

## **Reflections of an Australian Orthopaedic Surgeon**

**Henry Vernon Crock  
December 2014**

### **Biographical details**

Although my identical twin brother and I wished to study Medicine, we commenced our university education in the faculty of dentistry at the University of Western Australia, because there was no medical faculty in Western Australia at that time. We continued there for two years, where we both earned first place in the required subjects before getting the opportunity to join the medical faculty in the University of Melbourne in 1949. This was made possible by two diverse facts: one that a group of West Australians – encouraged by our strong academic performance – had provided a private scholarship for our early years, and secondly that a special request had been made by our family general practitioner in Perth, to the University of Melbourne, on our behalf. One important requirement for obtaining a place in the faculty of medicine was that we should study first year Botany syllabus during the Christmas holiday break and sit the Botany examination with those students doing the supplementary examination in February. Acceptance into the medical faculty depended on our passing that examination. Having succeeded in this, we commenced second year Medicine in Melbourne in 1949 and graduated in 1953. As medical students we lived at Newman College in the University of Melbourne.

I spent the first two years after graduation at St Vincent's Hospital, Melbourne and in my second year did a three-month roster in the orthopaedic department of Mr Thomas King.

In 1957, I spent 6 months as resident tutor in anatomy at Newman College in the University of Melbourne, before sailing on the SS Orsova to England, as assistant ship's surgeon. At that time it was expected that one contemplating a surgical career would go to England to study and obtain the Fellowship of the Royal College of Surgeons. Fortunately I had been granted a Nuffield Dominions' Clinical Assistant Scholarship to assist with the cost of living in London. For six months I lived in the Nuffield College of Surgical Sciences

annexed to the Royal College of Surgeons and was tutored there and in various hospitals around London by some of the important surgical figures of the time.

Having gained the English Fellowship, I moved to the Nuffield Orthopaedic Centre in Oxford to commence my orthopaedic training under Professor Josep Trueta.

In my first year at the Nuffield Orthopaedic Centre I worked as junior resident. This gave me the opportunity to observe most of the admissions, as well as to assist at many operations and to help to organise and attend the weekly case conferences. It was during this time that I began to study the blood supply of bones – researching at first in animals and later in the human.

### **St Vincent's Hospital, Melbourne**

My career in orthopaedic surgery really began in 1954, when I worked with a remarkable surgeon, Thomas King, at St Vincent's Hospital, in the University of Melbourne. He was a cultured man, an expert on hip disease, but with a particular interest in spinal surgery.

In 1960, on his retirement, I was appointed senior orthopaedic surgeon at St Vincent's Hospital, Melbourne, in the unit vacated by him, however, by then I held the position of lecturer in the Department of Orthopaedics in the University of Oxford and my time in Oxford had been extended. I applied to St Vincent's Hospital for leave-of-absence of one year, which was granted, and Mr. Brendan Dooley was given charge of the unit till my return.

On my return, I was given the opportunity to make overseas lecture tours to Japan, the United States, the United Kingdom, France and Italy and I was able to encourage overseas postgraduate surgeons to visit to learn spinal surgical techniques. Over the years, almost 30 postgraduate students came to study with me.

I carried out my research activities on the blood supply of bone in the dilapidated Devonshire Arms Hotel, Fitzroy, a building at the rear of, and owned by the hospital. This research resulted in the eventual publication of

my major work, *An Atlas of the Vascular Anatomy of the Skeleton and Spinal Cord*, together with articles in many orthopaedic journals. I was one of the founding members of the Facet Club and in 1985 was elected President of the International Society for the Study of the Lumbar Spine.

I held the position of senior orthopaedic surgeon at St Vincent's Hospital for 25 years, till 1986, when I returned to England.

### **Practice in London**

Between 1986 and 2001 I worked as senior lecturer in spinal surgery at the Imperial College, Hammersmith Hospital and in private at the Cromwell Hospital, London, where I continued my research. On retiring in 2001, I returned to live in Melbourne, Australia.

Practice in London exposed me to many patients who had already had multiple previous surgeries, but in some cases required further intervention. They were referred to me from many countries – the United States, France, Italy, Switzerland, Germany and the Middle East and even from Australia.

Much of my work was based on ideas and knowledge acquired through my association with Dr. Joseph Silver Collings (described later), and dealing with difficult cases became the nature of the London practice.

One particular case of great interest was that of an hotel owner who presented with a foot-drop resulting from back surgery one year earlier. At that time, it was thought that after such a lengthy period no improvement could be expected. Following a series of scans, I observed that a spinal nerve root canal stenosis was still present. Further surgery in the form of a bilateral decompression operation of the nerve root canals was performed, and within one week there were signs of good improvement. Over the course of two months the foot-drop completely resolved.

### **People Who Influenced Me**

During an active working life of 50 years, I had many important influences. My first tutor in anatomy in the dental faculty in Perth was a general

practitioner, who stimulated my interest in anatomy. At the University of Melbourne Professor's Sydney Sunderland, Les J Rae and Kenneth Russell were all important teachers in the anatomy department.

