Lumbar nerve root compression at the intervertebral foramina caused by arthritis of the posterior facets

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The authors report their experience with 12 cases in which the roots of the sciatic nerve were compressed at the intervertebral foramina by degenerative arthritis (arthrosis) of the posterior facets, and in which foraminotomy and facetectomy brought relief of pain. Patients with disc narrowing, spondylolisthesis, and transitional vertebrae place unusual stress on the posterior facets. This may lead to hypertrophy and the development of marginal osteophytes that project downward with eventual constriction of the intervertebral foramen and entrapment of the nerve root. Such alterations are common in patients over 40, and when found in the presence of unremitting sciatic pain without evidence of a herniated disc or other etiology, a causal relationship must be considered.

KEY WORDS - nerve root entrapment - intervertebral foramen - posterior facets - degenerative arthritis

The role of degenerative arthritis of the posterior facets (apophyseal arthrop-osis) in the production of intraforaminal nerve root compression often is unrecognized. It occurs in patients over 40 years of age who frequently are treated extensively with anti-arthritis drugs, analgesics, and physical therapy, usually to no avail. The possibility of surgical relief by foraminotomy and facetectomy is rarely considered because concomitant significant neurological abnormalities are rare, and the causal relationship is not recognized. Other sources of neural compression such as congenital vertebral anomalies, spondylolisthesis, and steno-sis of the spinal canal may be contributory factors, especially in elderly patients.

The importance of the posterior vertebral articulations in the production of low-back and sciatic pain was well known before recognition of the syndrome of the herniated disc. Ghormley,5 in 1933, described the clinical and pathological aspects of degenerative disc disease and osteoarthritis of the posterior facets with neural compression. Knowledge in this area was further expanded by Badgley,1 Gray,7 Jonck,9 and Mitchell.11 The effects of spondylolisthesis with and
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without an intact neural arch on the production of posterior facet changes were outlined by Macnab and Newman. Gray and Mitchell described the production of arthritic changes in the apophyseal joints in patients with transitional vertebrae and unilateral sacralization.

We have observed 12 patients with neural entrapment in the lateral foraminal recess caused by degenerative arthritis with hypertrophy of the posterior facets. Suggestions for clinical and radiological diagnosis and treatment constitute the basis for this communication.

Characteristic Cases

Case 1

The roentgenographic findings in a 67-year-old woman with spondyloarthrosis (Fig. 1) showed collapse of the intervertebral space at L4–5 and prominent asymmetrical hypertrophic alterations of the posterior facets. There were bilateral defects in the myelogram at the level of the facets immediately above the level of the intervertebral disc. Both dorsal and lateral intrusions deformed the column of oil in the oblique and lateral exposures. At operation, neural entrapment was demonstrated in the lateral foraminal recesses beneath the enormously enlarged facets. The floor of the canal showed only minimal alterations. Laminectomy of L-5 and removal of the major portion of the articular facets relieved symptoms. Spontaneous fusion had occurred at the L4–5 interspace.

Case 2

This 46-year-old woman had experienced chronic back pain for 8 years, which had been spontaneous in onset and was associated with increasing weakness and subjective numbness of both legs during the past year. Symptoms were intensified by standing and walking one or two blocks, with relief only on sitting or lying down (claudication). Neurological examination showed unrestricted straight-leg raising bilaterally, with absent ankle reflexes and profound weakness and atrophy of both anterior tibial muscle groups. Sensation was intact.

Spine films (Fig. 2) showed degenerative osteoarthropathy of the posterior facets at L4–5 with anterolisthesis of L-4 on L-5 and narrowing of the interspace. A nearly complete block on myelography was present at this level with characteristic lateral tapering of the oil column just above the point of obstruction. In the lateral view, the column was interrupted dorsally by facet encroachment and ventrally by the step deformity of the listhesis.

Bilateral laminotomy and foraminotomy with hemifacetectomy and undercutting of the facets unroofed the foramen (Fig. 2 E, F) and decompressed the roots at the L4–5 level. The underlying disc, degenerated
but not protruding, was excised with the cartilage plates of the vertebrae. The interspace was packed solidly with bone fragments taken from the intervening lamina and spinous processes. Recovery was uneventful with a solid fusion demonstrated after 6 months. Weakness and atrophy disappeared rapidly, with no residual pain after 3 months.

**Case 3**

A 50-year-old woman had a transitional L-5 vertebra and a large costotransverse process articulating with the sacrum on the left. Anteroposterior spine films (Fig. 3 A) showed prominent degenerative hypertrophic changes on the posterior facets on the right side in the convexity of the scoliosis at the L4-5 level. Myelography in oblique views (Fig. 3 B, C) revealed minimal indentation in the lateral aspect of the column of oil. Laminotomy at L4-5 (Fig. 3 D, E) disclosed marked arthrosis with hypertrophy of the posterior facets. The foramen was markedly narrowed, compressing the nerve root after its exit from the canal. Decompression of the L-4 root required excision of the thickened lamina and the overlying portion of the facets far lateral into the foramen. Exploration at L3-4 was negative.

