UNIVERSITI MALAYA
Faculty of Medicine

Inaugural Lecture

Conservative Spine Surgery

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Conservative Spine Surgery – The True "Minimally Invasive" Spine Surgery

Inaugural Lecture

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BIODATA

A conscientious, reliable and hardworking Neurosurgeon, Professor and a Senior Consultant in Neurosurgery, who pays attention to details, Dr. Dharmendra Ganesan is a 1995 MBBS graduate of the Faculty of Medicine, University Malaya. He completed his Masters in Surgery from the University of Malaya in 2002 whilst also obtaining an FRCS (Edinburgh) in August 2001 and an FRCS (Ireland) in September 2001. He began his neurosurgical training in the Division of Neurosurgery at the University of Malaya Medical Centre in the same year and went on to complete his clinical training in Cambridge, United Kingdom whilst working as a registrar and training with reputable names in the field of Neurosurgery. He passed the intercollegiate exam in United Kingdom and obtained an FRCS in Neurosurgery in June 2006.

He continued to sub-specialize in Complex Spinal surgery by pursuing a fellowship at Addenbrookes Hospital in Cambridge, as well as completing the Cleveland Spine Review course. His other area of sub-specialisation is Paediatric neurosurgery. One of the few in the country, he pursued a visiting fellowship in several hospitals of good standing namely, the Great Ormond Street in London, Necker Enfant Malades, in Paris and Montefiore Children's Hospital in New York. He has also completed the European post graduate and Asian Australasian advanced course in paediatric neurosurgery. Since his return, he has been a practicing Neurosurgeon in both University of Malaya Medical Centre (UMMC) as well as UM Specialist Centre (UMSC). He is registered with the National Specialist Registry as a neurosurgeon.

His current clinical practice involves all general neurosurgical cases although his area of expertise focuses on complex spinal problems and paediatric neurosurgical cases.

The complex spinal cases managed by him range from trauma, tumour, vascular, degenerative, craniocervical and other spinal cord related complications including infection, disc prolapses, osteoporotic fractures, vascular malformation and developmental problems such as spinal lipoma and tethered cord syndrome.

Dr. Dharmendra is just as much an avid writer as he is a surgeon, and has published several clinical papers based on interesting researches in reputable journals such as the Journal of Neurosurgery, British Journal of Neurosurgery, Child Nervous System, Journal of Spine, Lancet, Neurology Asia and others. He also conducts research at the University of Malaya pertaining genomics and its relationship to traumatic brain injury. He has presented in many local and international scientific meetings. He was the Treasurer of the Neurosurgical Association of Malaysia (NAM) for two terms. He is a member of Academy

of Medicine of Malaysia as well as the International Society of Paediatric Neurosurgery (ISPN). He is also a fellow of the Royal College of Surgeons of Edinburgh and Royal College of Surgeons in Ireland and a member of the American College of Surgeons.

SYNOPSIS

CONSERVATIVE SPINE SURGERY – THE TRUE "MINIMALLY INVASIVE" SPINE SURGERY

"Conservative spine surgery" is a concept or perhaps a philosophy that I coined after 12 years of practicing as a consultant neurosurgeon with a subspecialized interest in spinal neurosurgery. UM deals with a plethora of patients with spinal conditions, where degenerative spinal disorder (DSD) is the one most commonly diagnosed.

In managing DSD, it is imperative to understand that the symptom of pain could emanate from various anatomical structures from the spine and its surrounding structures. It is also important to appreciate the natural history of these conditions as it is equally important, to be cognizant of the immediate, short and long-term risk and benefits related to the treatment, as well as the short and long-term effects of the intervention on the inherent spine adjacent to the treatment area, which undergoes wear and tear as we age. By reflecting on the management of these cohorts of patients, I would like to discuss the importance of clinico-radiological features in identifying a clinically relevant, surgical pathology when strategizing treatment. Thence, determining the appropriate choice of "minimally invasive" surgical management, in treating that one, individual patient with the background belief that "less is more" in spine surgery.

In the quest of moving with the times, we have to embrace new technology and treatment modalities, however the onus is on us surgeons to do the critical appraisal prior to practicing it and this is an area I wish to expound on. In addition to that, I will also highlight the conundrums in the application of evidence-based surgical treatment in a patient-centred management.

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CONTENT

INTRODUCTION

"Conservative spine surgery" is a philosophy that I wish to propose after practicing as a consultant neurosurgeon with a subspecialized interest in spinal neurosurgery for almost 12 years. We deal with a host of spinal conditions with degenerative spinal disorder being one of the common conditions.

By virtue of practicing in a university hospital, I am exposed to a variety of patient cohort. There are new cases that come to see us as the first port of call. I also see a fair number of new cases seeking a second opinion and cases that have had surgery elsewhere, wanting a second opinion. Over the years, by reflecting on the management and seeing the outcomes of these cohorts of patients, I am ever more convinced on a few key features on management of patients with degenerative spinal disease. This philosophy can be extrapolated to management of other spinal conditions such as spinal tumour and spinal trauma.

