COMPARATIVE STUDY OF SPECIFIC ROOT SLEEVE DECOMPRESSION AT VARIOUS LUMBAR AND LUMBOSACRAL LEVELS IN STENOTIC AND WIDE CANAL

THESIS
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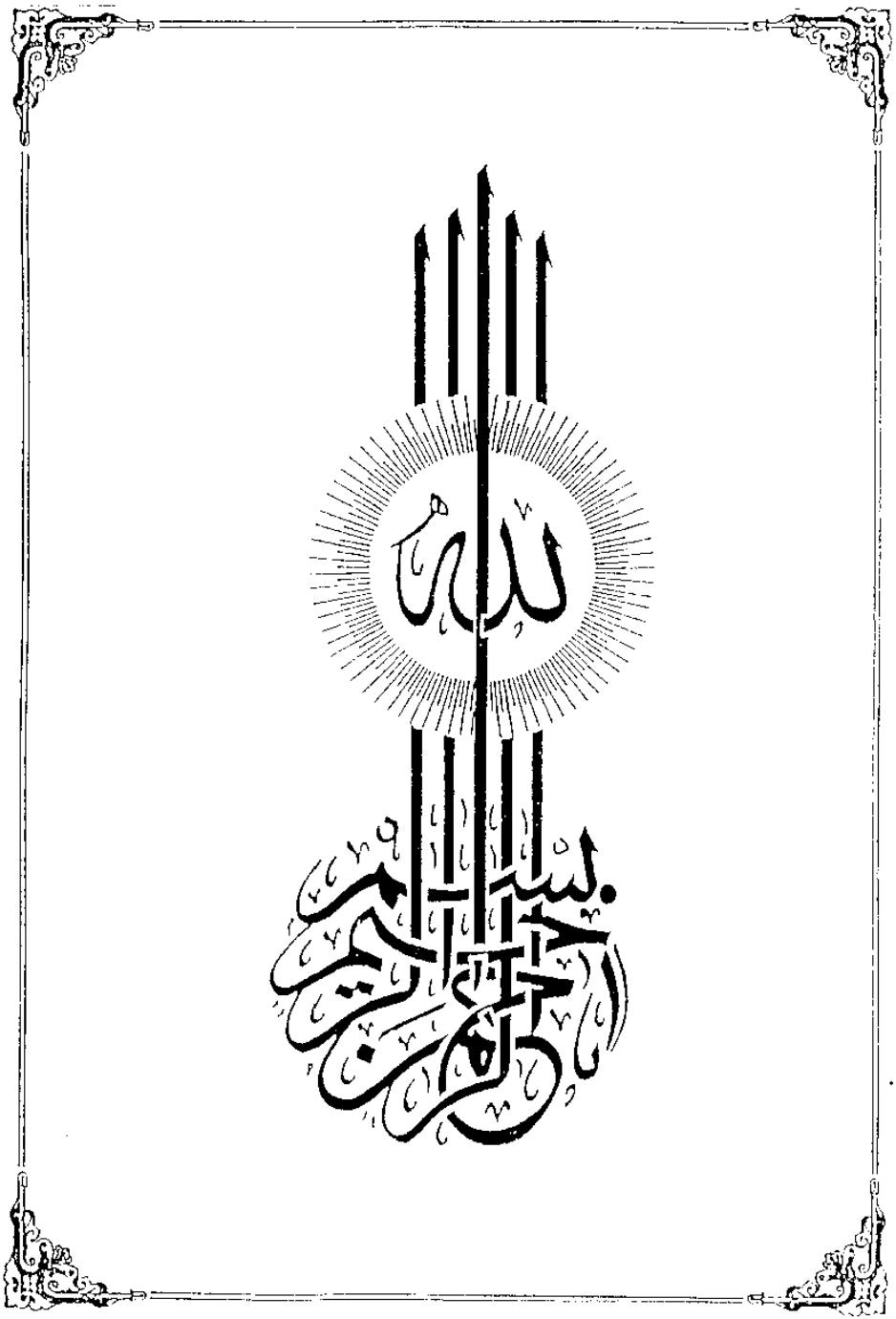

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HISTORICAL REVIEW

A- The development of spinal surgery:

The development of spinal surgery goes back to old ages. Texts on history of medicine mention the names of Hippocrates, Galen, Celsus and Aretaeus in connection with the genesis of the early notion on treating injuries of the spine. However no surgery was attempted in these early days for such ailment. A historical study on the early development of spinal surgery is reported by Walker (1951) who is quoted in the following paragraphs.