#### Mr Thomas King

Thomas King, Orthopaedic Surgeon, was an inspirational teacher with an international reputation. He introduced me to some of the world's leading orthopaedic surgeons of the time, including Professor Joseph Barr of Harvard University, who came to lecture at the hospital.

#### Professor Joseph Barr

In a lecture at St Vincent's Hospital in 1955, Joseph Barr, visiting from the Massachusetts General Hospital, stated that it was now 20 years since the publication of his seminal article on the relationship between disc prolapse and the cause of sciatica and that "perhaps it would have been better not to have put pen to paper, as it had resulted in surgeons focusing on disc prolapse as the only cause of back pain and sciatica."

That single statement acted as a stimulus to my future studies on back pain and sciatica, encouraging me to seek further causes of both and different forms of management. It ultimately resulted in the publication of my article in the Medical Journal of Australia entitled, *A Reappraisal of Intervertebral Disc Lesions*.

At that time, concepts about the function and pathology of intervertebral discs were simple. Discs were viewed as inert structures, which could cause sciatica by prolapsing or back pain by degenerating. However, Dr King and his neurological colleague, Dr F P Morgan, were beginning to identify annular tears in lumbar discs by using plain x-rays of the spine, taken in flexion and extension, to show vertebral instability. They thought that back pain was caused by this pathological change and they asked me to prepare a number of cadaveric specimens showing circumferential annular tears in lumbar discs. Photographs of these specimens were published in their paper *Primary vertebral instability as a cause of low back pain*.

### Professor Roy Calne

On the day of my arrival in Oxford, I was approached by a young surgeon, Roy Yorke Calne, who introduced himself, and said that he had heard that I had recently passed the English Fellowship examination in London. He asked if I would kindly tutor him for that examination. He was a general surgeon spending six months in the orthopaedic department preparing for that particular examination. Little did I realise that I was tutoring a person destined to become the first professor of surgery in the University of Cambridge, a Fellow of the Royal Society and the first man in Britain to perform liver transplantation. He has remained one of my closest friends.

### Kenneth Pridie

The British Orthopaedic Association meeting of 1959 had a major impact on my thinking about the management of certain joint conditions, as a result of one lecture given by a surgeon named Kenneth Pridie. He described a method of bone drilling in cases of articular cartilage damage, which would allow some regrowth of cartilage. At the time his lecture was greeted by laughs and ridicule, but I was impressed by his ideas and the thinking behind them. When I was in practice, I utilised his method many times, in various joints, with great success. For treatment of weight-bearing joints with articular cartilage damage, patients who had this form of surgery were kept non-weight-bearing for periods up to three months, with passive movements encouraged during this time. This form of management produced excellent results. As it was surgery of such a conservative kind, it was possible to be repeated years later should the need arise. Now, after more than 50 years, his treatment is an accepted and very successful form of management of this articular cartilage condition.

### Professor Emmanuel Ciprian Amoroso FRS

At the Royal Veterinary College in London, Professor Amoroso was introduced to me by Professor Trueta and became a personal friend. He provided facilities to help me commence my studies on the blood supply of

bone and helped in planning and publishing the results of my studies, under the title, *The Arterial Supply and Venous Drainage of the Vertebral Column of the Dog*.

#### Joseph Silver Collings

In 1962, I was approached by Dr Joseph Silver Collings, an Australian who had been the first Nuffield Professor of Physical Medicine in Manchester, England. He had returned to Melbourne to work as director of rehabilitation at the Royal Melbourne Hospital. He had heard that I was interested in the spine and he invited me to consult with him on a weekly basis, in order to review with him the histories and management of patients following failed spinal surgery.

After that meeting, we continued to review patients together every week for nine years. As a result, it became clear to me that there were more problems in the intervertebral disc than could be accounted for by simple disc prolapses.

These patients were all manual labourers who had had one or more operations which had failed to relieve their symptoms and the regular reviews enabled us to assess their long-term progress. As mentioned earlier, I had been stimulated by the lecture given by Dr Joseph Barr in 1955 at St Vincent's Hospital, Melbourne, to consider causes (other than disc prolapse), of severe back and leg pain.

From these reviews I drafted a paper, with the approval of Dr Collings, entitled, *A Reappraisal of Intervertebral Disc Lesions*. Its publication was accepted by the Medical Journal of Australia. 35 years later, in 2005, in a section of the American Spine Journal entitled, *Spineposts*, this article was cited as a seminal paper of the 20<sup>th</sup> century for the management of spinal problems.

#### Dr Leon Lamont Wiltse

In 1970, I had the privilege of meeting Professor Leon Lamont Wiltse, one of America's greatest spinal surgeons. He was the first president of the

International Society for the Study of the Lumbar Spine, which was founded in 1974. He was an authority on the treatment of spondylolisthesis, with a wide experience even in treating cases of spondyloptosis, for which he favoured the relatively simple operation of inter-transverse alar fusion. He issued warnings about the use of complex operations involving the use of pedicle screws and anterior interbody fusions in these patients.