BASIC SCIENCES

The spine is a stack of multiple vertebrae which are held together by ligaments, discs, joints and muscles (Figure 1). The stack of vertebrae is called the spinal column. There are cervical (7), thoracic (12), lumbar (5) and sacrum (5 fused vertebrae) and coccyx (residual bone). Within the spinal column sits the delicate neural structure called the spinal cord which gives out nerves at regular intervals that emanate out from the neural foramen.

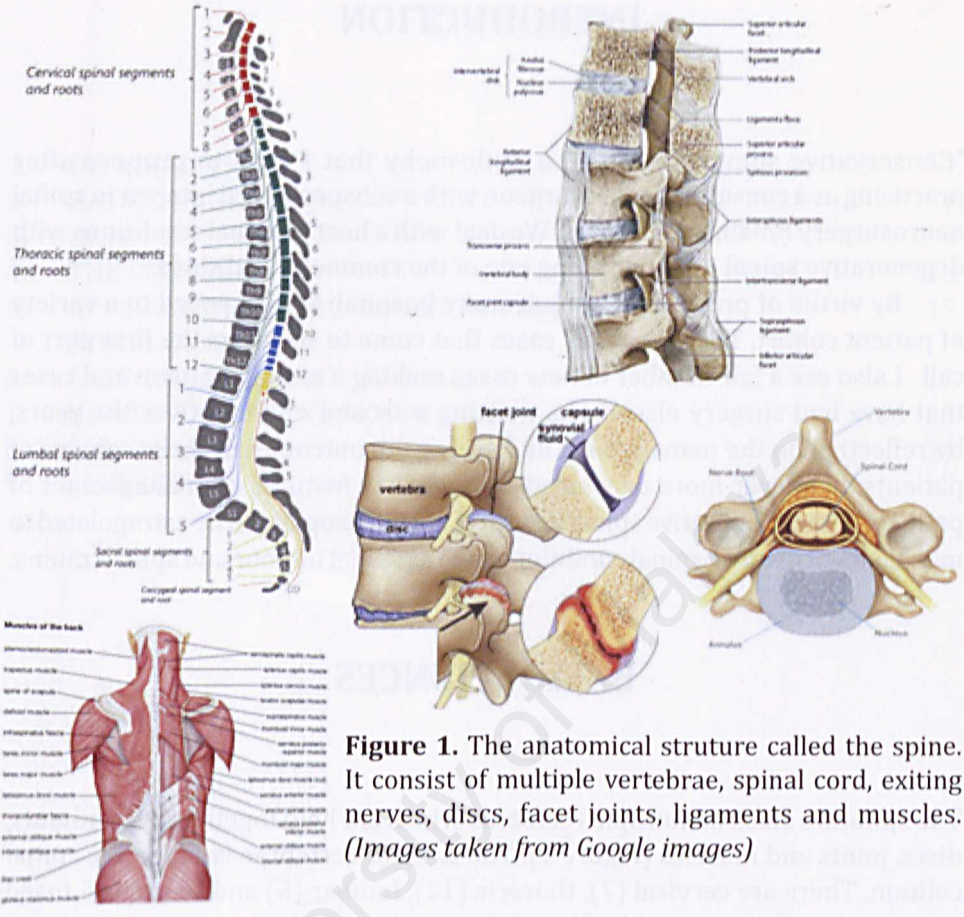


Figure 1. The anatomical struture called the spine. It consist of multiple vertebrae, spinal cord, exiting nerves, discs, facet joints, ligaments and muscles. *(Images taken from Google images)*

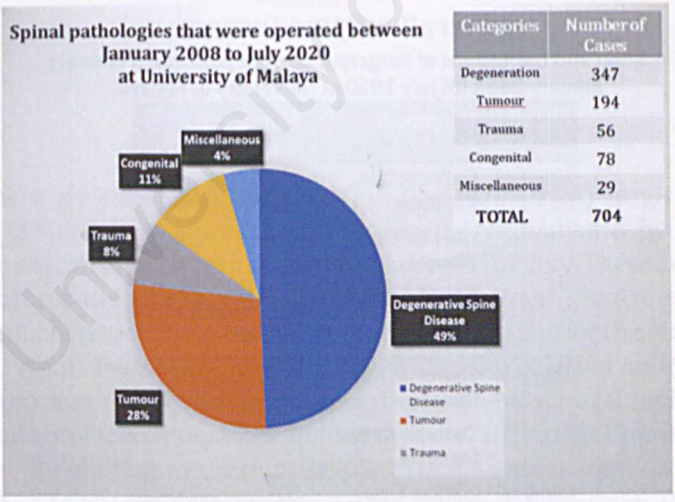
The function of the spine is carrying a delicate neural structure that transmits the electrical impulse to initiate movement and to receive sensory feedback to the higher centres in the brain. The uniqueness of the spine is whilst doing such a complex function; it must also permit a person the flexibility to move. This flexibility allows the human body not only to be ambulatory but also to participate in various vocation and sporting activities that require flexion, extension, lateral bending and rotation. The spine allows these various axes of motion without hurting the neural structure as opposed to the brain which is nestled in the cranial cavity that does not bend or move.