Operations on the spinal cord did not begin until the middle of the sixteenth century. It was Ambroise Paré, a French army surgeon, who led the way to radical treatment of spinal injuries. He operated for depressed splinters of bone and fragments inpinging on the cord and nerve roots as early as 1549.

The cause of spinal surgery was advanced by Macewen in 1883 when he removed a "fibrous neoplasm of the theca" in a case of angular curvature of the spine with signs of complete sensory and motor paralysis of two years duration. The patient made a complete functional recovery. In the following year Macewen operated on a similar case again with good results. In 1887, Victor Horsley removed a "fibromyxoma on the theca" and the patient made complete functional recovery.

In the previously mentioned operation of Macewen and Horsley, a midline incision was used. The spines and laminae were removed with various instruments, and no attempt was made to close the bone defect. With more patients surviving the operation, surgeons became concerned about the post-operative stability of the spine. It was believed that laminectomy so weakened the vertebral column that it was likely to collapse if the patient became ambulant. Accordingly surgeons sought to re-establish bony continuity in so far as possible thus the era of osteoplastic laminectomy was inaugurated.

One of the earliest osteoplastic methods was that of Dawbarn in 1889 who made an H-incision over the spines. The two lateral incisions were carried down to the transverse processes on either side and laminae divided. The lateral incisions were then connected by a transverse incision down to the supraspinous ligament which was divided at this point. The arches with their spines, muscles, fascia and skin attached, were reflected superiorly en masse, while the lower half of the H was turned inferiorly. At the end of the operation the two flaps were replaced and sutured.

After Dawbarn's report, many modifications of the osteoplastic principle were introduced. Urban in 1892 and also Bickham in 1905, made U incisions over the spinous processes and reflected the skin muscle bone flap superiorly. Marion in 1895 used a semilunar paravertebral incision and reflected the osteoplastic flap laterally to the opposite side.

Krause in 1911 perforated the denuded laminae on either side with a drill at two levels. The upper and lower perforations of either side were connected by dividing the laminae with a special biting forceps so that the bony arches, with spines intact, could be lifted out in one piece and replaced at the end of the procedure.

Not all surgeons of this period, however were proponents of the osteoplastic method. As early as 1894 Chipault objected to these procedures. His method did not differ fundamentally from the modern laminectomy.

In 1902, Lorenzo Bonomo described his new technique of hemilaminectomy. His incision was in the midline and vertical. The paravertebral muscles were dissected subperiosteally. With a curved chisel introduced through an interlaminar space the lamina on one side was elevated sufficiently to admit rongeurs. Then the laminae of two or three vertebrae were rongeured from the base of the spinous process laterally to the articular facets. Bonomo said that exposure allowed room for adequate visualization of the vertebral canal posteriorly and laterally and even of the posterior surfaces of the vertebral bodies.

Elsberg (1913) described a new technique of bilateral laminectomy. He made a vertical midline incision and reflected the muscles by subperiosteal dissection. After dividing the supraspinous and interspinous ligaments, the spines were cut off with bone cutting forceps and the laminae rongeured away. He

condemned the chisel and mallet in spinal cord surgery and was opposed to the use of drains and to the practice of leaving the dura mater unsutured. The important contribution of Elsberg is the development of a simple technique based on sound anatomical and surgical principles. He stressed the necessity for accurate localisation of the lesion, careful dissection, adequate exposure and respect for the contents of the vertebral canal. By 1920 osteoplastic laminectomy was seldom practiced and from that time the basic principles of bilateral laminectomy did not alter notably.

Although sciatica was well known to the ancient physicians it had not been the subject of careful observation and discussion until 1794 when Cotugno wrote his monograph and related the pain to disease of the sciatic nerve. Lasègue, in 1864, commented upon the physical signs of patients with sciatic neuritis. Walker reports that the first description of traumatic rupture of the intervertebral disc was given by Virchow in 1857.