Many surgeons seem to ignore the natural history of spondylolisthesis, because of the then current obsession with spinal instability. In adults, progression of vertebral slip is uncommon except in patients with pseudospondylolisthesis. Simple conservative treatment will keep symptoms of most patients under control. Too little attention has been focussed on the wide range of variations in the shape and sizes of laminal pseudarthroses, and on the pathological changes seen in them. The distal facet of a pseudarthrosis may dislocate proximally, coming to lie behind the proximal facet. In such cases, it may not be possible to use transfixing screws or other devices for fixation. Doctors Gill and White, who were also American, developed an operation for the relief of referred leg pains in patients with spondylolytic spondylolisthesis. They excised the loose lamina, described colloquially as the rattler. Professor Wiltse was somewhat biased against this procedure, though it did enjoy a short period of favour in use worldwide.

Professor Henk Verbiest

The other great figure in spinal surgery in the latter half of the 20<sup>th</sup> century was Professor Henk Verbiest, a neurosurgeon from Utrecht, in Holland. I think it is fair to regard him as the father of surgery for spinal stenosis. He was a scholarly gentleman. Like many others, he too had faced disappointments in attempting to have his work published. His original paper on congenital lumbar canal stenosis was refused publication by neurosurgical journals. It was eventually published in the British Journal of Bone and Joint Surgery.

## Events which influenced me

1966 Overseas visit of 6 weeks with Malcolm Menelaus, Paediatric Orthopaedic Surgeon at the Royal Childrens' Hospital, Melbourne

This visit to the USA, England, France and Germany gave both Malcolm and me the opportunity to make contact with leading orthopaedic surgeons, including Leon Wiltse and J. Ted Hartmann in the USA, Sir Reginald Watson-Jones, Sir Osmond Clarke in the United Kingdom and Professor Lorenz Böhler in Vienna, from whom I learned conservative management of limb fractures. This knowledge was extended further a few years later by the visit to Australia of Professor Ranga Chari from Hyderabad, who treated these conditions with superb skill.

1968 visit to Keio University, Tokyo.

This visit took place after the publication of my first book, *The Blood Supply of the Lower Limb Bones in Man*.

In 1968, one of my assistants, Mr Douglas Berryman, visited Japan, where he had met Professor Torai Iwahara, known as the "Emperor" of Japanese Orthopaedics at Keio University at that time. It was arranged that I should give a lecture, based on the material in my book, after which I presented Professor Iwahara with a copy. After the lecture the Professor asked me if I would honour him by taking one of the best students he had had in his department, Dr Hidezo Yoshizawa, to work with me in Australia, to study the blood supply of the human spinal cord. Dr Yoshizawa arrived in Melbourne with his wife and children in 1970.

The meeting with Professor Iwahara opened up contact with other Japanese orthopaedic surgeons, many of whom came to both Australia and England over the years, as postgraduate students, to learn spinal operative techniques and assist with research. This facilitated my being invited to visit and lecture in numerous Japanese universities on many occasions. Several close Japanese friendships ensued.

Professor Hidezo Yoshizawa later collaborated with me in the work, *The Blood Supply of the Vertebral Column and Spinal Cord in Man*, and co-authored the publication of the book.

I was later appointed to the editorial board of the Japanese Orthopaedic Journal and invited to become a corresponding member of the Japanese Orthopaedic Association – an honour rarely extended to foreigners.

At first Dr Yoshizawa and I studied the anatomy of the blood supply of the vertebral body. Previously I had described the subarticular venous drainage in the bones of the knee joint. The technique had involved the use of a tourniquet on the thigh, and quite high injection pressures to force the medium through the intravenous catheters that kept the venous valves open. Our attempts to fill the vertebral venous system met with many failures, until we devised a method of removing one or two vertebral bodies and filling the cavity with liquid nitrogen, thereby creating a tourniquet effect around the vertebral column. We succeeded in producing the first images ever seen of the horizontal subarticular collecting veins in the human vertebral body. The work was published in the British Journal of Bone and Joint Surgery. The function of this system of veins is still not understood. Only recently has it become possible to image them in vivo using special MRI techniques.

Probably the most important findings to emerge from our studies relate to the arterial supply of the human spinal cord. The first work on that subject was published from Oxford by Professor Thomas Willis in 1663, with a beautiful drawing of the anterior surface of the spinal cord in the human foetus showing that the arterial supply of the cord was segmental. In our work in the adult, we confirmed that the arterial supply of the cord remains segmental throughout life. The vascular injections were performed at post mortem within 6 or 8 hours of death. Dr Yoshizawa returned to Japan before our first paper was published in the British Journal of Bone and Joint Surgery. Nearly 5 years elapsed before I had completed the manuscript of our book, *The Blood Supply of the Vertebral Column and Spinal Cord in Man*.

About the time that Dr Yoshizawa was in Australia with me, Alan Dwyer, an orthopaedic surgeon practising in Sydney, introduced a new approach to

scoliosis surgery. He was a lateral thinker who helped to revolutionise the approach to spinal surgery in general.