In degenerative spinal disease, the symptom of pain could emanate from various anatomical structures within and around the spine. Injuries to the muscle, discs and ligaments are common causes of axial (central, local) spine pain; most of these are mended by the human body's reparative mechanism with time. As we age, there will be motion related "wear and tear" changes affecting the most mobile levels of the spine namely the cervical and lumbar spine. The areas that are typically affected will be the facets and disc material. The exact

focus of pain needs to be elicited prior to deciding on the right treatment. Most times, with a good history and physical examination, a narrowed differential can be made. The investigation will help confirm the structural lesion, be it compression or instability. The investigation of choice for spontaneous spinal pain would be MRI, to assess neural elements and if required a CT scan to look at the spinal column in three planes and a radiograph to look at the dynamic spinal views namely in flexion and extension.

If no clear compressive elements or features of instability are demonstrable on clinico-radiological appraisal of the case; the indication for surgical treatment is not present. If such a case is still treated surgically; the outcome is typically dismal. Worse still, the patient is unnecessarily subjected to other risk that maybe related to the treatment be it in the near or long term. We must be cognizant that not all back pain is related to the spinal column itself, many are related to the musculo-ligamentous structures or neuropathy. These are best managed with core strengthening exercises or medical means rather than surgery. Surgery is not the remedy for all types of back pain.

DATA



Categories	Number of Cases
Degeneration	347
Tumour	194
Trauma	56
Congenital	78
Miscellaneous	29
TOTAL	704

Table 1. The data shows that the good size of work that we perform is related to degenerative spinal disease (49%). These numbers enable us to reflect on the outcomes that we achieve with the surgical philosophy that we practice – conservative spine surgery. We also see cases that come for second opinion (these cases are not in the statistics above); insofar we are able to have a subjective gauge of the spinal practice that is professed in other hospitals, as well as we are able to appreciate the issues related to certain surgical techniques that have been already performed outside.

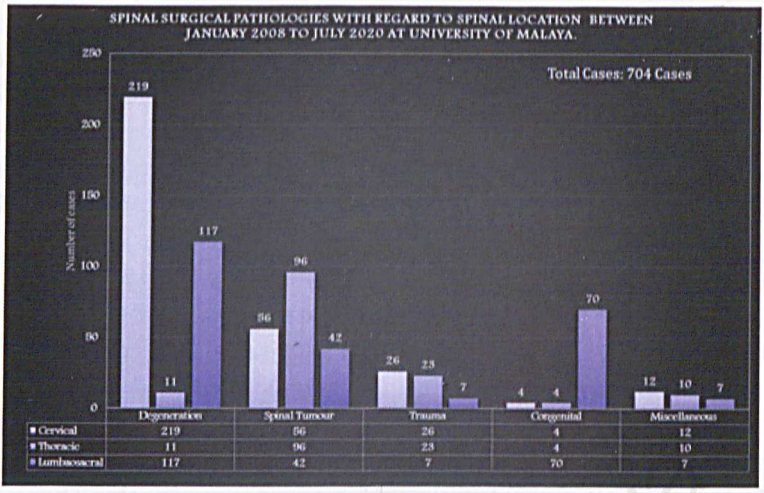


Table 2. Most degenerative spinal conditions affect the most mobile part of the spine which is the cervical and lumbosacral spine. The thoracic spine is splinted by the ribs, hence the degree of movement there is somewhat lesser, and therefore degenerative changes in this segment of the spine are lesser. We also manage a host of other spinal conditions such as spinal tumours, congenital spinal disorders in the paediatric age group and spinal trauma.

Degenerative Spine Disease:

Location and Indications of Surgery that were performed between January 2008 till July 2020 at University of Malaya

Location	Diagnosis	Number of Cases
Cervical	Cervical Disc Prolapse	138
	Cervical Canal Stenosis	63
	Spondylolisthesis	1
	Others	17
Thoracic	Thoracic Disc Prolapse	5
	Thoracic Canal Stenosis	6
Lumbosacral	Lumbar Disc Prolapse	56
	Lumbar Canal Stenosis	53
	Spondylolisthesis	8

Table 3. The most common pathology resulting in the symptoms in both the cervical and lumbosacral spinal segment are disc prolapses and canal stenosis. Both these lesions compress either the cord or the nerve root bringing about either myelopathy or radiculopathy features; sometimes combination of both.

Types of Surgery Conducted for Cervical Degenerative Spine Disease between Jan 2008 till July 2020 at University of Malaya

