD is a process that includes a progressive decrease in disk nutrient supply and changes in extracellular matrix (ECM) composition, which weakens the tissue strength and alters the cell metabolism. Diagnosis of DDD is done by various methods, computed tomography (CT) scan, magnetic resonance imaging (MRI), and provocative discography. These methods should be used in conjunction with the patient history, physical examination and specific biomarker to monitor the response to treatment. There are three major lines of treatment;Treatment Options for Relief of Pain in Conservative Therapy.Treatment with aims of Restoration, Repair, and Regeneration of Intervertebral Disc Diseases: Molecular Therapy.Reconstructive Strategies: Percutaneous Intervertebral Disc Techniques. Definitive Treatment for Intervertebral Disc Diseases :(surgical management).

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