My second Japanese Fellow, Dr Masaaki Yamagishi, also from Keio University, arrived to work with me and with my wife, Dr M C Crock, early in the 1980's. Together we made further studies on the blood supply of the cauda equina, showing that the arteries of the cauda equina ran without interruption from their origins at the intervertebral foramina right up to the surface of the spinal cord. That finding contrasted with the widely quoted American paper by Parke et al, in which it was claimed that there are no blood vessels in the cauda equina at the junction of its mid-and upper two thirds, a conclusion that runs against all anatomical and physiological principles of neural function.

We paid close attention to the venous drainage of the nerve roots themselves, producing images that should alert surgeons to the potential hazards of using electro-coagulation on the perineural venous system during spinal surgery. We were also able to demonstrate the role of the valvular system which lies between the intradural veins and the extradural internal vertebral venous plexus, which had been described by Suh and Alexander.

The implications of the anatomical findings of the blood supply of the spinal cord and cauda equina have still not been put to effective use clinically.

Professor Yoshizawa and his colleagues from Nagoya have published an important paper on the effects of the ligation of multiple adjacent radicular vessels on spinal cord function in dogs in "Neuro.-orthopaedics." This work, coupled with our anatomical studies in man, have led us to reappraise the role of the arteries of Adamciewicz in spinal cord nutrition, contradicting the view that damage to these vessels alone may lead to paralysis. Our work with Dr Yamagishi, *The conus medullaris and cauda equina in man – an atlas of the arteries and veins*, was published in 1986.

My involvement with Keio University and with the many Japanese surgeons with whom I have had very friendly relationships over many years has been one of the highlights of my career.

## 1970 Formation of the Facet Club

In 1970, following the 5<sup>th</sup> Combined Meeting of the Orthopaedic Associations of the English Speaking World held in Sydney, a number of local and visiting surgeons held a meeting in Ballarat, which led to the formation of a group interested specifically in the surgery of the spine, and which became known as “The Facet Club.” Four years later some of the original participants at Ballarat, were responsible for the formation of the International Society for the Study of the Lumbar Spine (ISSLS). In 1990, the name “Facet Club” was changed to the “Spine Society of Australia.” I was fortunate to be on the Executive Committee formed at this first Facet Club meeting. In 2008, after my retirement, I was elected an Honorary Member of the Spine Society of Australia.

ISSLS became a very important association for research, and education relating to spinal conditions. It has now become multi-disciplinary. This association gave me the opportunity to make friendships and exchange ideas with spinal surgeons and practitioners of other disciplines associated with the spine from around the world.

I was elected President of ISSLS and presided at the 12<sup>th</sup> Annual Meeting in Sydney in 1985, which was voted as both an academic and social success. It gave local spinal surgeons the opportunity to exchange ideas with world leaders in their field and, for the visiting surgeons, the chance to enjoy Australia.

### Meetings with Dr. Joseph Silver Collings and the use of discography in diagnosis of internal disc disruption

Because of my working with Dr. Joe Collings, I developed expertise in the use of discography in the diagnosis of internal disc disruption and was able to perfect the techniques required for both anterior and lateral interbody fusion surgery.

My weekly meetings with Joe in the early 1960s gave me the opportunity to observe a large number of patients presenting with a variety of symptoms associated with back pain which did not fit in with the usual symptom pattern of disc prolapse. Over the course of time it became clear that many were complaining not simply of local symptoms but of a general disturbance which could not be explained. Most of these patients were workers who regularly performed heavy work and had had some incident at work or a serious motor accident. From this it was eventually deduced that damage to the disc could result not only in back pain and/or leg pain of an unusual intensity and distribution but also in a variety of generalised symptoms, including limited spinal movements, profound weight loss and psychological disturbances. When discograms were performed on these patients, many exhibited an abnormal dye pattern on radiology, which showed dye leakage and indicated damage to one or more discs, without actual disc prolapse.

With my experiences of operating on many of these patients, and observing their tissues at operation, I was able to diagnose a number as having disruption of one or more discs produced by injury. I gave this condition the name, "internal disc disruption".

I treated this condition with total disc excision and interbody fusion, using the patient's own bone for grafting. After satisfactory interbody fusion and a suitable period of rehabilitation, many patients were able to return to work.

At this time, few people worldwide were performing discography and there was some controversy over whether or not it was a reliable and safe investigation. In experienced hands, it provided the only reliable method of proving that an internal disruption of the disc had occurred, as other radiological investigations were often inconclusive.

To perform discography, dye is injected into one or several discs and radiological images are produced. If the disc is normal, a small regular image of the central disc is obtained, but if the disc is disrupted, the dye will leak in an irregular pattern and may travel through the posterior portion of the disc, thus giving a definite diagnosis on X-ray.

The case of discography in relation to the diagnosis of disc disruption illustrates the importance of relevant investigations and their results, even when they prove controversial.