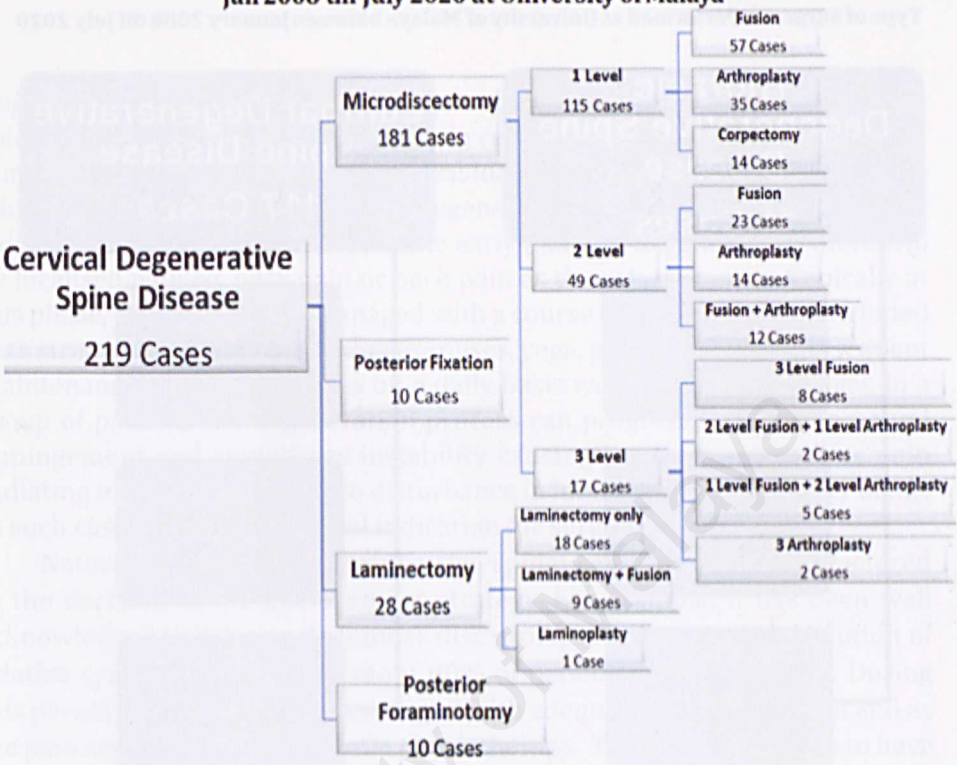


Table 4. There are either anterior (front) or posterior (back) surgical approach to the cervical spine. The approach is determined predominantly by the surgical pathology that is causing the neural compression or instability. These are appraised by clinical features and imaging (MRI, CT, dynamic radiograph). As a broad principle, if the predominant issues are in the front of the spine, an anterior (frontal approach) is preferred. Apart from the location of the lesion, the decision on the approach also takes into account the inherent spinal alignment, natural mobility of the spine, any vertebral instability, bone quality and overall patient fitness to undergo an operation. By abiding to these principles, we have done various approaches namely microdiscectomy with fusion/ arthroplasty, laminectomy, laminoplasty and posterior foraminotomy.

Thoracolumbar Degenerative Spine Disease:

Type of Surgeries Performed at University of Malaya between January 2008 till July 2020

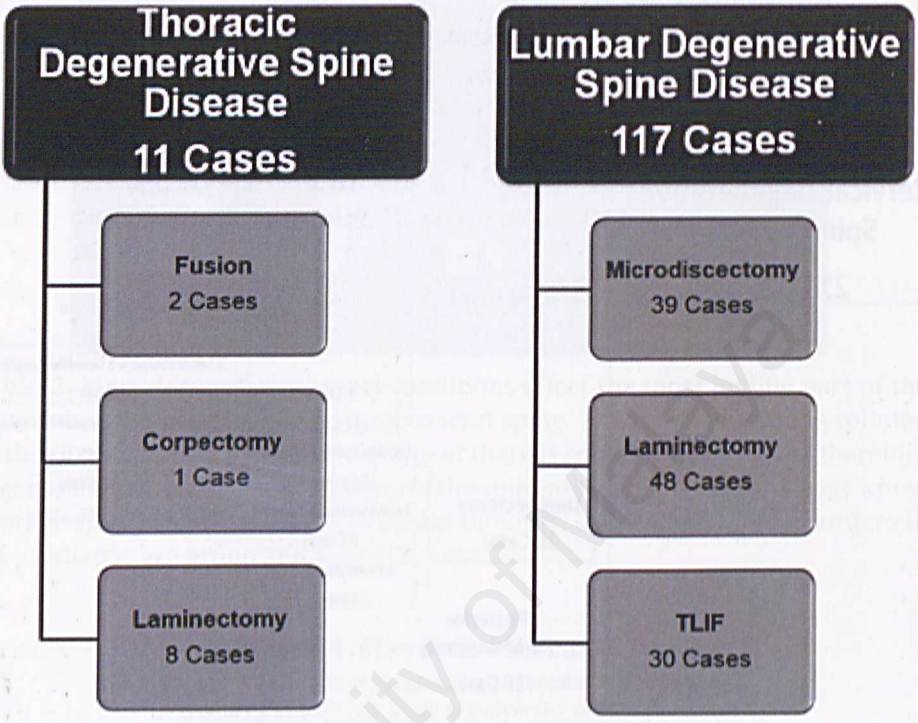


Table 5. The thoracic degenerative cases are rare. The lumbosacral degenerative cases are more frequent with microdiscectomy and laminectomy operations being the common procedures. The laminectomy is a term to describe the surgery from the posterior to remove a bony element called the laminae. Most cases also incorporate lateral recesses decompression. There are cases where the lamina is preserved but inter-laminar decompression is performed. The transforaminal decompression and interbody fusion (TLIF) is performed for selected cases that genuinely fulfil the stringent indication ie. mainly for three indications: mobile spondylolisthesis with neural impingement, foraminal stenosis with nerve root impingement as a result of collapse of disc height due to disc degeneration or re-prolapse of lumbar disc.