Kocker in 1896 also reported a traumatic protrusion of an intervertebral disc found at autopsy.

Krause in 1908 successfully removed what can be regarded with certainty as a ruptured disc. He made a low lumbar midline incision and reflected the paravertebral muscles from the laminae which were then removed in one piece. The lesion was resected transdurally. It was thought to be an "enchondroma". Goldthwait in 1911 discussed a case of recurrent sciatica which had been

operated upon by Cushing but no lesion was found. He believed the pain was due to recurrent dislocation of the disc into the vertebral canal, and he explained the negative exploration by assuming that the disc had slipped back in place. Moreover, Goldthwait expressed the opinion that such a condition could produce the symptoms of sciatica and low back pain. Elsberg, in 1915, operated on a patient with sciatica, finding a "ruptured ligamentum subflavum" compressing the fourth lumbar nerve root. After this was resected, the pain disappeared (Mixter and Barr; 1934).

Dandy in 1929, after operating on two patients with sciatica, regarded the cartilaginous masses as traumatic in origin. He further noted that in his cases the protrusion occurred laterally where the posterior ligament was defective. But the idea was still prevalent that disc herniation were neoplastic. Evidence rapidly accumulated in favor of the traumatic origin of the protruded cartilage and its role in neurological disturbances. In 1931, Sashin reporting on nine cases, attributed the principal causes of disc protrusion to trauma and degenerative changes of the cartilaginous plate.

It was the detailed analysis of Mixter and Barr (1934) which established the traumatic or degenerative origin of disc herniation and its relationship to sciatica.

The full laminectomy and transdural approach gave way to hemilaminectomy, then partial hemilaminectomy and extradural

removal of the disc. In 1939 Love reported that the disc might be removed through the interlaminar space without removing bone (Love; 1947).

Recurrence of symptoms and failure of relieve the back pain prompted orthopedic surgeons, in particular, to recommend spinal fusion at the time of removal of the disc. But neurosurgeons were loath to increase the period of hospitalisation unless there was definite evidence of unstable spine. (Paine and Haung; 1972).

B- <u>The development of the modern notion of "spinal stenosis":</u>

Although thickening of the posterior elements of the lumbar vertebrae was described as early as 1900 by Sachs and Fraenkel and subsequently by others, its importance was obscured by the discovery and popularization of the ruptured intervertebral disc by Mixter and Barr in 1934. Bailey and Casamajor (1911) referred to one patient with pain and weakness of the leg relieved by laminectomy. They thought that thickening of laminae and ligamenta flava and bony exostoses could cause compression of nerve roots in the cauda equina. Bailey and Elsberg (1912), described 7 cases of back and leg pain. In 4 of these in which no cause for compression was found, relief was obtained by laminectomy with opening of the dura. In 1913, Elsberg reviewed 60 laminectomies; he thought that this operation might have improved the circulation to the nerves in the cauda equina or that the introduction of air might have been beneficial. He also reported that the nerve roots were edematous and hyperaemic in many of these cases. Parker and Adson (1925) described the

syndrome clearly, they reported 8 cases of which 6 where lumbar. At laminectomy the bone of the laminae was thickened, vascular, and spongy. Microscopic examination revealed marked new bone formation, periosteal edema, and the presence of many active osteoblasts. The narrowing of the dura was segmental in nature. The immediate results of operation were satisfactory. Towne and Reichert (1931), recorded 2 cases in which the only operative finding was thickening of the ligamentum flavum at 2 or 3 levels. Excision of the ligaments and laminectomy produced relief of symptoms. They attributed the compression to the thickened ligamentum flavum. Spurling et al. (1937) also stressed the importance of hypertrophied ligamentum flavum as a cause for compression of the cauda equina.

In 1945, Sarpyener was the first writer to describe congenital narrowing of the bony canal as responsible for pressure on the cauda equina. Schlesinger and Taveras focused attention upon the anatomical basis of the narrow canal syndrome and emphasized the difficulties encountered in obtaining adequate surgical exposure of herniated disc which tend to be hidden from view; high under the lamina due to the low position of the interlaminar space relative to the intervertebral space.