In 1983, I published my first clinical book, in which I stressed the importance of correlating anatomical findings with surgical techniques in spinal surgery. There were many patients in whom diagnoses could not be established with the use of plain x-rays or myelography. Discography became popular and it was customary to perform discograms at 3 levels in the lumbar spine. If there was an abnormal disc at L5/S1, it was necessary to know what the discs above were like. If there was an abnormal disc at L4/5, it was necessary to know what the discs were like above and below it. Although that investigative method had been introduced in Sweden, it was never popular there. Despite bias, discography did serve a useful purpose in identifying patients with intractable pain in whom plain x-rays were normal, or in others who had persistent pain after unsuccessful lumbar disc surgery.

The Volvo Prize was awarded, through ISSLS, to Professor Robert Fraser et al from Adelaide for work on post-discogram discitis in sheep, based on the hypothesis that organisms were carried into the disc on the point of the needle. Although the pattern of discitis produced in these experiments did not match the radiographic appearances in man, nonetheless in recommendations for the routine use of intradiscal antibiotics at discography proved beneficial.

During discography, dye may pass into the vertebral venous system and spread extensively in the internal vertebral venous plexus. Having read the protocols of patients who died from subarachnoid haemorrhage and progressive paraplegia following the use of chymopapain, I felt that those complications were probably the result of intravascular coagulation produced by chymopapain which would enter these veins after its injection into the disc.

Another important lesson to emerge from examination of these post mortem specimens was that remnants of disc tissue left in a disc space prepared for

bone grafting can infiltrate a graft and lead to non-union. Hence in interbody fusion, it is essential to remove virtually all the disc tissue from the interspace before inserting the bone graft.

In writing about internal disc disruption, I introduced the concept of discogenic pain and the rationale for treating the condition by disc excision and interbody fusion. This was based on the theory that irritant chemical substances from the damaged disc were emerging through the vertebral end-plate circulation into the general and perineural circulations, producing symptoms described in that form of disc disorder. These could be relieved by complete removal of the disc and interbody fusion.

#### Psychiatric Symptoms in patients with internal disc disruption

Without discography, many patients remained undiagnosed; they went from doctor to doctor seeking help and often developed psychological symptoms resulting from the fact that their symptoms had been doubted. The diagnosis made may have been “Litigation Neurosis” or provocatively, referred to by some practitioners as “Mediterranean Back.” Their condition may have ranged from the simpler psychological disturbance seen in patients with disc prolapse requiring surgery, to acute psychotic reactions leading to long term depressive illness with associated generalized symptoms.

A small number of patients on whom total disc excision and interbody fusion was performed for internal disc disruption would develop an acute psychiatric illness within days of operation, becoming disorientated or violent – a phenomenon rarely seen following other orthopaedic operations. One is tempted to relate such disturbances to some biochemical abnormality in the damaged disc tissue, postulating that the psychiatric upset is caused by the sudden release of a sensitizing substance into the general circulation at the time of operation. In the management of these patients it is desirable to work closely with a psychiatrist who has a special interest in these matters.

Patients with prolonged disc disease and chronic pain develop a typical syndrome of irritability, intolerance to noise, periods of severe depression, headaches starting at the back of the head and going over to the front of the head, sometimes with blurring of vision, dizziness, limb pain (not

corresponding to anatomical areas of supply), poor memory, reduced concentration and reduced sexual function.

The condition of internal disc disruption is discussed in detail in the book, *A Short Practice of Spinal Surgery*.

### **Operative and diagnostic innovations**

#### **Lateral Approach to the spine**

In addition to performing the anterior lumbar fusions, I developed a method of making a lateral approach to the spine for lesions on the upper lumbar region and the thoracic spine.

#### **Instrumentation**

The performance of anterior interbody fusion required special instruments which would allow the precise removal of the damaged disc without damaging spinal cord or nerve roots, and the accurate placement of the bone graft. Previously, surgeons who performed anterior cervical fusions removed the disc by drilling and this had resulted in the disc tissue being ground into the vertebral bodies, leading to non-union in a small number of cases.

Specially calibrated dowel cutting instruments designed at St Vincent's and produced by Trewavis, instrument-makers in Melbourne in the 1960's, avoided this problem and carried the advantage of enabling the surgeon to obtain a specimen of disc tissue with intact vertebral end-plates on both sides of it, together with elliptical shaped segments from the vertebral bodies. The instruments consisted of circular cutters of various diameters, calibrated to cut to different depths for cervical, thoracic and lumbo-sacral vertebral column sites. They produced accurately measured cylinders of graft bone (dowels) to fit in the space from which the disc had been removed. The disc and accompanying bone was removed with the same cutter so that when the graft was impacted it fitted accurately, without the necessity of using internal fixation. By using autogenous bone grafts, placed in the dowel cavity *without internal fixation*, satisfactory fusion could be obtained in a high percentage of cases.

The dowel cutter was used for more than 40 years and there were no cases of neurologic damage reported (see Figure 1, sent separately as attachment).

### Spinal canal and nerve root canal decompression

Spinal decompression for stenosis had been performed for some time and the usual method consisted of removal of all of the posterior elements of the spine, spinous process, interspinous ligaments and laminae at the level requiring decompression, thus leaving a large space which was eventually filled by the overlying muscles.