CONCEPT

Degenerative spinal disease is a "wear and tear" condition affects the entire spinal column but more so in the mobile cervical spine and lumbar spine. The lumbar spine has to take the additional load of the body weight on the spine which can aggravate the progressive degeneration. In a way, degeneration is not a disease but an ageing process. In the early phase of degeneration, there will be localised pain eg. neck pain or back pain as the sole symptom. Typically at this phase, the cases can be managed with a course of physiotherapy (included core strengthening and stretching exercises, yoga, pilates etc.) and subsequent maintenance of these exercises on a daily basis would suffice. However, in a group of patients the degeneration process can progress and lead to neural impingement and sometimes instability causing local pain as well as pain radiating to the limbs leading to disturbance in functionality and quality of life. In such case, there is a potential indication for surgical intervention.

Natural history of the degenerative spinal condition has to be factored in the decision of the management strategy. For example, it has been well acknowledged that for acute lumbar disc prolapse spontaneous resolution of sciatica symptoms is seen in about 80% of patients within 6 weeks. During this period, the patient can be managed with adequate pain medication and as the pain settles, embark on gentle physiotherapy. Those who continue to have symptoms beyond that period of conservative management are potentially candidates for intervention e.g. lumbar microdiscectomy. However, if the slipped disc is associated with cauda equina syndrome (i.e. sphincter dysfunction, foot weakness, diminished anal tone etc.) this would herald an emergency lumbar microdiscectomy. Therefore, being aware of the natural history of a disease condition will prevent premature initiation of any form of interventional treatment. Any form of interventional treatment, has it ensuing risk which is not worth taking if the disease process can recover on its own accord by the body's inherent reparative mechanism with time.

In order to perform any form of surgery, the lesion that is detected as the cause of the symptoms must be tangible and objective on the imaging and must correlate to the location of the symptoms. If the anatomical location of the lesion as seen on the scans correlates with the symptoms /signs with regard to the dermatomal sensory and pain distribution as well as motor dysfunction, there is a very high possibility that the surgical outcomes would be good. Sometimes, an ideal clinical presentation does not occur depending on levels involved, duration of the symptom etc. In such case, the constellation of symptoms / features that the patient experiences needs to carefully appraised against the MRI imaging. This decision can sometimes be challenging.

In the decision making in managing degenerative spinal condition, we ought to strike a balance between the intent to obtain the best short term outcome while not compromising the long term outcome for the patient. The working principle should be to keep the destruction of normal anatomy to the minimum, maintaining mobility as much as possible, tackling the pre-determined structural issue only while minimising collateral injury. The principle of "less is more" is a quote worth adhering to in spine surgery. The decision is made on the current structural changes in the spine that is causing the symptom; any form of extrapolation of potential problems in the future and performing prophylactic spinal surgery is most probably not proper in most cases. The reason being the progression of the ageing process differs from person to person depending on a multitude of factors. It is not uncommon to see a patient with radiological features of neural impingement but has no symptoms related to that. There is a chance that the patient might not have any clinical problem related to the structural change that is seen on the radiological imaging in his life time. This leads to the concept of "treat the patient and not the scan". In essence, the decision to treat must be based on sound clinical sense.

The management of patients with degenerative spinal disease must take in to account the three factors: the patient, the investigation and surgical factors. The patient factor being patient symptoms and signs, background medical illness, fitness (functional age), functional state, quality of life and patient wishes. The investigation factor being the structural changes as depicted by imaging i.e. MRI and in certain cases supplemented with CT and dynamic radiograph. The surgical factor includes clinical evidence, options of treatment i.e. rehabilitation, medical or surgical, surgeons training and philosophy in managing degenerative spine, surgeon experience and expertise in surgical techniques – open discectomy, microdiscectomy, endoscopic discectomy etc. The assimilation of all these factors and making a reasonable and sensible management plan is called clinical judgement. The clinical judgement is not merely looking at the symptom and the MRI images to make the decision. The process of acquiring this knack unfortunately comes with clinical exposure and apprenticeship with a good mentor whilst gradually imbibing and formulating your understanding the strategies; it is not something you learn from the books, journals, surgical simulation lab or just watching / learning surgical techniques in workshops or theatre. Hence, a sound clinical judgement is an essential part of treatment.

APPLICATION OF THE CONCEPT IN DEGENERATIVE SPINAL DISEASE

Here are some cases of degenerative spinal disorder where the philosophy of conservative spinal surgery has been employed successfully.

A case of cervical disc prolapse which is managed with anterior cervical microdiscectomy and arthroplasty (disc replacement) maintains good cervical motion and reduces adjacent segment disease in the future. This technique is preferable to fusion techniques which limits movement at that segment and heralds adjacent segment degeneration. (Figure 2)

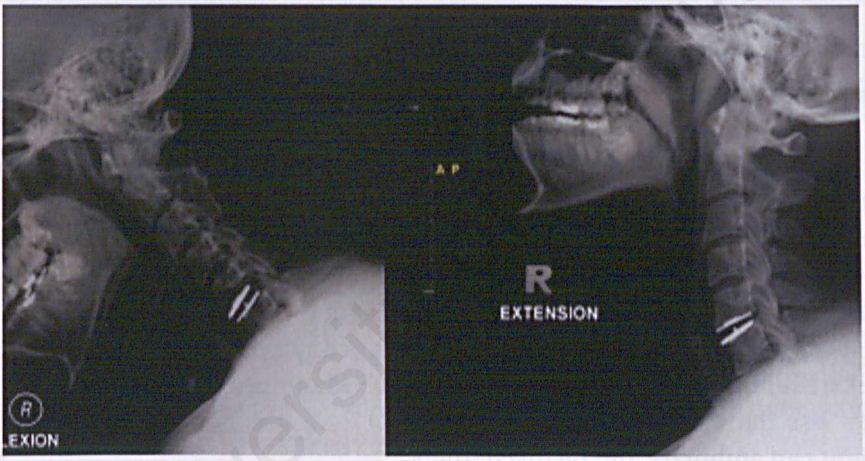


Figure 2. Cervical disc replacement (arthroplasty) keeping neck mobile while tackling the pathology