Verbiest (1973) clearly described the symptoms of intermittent claudication due to cauda equina compression. He though that narrowing of the canal was developmental in origin but that disc protrusion and degenerative changes could aggravate the condition. He concluded that narrowing was confined to the

sagittal plane, producing complete block as revealed by myelography. Munro (1956), appears to be the first to emphasize that causes of compression other than disc protrusion are almost as important as the latter. (Paine & Haung; 1972). Blau and Logue (1961) introduced the term "intermittent claudication of the cauda equina" for the first time in the literature.

Epstein et al. (1962) reported twenty-nine patients with symptoms related to narrowing of the lumbar spinal canal, 18 of whom had a sagittal diameter of 15 mm or less. The interpedicular distance was in the lower limit of normal in 10 of their patients. They stressed the significance of relative flattening of the intervertebral foramina as shown in the lateral radiograph. Teng and Papatheodorou reported thirty patients with so-called spondylosis of the lumbar spine, in three of whom they described narrowing of the lumbar canal due to reduced anteroposterior diameter. Hancock recorded the finding of short pedicles in the narrowed lumbar canal, but in his first patient he also noted a reduction in the interpedicular distance at L_4 and L_5. Ehni emphasized the harmful effects of hyperextension. Jones et al. reported 13 cases with emphasis on radiological and myelographic diagnosis (Jones and Thomson; 1968).

Schatzker and Pennal recommended that the only form of successful treatment is surgical, and consists of a decompression which must be sufficient both longitudinally and laterally to relieve completely the stenosis. They pointed out that compression of the roots occurs in the lateral recess. It is only

when sufficient resection of the superior articular facets is carried out, to unroof the whole of the lateral recess, that the roots are adequately decompressed (Schatzker & Pennal; 1968).

Clark (1969), however, stressed that the total interpedicular distance may be reduced at all levels and this may account for considerable difficulty at operation. They were of the opinion that the common cause of the narrow canal is an abnormality of development, but that disc protrusion and degenerative changes make cauda equina compression more likely. Ehni et al. (1969) discussed at length the significance of the small spinal canal and cauda equina compression syndrome. Cauchoix et al. (1974) thought that it was not rare for the canal to become narrow following spinal fusion and that the nerve roots in the cauda equina can be compressed by pseudo-spondylolisthesis. Macnab (1971) described 8 cases of spinal stenosis with cauda equina compression. He also thought that stenosis can follow posterior spinal fusion and recorded 34 cases in which decompression was required. Yamada et al. (1972) recorded 5 cases of stenosis. Fluoroscopy showed that hyperextension caused a block presumably due to buckling of the ligamentum flavum. In 1973, Nelson reported nine patients with spinal canal stenosis. He suggested the classification of spinal stenosis into primary or secondary types. The primary type may be due to a reduction in either the sagittal, coronal or both diameters of the spinal canal. Secondary narrowing of the canal may be superimposed upon a primary anatomical abnormality or may cause narrowing in a previously normal canal. Symptoms are

thought to be caused by a further reduction in the size of an already narrow canal, producing traction on the nerve tissue, which is then unable to move freely. Epstein et al. (1972) described 15 patients with nerve root entrapment in the lateral recess due to enlarged superior articular facet.

Kirkadly-Willis et al. (1974) reviewed the subject, extensively and proposed the classification of spinal stenosis into developmental, degenerative and combined. An international classification of lumbar spinal stenosis was established in 1976 in which stenosis was divided into congenital and acquired. Congenital (or developmental) stenosis could be idiopathic or achondroplastic. Acquired stenosis could be degenerative, combined (developmental and degenerative), spondylolisthetic, iatrogenic, post traumatic or due to uncommon diseases (Paget's disease, Fluorosis).

Macnab (1975) enhanced the concept of root entrapment syndromes, as it allows a more logical approach to nerve root decompression. Epstein et al. (1977) reviewed the pathological changes in different forms of lumbar canal stenosis, and correlated these changes with the radiological findings. In 1980, Getty reviewed the results of 31 of his patients operated for lumbar spinal stenosis. He noticed that in patients with degenerative changes, one important reason for failure was inadequate decompression. The good results of operation were characterised by rapid resolution of pain in the leg. Ciric et al. (1980) described the lateral recess syndrome as a variant of