I developed a technique of performing a more conservative procedure in which both a central canal decompression and bilateral nerve root canal decompressions were performed, but with preservation of spinous processes, interspinous ligaments and laminae. After exposing the back of the vertebral body and facet joints, small pieces of laminal bone were nibbled away using small-sized bone nibblers, but the facet joints were carefully preserved. Decompression was deemed to be complete when the small veins present in the depth of the wound were seen to dilate and fill with blood. The muscle was allowed to fall back into normal position, rather than to bowstring across the decompressed segment of vertebral column. No sutures were placed in the muscle and the lumbo-dorsal fascia was reattached to the interspinous and supraspinous ligaments and the spinous process. This wound closure obviated the necessity for wound drainage, even after multilevel decompressions.

### Management of erosive extradural meningeal sacral cysts.

This is a rare but debilitating condition, occurring predominantly in female patients, which produces severe buttock, leg and perineal pain, aggravated by sitting. Diagnosis is made using plain x-rays and CT or MRI of the sacral area.

Most of the papers published on this topic have focused on excision of the cysts together with obliteration of the pedicles. However, in many cases, the cyst is so large and its wall so thin that closure of the defect after excision would be almost impossible. A method was devised to treat these cases with sacral laminectomy, so allowing the transparently thin-walled cysts to expand. In my series of 10 patients who were operated, 6 were graded as having

excellent results, 2 had some residual pain controlled by analgesics and 2 were graded as fair. This operation has been regarded as an alternative procedure to cyst excision, with its concomitant dangers of cerebrospinal fluid leakage, infection and continued severe pain.

Identification of Nucleus Pulposus Calcification as a cause of severe spinal pain

This is an uncommon cause of excruciating spinal pain, and is a condition usually caused by heavy lifting. It is identified using plain x-rays on a lateral film and can be treated with a high success rate by excision of the disc involved and interbody fusion.

The diagnosis of nucleus pulposus calcification illustrates the importance of history-taking, as this condition can be identified, for example, by the history of heavy lifting (even of one significant episode), and the absence of physical signs seen in disc prolapse. It is described in detail in the book:

“A Short Practice of Spinal Surgery.” H.V. Crock. Second revised edition. 1993 Pp.150 – 153 Springer Verlag Wien New York

### **Post operative nursing care**

In the early 1970's I introduced the use of tilting beds in St Vincent's Hospital, Melbourne, to assist with the early ambulation of patients who had undergone spinal surgery. When the bed was tilted to the upright position, the patient was able to walk from the end of the bed and, after a short exercise, return in the same way. The bed was then returned to its normal position. It provided a simple and yet obvious method of assisting the patients and did away with their need to twist and lift to get out of bed.

### **My thoughts on early intervention in traumatic spinal cord injury.**

Although advances in the management of spinal injuries during the past 60 years have led to greatly increased life expectancy for paralysed patients, most remain disabled. Around the world, spinal injury centres have become specialized rehabilitation units, where staff accepts the inevitability of persisting paralysis. In part, this pessimism has been based on incorrect information about the anatomy and function of the circulation of the spinal cord. Since the publication of accurate descriptions of the segmental nature

of spinal vasculature, research and clinical data suggest that reversal or prevention of paralysis after spinal injury may be possible in many patients. These improved outcomes will depend on the recognition that urgent correction of spinal cord blood supply in patients with traumatic spinal injury is critical to the long term results of treatment and it is my opinion that urgent correction of damaged spinal cord blood supply be included in the emergency treatment of injury.

The creation of specialist spinal units within trauma centres for the urgent treatment of patients following spinal injury will require considerable logistical change, but has the potential to lead to a revolution in spinal care, driven by the knowledge that spinal cord function can often be saved.

Dr. L G Svensson from the Department of Thoracic and Cardiac Surgery at the Cleveland Clinic published a research article in *Surgeon*, a publication of the Royal College of Edinburgh and Ireland, in which he suggested techniques which may improve cord blood supply in cases of severe spinal trauma.

L G Svensson. 2005 *Surgeon* 3: 6: 396 – 406 Royal College of Surgeons of Edinburgh and Ireland.

Crock H V et al. 2005. Commentary on the prevention of paralysis after traumatic spinal cord injury in humans: the neglected factor – urgent restoration of spinal cord circulation. *European Spine Journal*, Volume 14, Issue 9, November pp 910–914.

## **Teaching**

### **Importance of history-taking.**

This has now become an under-utilized “art” with most reliance placed on special investigations. As discussed above (in the case of the diagnosis of nucleus pulposus calcification), some diagnoses can be made almost exclusively from the patient’s history. It is important to listen to what the patient is telling and to deduce its relative importance and to order the relevant investigations suggested by the history.

### **Importance of surgical technique**

In 1993, the second edition of my clinical book appeared under the title “A Short Practice of Spinal surgery.” Once again I stressed the importance of

respecting anatomical principles in spinal surgery. The musculature of the paraspinal region is compartmentalised by the lumbodorsal aponeurosis. Damage to those muscles resulting from modern surgical techniques has in many cases been severe. Attention to the protection of the blood supply of these muscles during surgery is central to obtaining good results after operations on the spinal canal.