If there is a lateral disc prolapse at the cervical spine, a technique known as posterior foraminotomy is used whereby freeing the exiting nerve but still maintaining mobility and stability of the spine without any use of implants. (Figure 3)

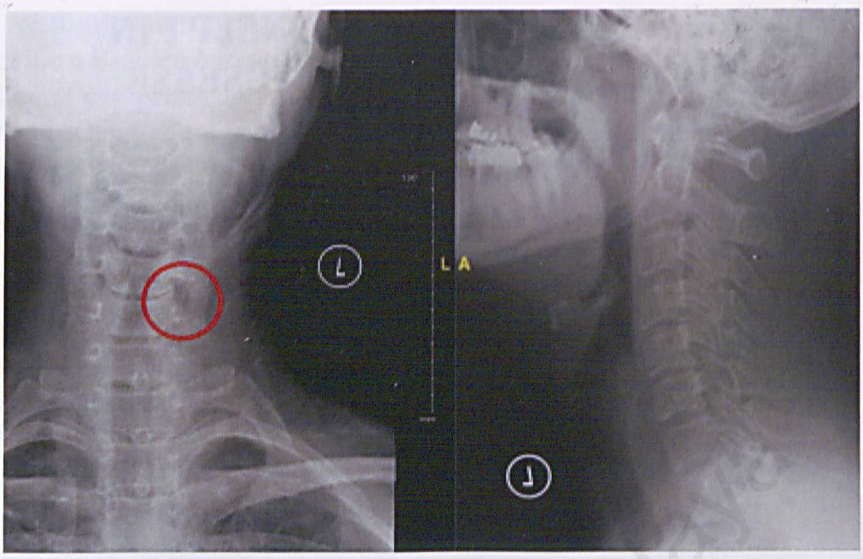


Figure 3. Left posterior foraminotomy (red circle), no implants need to be used

A case of lumbar canal stenosis with no instability features clinicoradiologically can be managed with simple lumbar decompression. The lateral recesses must be adequately decompressed to obtain good symptom relieve of the neurogenic claudication. It is paramount to maintain the integrity of the facets in this operation to reduced risk of future instability.

A case of lumbar disc prolapse with sciatica symptoms lasting more than 6 weeks, a lumbar microdiscectomy accords good symptom relief. The operation takes less than an hour. The incision about 3cm in length. The next day the patient can ambulate and be discharged.

Cervical canal stenosis with cord compression at multiple levels would require appraisal of the predominance of compression either at the front or the back of the spine. The alignment (lordotic or kyphotic spine) is an important determinant factor. The stability of the vertebrae is determined with dynamic cervical radiograph. The choices would be either cervical laminectomy with preservation of the integrity of the facets or anterior multi-level microdiscectomy and arthroplasty (disc replacement) or hybrid implants (fusion + disc replacement). The need for posterior instrumentation would be considered in demonstrable instability. (Figure 4)

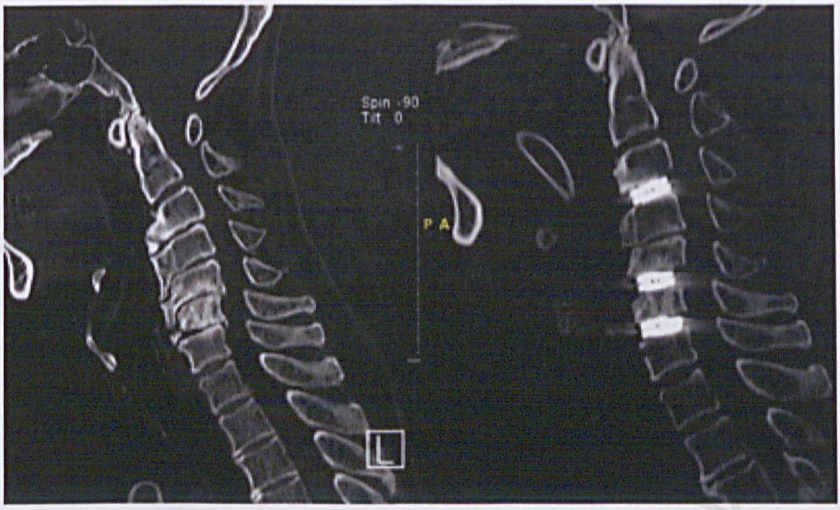


Figure 4. Anterior cervical degeneration managed by removing the extensive anterior osteophytes and performing 3 level cervical disc replacements hence maintaining the neck mobility

EXTRAPOLATION OF THE CONCEPT

This philosophy of conservative spine surgery can be employed in management of spinal tumour and spinal trauma.

A case of a cervical C3 to C6 spinal cord tumour, we would perform a C3 to C6 laminotomy ensuring the facet joints are not breached. Then the dura is opened and the tumour excision is performed with the aid of the microscope. Once that is complete, we would replace the C3-6 lamina and hold it with plates and screws. This technique is called laminoplasty. It prevents adhesion of the muscles to the dura. By not breaching the facet joints, the risk of subsequent kyphotic deformity is minimised. Eventually, the patient has to perform neck exercises to maintain the strength and balance of the anterior and posterior group of muscles. (Figure 5)

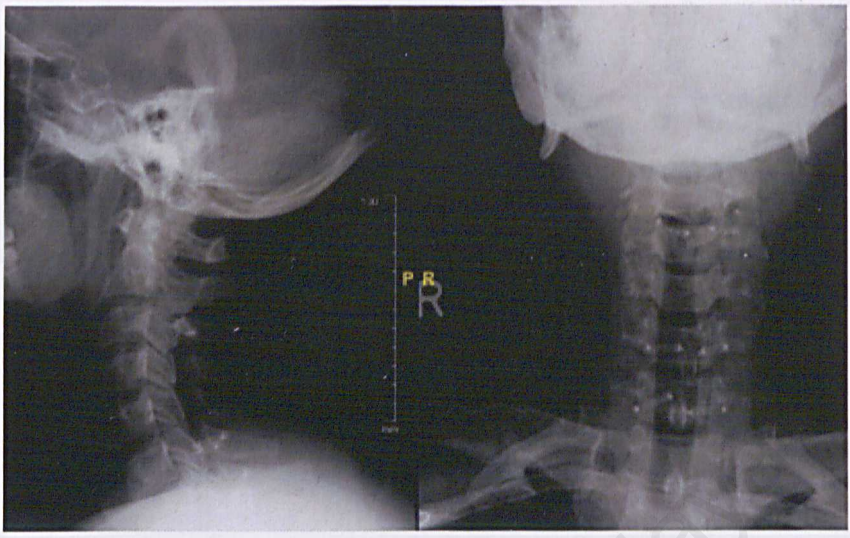


Figure 5. Cervical C3-6 laminoplasty, tiny titanium plates hold the C3, C4, C5 and C6 lamina to the parent vertebra (cervical radiograph – lateral and AP view)

There are cases of extradural spinal tumour or dumb-bell tumours where the facet joints are partially eroded by the expansile tumour. In performing the surgical access to remove the tumour, laminoplasty can be employed with attempts to preserve the partially eroded joints. The tumour is debulked from a trajectory that works from under the facet joints hence precluding from removing the joint itself. By not removing the joint, that the patient would not need posterior instrumentation which would impede the mobility of the neck. These have been successfully performed for cervical, thoracic, lumbar spinal tumour cases (Figure 6). In certain cases, the tumour has eroded the facets completely or destroyed the body of the vertebrae resulting instability, these cases would require instrumentation and fusion but again the intent is to keep the construct as short as possible to hold the segment together. The length of the constructs is dependent on the level of the spine, bone quality and the extent of primary bony destruction. By keeping the construct as short but sufficient to perform the job, the adjacent level degeneration in the future would be reduced. This same principle is applied to the traumatic spinal subluxation (Figure 7).

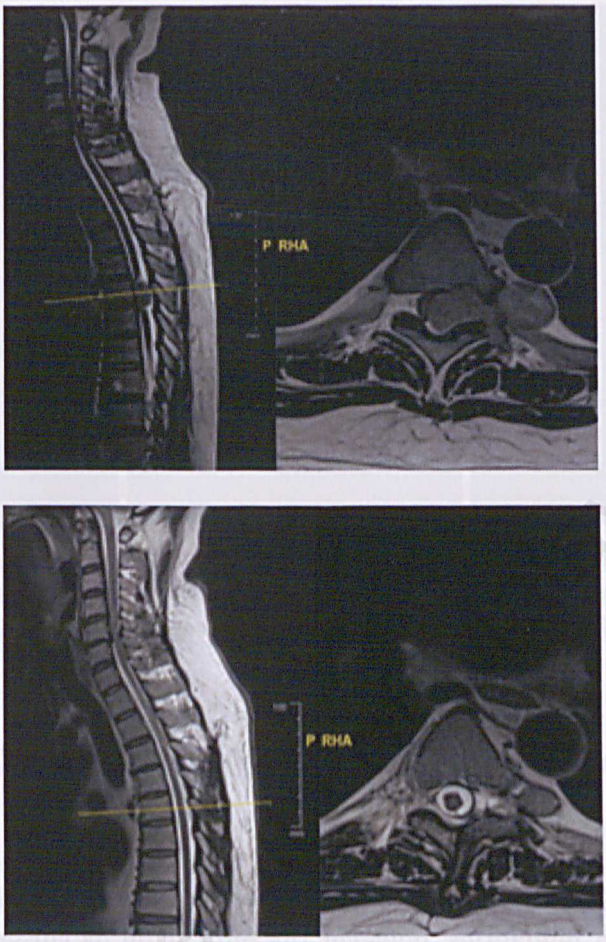


Figure 6. Thoracic extradural tumour (pre op and post op MRI images) which was excised preserving the facet, no spinal implants used, almost 90% tumour resected, there is a small residue in the left extrapleural cavity, histology of tumor was benign schwannoma, he is on clinical and radiological surveillance