Many controversies persist in spinal surgery. In this second edition, I drew attention again to the clinical problems seen in patients with isolated disc resorption. In the first edition of the journal "Spine," Professor Nachemsoon presented a table of radiological abnormalities in the lumbar spine with significance for lower back pain. He classified a number of conditions as *irrelevant*, one of them being single disc space narrowing, another segmentation of the lumbar spine.

Isolated disc resorption fits into his classification of single disc space narrowing. However, contrary to his views, it is a common condition and a potent cause of bilateral buttock and leg pain, symptoms which are readily relieved by bilateral foraminal and nerve root canal decompressions, with preservation of the midline structures of the spine. These vessels are obstructed in isolated disc resorption and restoration of blood flow within them is an important indicator at operation of the adequacy of nerve root canal decompression. Haemorrhage from them during surgery is easily controlled with the use of a patty and gelfoam. The use of electrocoagulation on these veins should be strictly avoided.

Over the past fifty years, the most significant contributions to cervical spinal surgery were made initially by the American surgeons Robinson, Smith and Cloward. Of equal importance have been the contributions of Japanese surgeons with their introduction of open door laminoplasty for the treatment of severe cervical canal stenosis. Their work in this difficult field of cervical surgery is the most outstanding in the world. The names of the leaders in this work can be found together in the work "OPLL. Ossification of the Posterior Longitudinal Ligament."

## **My thoughts on the development of safe and successful surgical technique**

The first requirement for a spinal surgeon is a detailed knowledge of the anatomy of the spine and associated muscles, ligaments, spinal cord and nerve root and blood vessel supply. This may seem obvious, but it has always been surprising to me, when being assisted by young surgeons-in-training, to find that they were unable to identify many of the normal structures appearing in the operative field.

Knowledge of the blood supply and its preservation is vital in all regions.

Care must be taken at all times to preserve sterility.

Muscles, nerves, blood vessel and ligaments are all living tissues and should be gently treated so that no operative damage occurs to any of these structures.

Haemostasis is important and can often be produced by simple methods, e.g. pressure. Diathermy should be used with care and in moderation. The operative field should be kept clear of blood, using suction where indicated, so that visibility is preserved. There is no case in which one should proceed in a field of blood.

Nerves must be preserved at all times.

Care must be taken in the precise closure of wounds, with or without drainage.

Surgeons should learn never to make the same mistake a second time.

Students should seek to gain experience with skilled and reputable surgeons.

Careful selection of patients and of internal fixation devices,

I wish to draw attention once again to the disasters of modern spinal surgery which have resulted from the over-enthusiastic use of internal fixation devices in operations combining lumbar canal decompressions and spinal fusions.

When these complex procedures are performed on patients who have already had a number of failed operations, the damage to the paraspinal muscles often leads to their total destruction and replacement with dense fibrocartilaginous scar tissue, in which ectopic bone formation occurs, leading to re-stenosis of the lumbar canal. Our profession is losing sight of the

importance of biological principles in surgery as the tendency towards the use of internal fixation devices in the spine becomes more widespread.

### **General patient management and communication**

As an elder statesman in orthopaedics, I am concerned by the current poor reputation of orthopaedic surgeons. The impression in the community is that orthopaedic surgeons are often disinterested and lacking in good communication skills.

Successful patient management depends very much on developing a relationship of trust with both the patient and the family. It is important to listen to what the patient and family have to say, to consider their viewpoint and to respond suitably. Often there are problems apart from the important medical and surgical condition of the patient, such as difficulties relating to employment and finances. All of these must be taken into consideration for the best possible experience for the patient.

Good doctor/patient communication is integral to the best possible outcome for the patient. This aspect of medical care can often be regarded as a “soft” skill when, in fact, a trusting relationship with excellent two-way communication is vital to achieve the best and safest outcome for the patient. The investment of time in building this relationship is guaranteed to save time in the long term.

Similarly, and no less important, is respectful communication and relationship with other staff, doctors, nurses, cleaners and administrative workers. This provides a calm and cooperative working community, in which mistakes are less likely to occur.

### **Mistakes I have seen**

The worst surgical disaster I saw was in the course of giving evidence on behalf of a 27 year old patient who had had an upper lumbar anterior interbody fusion at L2/3. He had previously developed a vertebral body infection following a serious spinal injury while working overseas.

The fusion operation was performed some years after this patient’s vertebral osteomyelitis.

He was operated on from an anterior approach to L2/3 level on the grounds of vertebral instability, but in my opinion, X-ray showed evidence of post-infection new bone formation at the L2/3 level, indicating that this segment of the lumbar vertebral column was stable and that fusion was therefore unnecessary.

In court, the surgeon described details of the anterior approach to the lumbar spine, and stated that one lumbar artery and later a second one had been torn, and that two different vascular surgeons had been called, several hours apart, to repair the vessels and stem the blood flow. The anaesthetist was not called to give evidence nor did he provide any comment on the control of blood loss under his supervision.