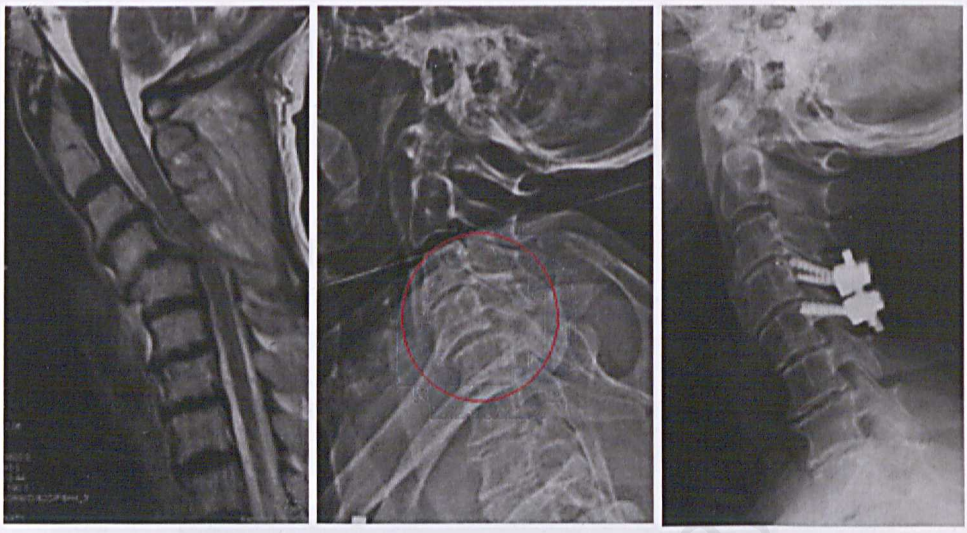


Figure 7. Elderly lady with traumatic C4/5 cervical subluxation with no disc prolapse, it was reduced and fixed posteriorly in theater under neurophysiological monitoring (MRI, cervical radiograph lateral: per operative and post operative)

NEWER TREATMENT MODALITIES

In the quest of moving with the times, we have to embrace new technology and treatment modalities, however the onus is on us surgeons to do the critical appraisal of these techniques / modalities prior to practicing it. Clinical papers are there to help guide the usability, safety and state of a particular new technique or modality. The best evidence in surgical practice is typically considered a meta-analysis or systematic review. Rarely, there is the randomised control study as evidence in the practice of surgery. We have to be aware of the limitation of these literatures as surgical evidence. The limitation stems from the several variabilities in data acquisition namely age, selection bias, etiological heterogeneity etc. There is also variability in interpretation of clinical outcomes, radiological features, determining complications, definition of short and long term outcomes and methods of statistical analysis. In the making of meta-analysis and systematic review, it is sometimes difficult to ensure that a particular procedure is performed in a standardise fashion in all centres and hence the reproducibility of the results to make a reasonable conclusion. The evidence based surgery at its best form is a broad guide on the usability of that procedure / technique for a particular condition as well as its safety and potential complications to be expected amongst others. Some quarters consider

the application of the evidence based surgery in a day to day management of a case, a fallacy. In certain terms it may be true; ultimately the right treatment strategy for that one patient must take into account the multitude of factors in his or her circumstances culminating in a sensible and sound clinical judgement in what we call a patient centred management.

On that note, there are several procedures that are being practiced such as surgical placement of interlaminar spacer, percutaneous nucleoplasty using radiofrequency, laser etc., intradiscal gel injection, stem cell injections into the disc to name a few. These modalities are being used as treatment for neck pain and back pain. Unfortunately, at this point in time, I am yet to be convinced of the utility of these modalities in my spine practice due to the lack of adequate biological science and robust literature support for it to be used in standard clinical practice even though the laboratory, mechanical studies and physical science may have shown some positive results. These techniques may appear minimally invasive as there might not be a surgical incision, but are these sorts of interventions really bringing about sustained short and intermediate relief or are they just providing an "ultra-short" symptom relief which oral medication and the body's self-healing can achieve if sufficient time is given.

CONCLUSION

In degenerative spinal conditions, case selection for surgery is paramount: surgery brings on the best results in cases that have proven mechanical compression of the neural structure or evidence of spinal instability both of which has to be correlated to the symptoms or signs. If such a correlation cannot be proven prior to surgery, then success of the intervention is diminished. The philosophy of tackling the spinal problem with a quest to maintaining as much mobility of the spine after the intervention and restoring neural function to the optimum is the true "minimally invasive" spine surgery. If this is achieved with a slightly longer scar so be it; safer surgery and functional wellbeing in the short as well as long term is more crucial than any other parameter e.g. shorter hospital stay, cosmetic scar etc. Each case has to assessed on its own merit with the right clinical judgement applied. The use of a multitude of newer modalities of treatment to manage pain, has to factor the natural history of the disease condition; any premature initiation of treatment prior giving a chance to the body to self-heal itself places the patient in an unnecessary risk of the that particular intervention.

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