After an operation lasting 11 hours, blood loss was estimated to be in excess of 10 litres and when the covering sheets were removed it was found that the legs were white and cold and that leg pulses were absent.

The patient had had a massive aortic thrombosis. This disaster resulted in further vascular operations to attempt to restore blood flow. He was left wheelchair bound, unfit for work and with a young family to support and educate.

The fundamental advice on the practice of Medicine and Surgery: *Primum non nocere* was sadly neglected in the management of this man's case. It was my view that the level at which the surgery was being performed was an incorrect level, and that after the first vessel had been damaged, the operation should have been aborted. After the second arterial damage, the fusion operation should definitely not have continued for several more hours.

A second case is that of a colleague of mine who had had a decompression of his lumbosacral spine for the relief of sciatic pain, performed by a neurosurgeon. Following this operation he was unable to walk and asked for my opinion. As he had had no postoperative x-rays I requested AP and lateral views of the spine, which indicated that laminae, spinous processes and facet joints, from the sacrum to the level of L1 had all been removed and on the lateral view of the spine, the vertebral body of L2 had dislocated anteriorly over L3. Although the neurosurgeon went on to insert metallic

devices, my colleague failed to recover mobility after this procedure and remained wheelchair-dependent. He died shortly afterwards. This patient could have been safely assisted if a more conservative approach had been taken and posterior elements of the vertebral column preserved to maintain stability.

While I was in active surgical practice, many patients were referred to me who had had complications following the insertion of metallic devices and I performed many operations to remove them. One Swedish patient was left with complete destruction of the paraspinal muscles with solid scar formation, after insertion of screws and plates at all levels of the lumbar spine. I eventually excised all this scar tissue and, with the assistance of a microvascular surgeon, replaced it with a vascularized latissimus dorsi flap. This patient recovered mobility and has since continued to work at a high professional level, 20 years after the surgery.

### **Postoperative complications I have seen**

Profound para-spinal muscle damage resulting in dense fibrosis. This is common in patients who have had repeated operations for lumbar disc lesions and laminectomies for lumbar canal stenosis, and following the implantation of metallic devices.

Gross vertebral instability following excision of laminae, facet joints and spinous processes.

In the Cloward interbody fusion system, the drill used caused disc tissue to become embedded into the vertebral bodies and produced graft failure and in some cases serious cord injury.

Epidural cyst formation following multiple lumbar puncture procedures. This condition is rare, but is seen sometimes in children with malignant conditions who may require repeated lumbar punctures (sometimes up to 100) in the course of their treatment.

Discitis was produced in a small number of patients who underwent discography – a complication which was often reversed with a single cortisone injection into the affected disc.

A diabetic patient who presented with an epidural abscess following repeated intrathecal injections of cortisone had had symptoms for several days after the

last injection. The epidural abscess was drained, but paraplegia had already resulted from his delayed presentation. More rapid examination and treatment may have prevented this poor outcome.

### **Summary**

In my career spanning 50 years, I have been fortunate to have worked with a wide range of local and international orthopaedic surgeons, colleagues, mentors and students, gaining valuable experience and sharing my own with them. I have worked alongside exceptional practitioners and have also seen the work of those whose surgical skills and standard of care fell far short of acceptable, but all have taught me valuable lessons.

Successful surgery begins with positive and considerate relationships, good communication with patients, colleagues and other staff. This then paves the way for the following fundamental principles:

- Careful history-taking, note-taking and diagnosis.
- Close collaboration with other respected clinicians over difficult cases.
- Sound knowledge of anatomy.
- Sound surgical training and technique.
- Care when handling tissues and avoidance of damage to structures.

Due attention to each of these key principles has been the basis of my career in orthopaedics. These are the principles that are essential for students and future surgeons to embrace in order to ensure sound surgical practice. Furthermore, while changes are inevitable in surgery, it is our duty as surgeons to ensure that innovation is always carefully evaluated, and that the interest of the patient is paramount.

To conclude, I would like to refer again to the difficulties which are often experienced in trying to find a publisher for one's work. My most recent book "An Atlas of the Vascular Anatomy of the Skeleton and Spinal Cord in Man" appeared after my searching for a publisher for more than 3 years. It was eventually produced by a small medical publishing house in London, Martin Dunitz, and was awarded the British Medical Association Prize for Basic Science and Clinical Medicine, and has been displayed in the

Science Museum in London. I draw attention to this for a special reason, because the work of my Japanese and Indian scholars has now been displayed in one of the most important museums in Europe. It is to be hoped that some bright enthusiastic young person may see the images and be simulated to extend our studies and so find answers to questions about the functions of these vascular systems in health and disease.

My final message to young surgeons is to repeat the admonition of John Hunter, a Scotsman by birth, but England's most famous surgeon anatomist of the 18<sup>th</sup> century. *"No surgeon should approach the victim of his operation without a scared dread and reluctance."*

**\*AOA Disclaimer**

The opinions presented in this article are purely those of the author and not AOA.