**Analysis of 12 Cases**

There were eight women and four men in this group, whose ages varied from 46 to 69 years, the majority being over 60. Each had had chronic low-back pain for many years, as long as 20 years in four patients. Acute, unremitting sciatica lasting 1 to 6 months occurred in three. The others had remissions and exacerbations of low-back and radicular pain and were eventually totally disabled. Only after prolonged conservative care were these patients considered candidates for surgery. The usual opinion was that osteoarthritis and the chronic nature of the illness were contraindications for any operative procedure.

**Symptoms**

Symptoms appeared spontaneously in all patients. Unilateral sciatica occurred in six,
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Fig. 3. Case 3. A. Spine film showing transitional L-5 vertebra with large costotransverse process articulating with the sacrum on the left, and changes in the posterior facets at L4-5 on the right (arrows). B. and C. Myelograms showing minimal changes, with indentation in the lateral aspect of the oil column in oblique views. D. and E. Drawings illustrating laminotomy at L4-5. There was marked arthrosis with hypertrophy of the posterior facets (P.F.) and thickening of the joint capsules and investing tissues. The foramen was markedly narrowed, compressing the nerve root after its exit from the canal. Decompression of the L-4 root required excision of the thickened lamina and overlying portion of the facets lateral into the foramen. The dotted line in E indicates the position of the pedicle.

Findings

Back mobility was restricted in all. Flattening of the lumbar curve was present in nine, with hyperlordosis in one. Evidence of paravertebral muscle spasm and scoliosis was found in two patients; others had had varying degrees of tilt in the past. A positive Lasègue maneuver was the principal finding in six patients. However, unrestricted straight-leg raising was observed in four patients with spondylosis and claudication, and in two with anterolisthesis. Depressed-to-absent ankle reflexes were found in 10
FIG. 4. Dry specimens of the lumbosacral spine showing transitional L-5 vertebra with the costotransverse process on the left articulating with the sacrum (arrows). Note hypertrophic, degenerative alterations in the posterior facets at L4-5 on the right (arrows). The lumbosacral facets are small, asymmetrical, and rudimentary (hollow arrows), and there is little mobility at this site because of the buttressing effect of the massive costotransverse process united to the sacrum. B. L-4 vertebra, caudal view, shows hypertrophy of the inferior facet on the right with marginal osteophytes intruding into the intervertebral foramen along the dorsal aspect (arrows). The normal funnel-shaped foramen is seen on the left. There is no spur formation along the dorsal aspect of the vertebral body. C. L-5 vertebra, cranial view, showing massive hypertrophy of the superior articular facet on the left with marginal osteophytes intruding into the foramen along its entire length causing stenosis (arrows). In contrast, the foramen on the right shows no alterations associated either with spondylosis or apophyseal arthrosis.

patients. The patellar responses were diminished in six and absent in two, the remainder being normal. Sensory alterations were evident in three patients. In only one was there a clearly recognizable S-1 dermatome pattern. Weakness with atrophy was most evident in the extensor hallucis longus and anterior tibial muscle group. This finding was present in varying degree in all patients, while paresis of the quadriceps and slight-to-moderate weakness of the hamstrings were observed in five. The neurological alterations were not conspicuous and were of little value in localization.

Diagnostic Studies

Routine x-ray examination revealed three distinct skeletal abnormalities, each sharing the common finding of degeneration of the intervertebral disc and narrowing of the interspace at the level of nerve root compression. The largest group included six patients with spondylosis and moderate-to-severe collapse of the intervertebral space, with associated signs of spinal stenosis in three (Fig. 1). Degenerative spondylolisthesis without a defect in the neural arch occurred in three cases, one with retrolisthesis (Fig. 2). The remaining three had transitional vertebrae with unilateral sacralization, the degenerative arthritis occurring at the interspace above and confined to the posterior facets opposite the articulation.
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between the costo-transverse process and the sacrum below (Figs. 3 and 4).

Degenerative osteoarthritis of the posterior facets was prominent radiologically in seven of the 12 patients. In the remainder, these alterations were less evident. Changes included narrow, uneven apophyseal joint surfaces and fusion. Stereoroentgenograms and laminagrams in the supine and oblique position were helpful in evaluating the facets.

The L4–5 interspace was affected in nine patients, and the L2–3, L3–4, and L5–S1 levels were involved in one patient each. In seven patients, two or more levels were implicated with the structural changes always prominent at L4–5. Cerebrospinal fluid was normal in all except three patients in whom elevations of total protein as high as 97 mg% occurred.

Myelography. An inconstant pattern of defects was revealed by myelography. Some patients showed only a minimal elongated smooth lateral intrusion (Fig. 3), but others had deeply indented unilateral or bilateral deformities (Figs. 1 and 2). The latter were observed in patients with stenosis, spondylolisthesis, and arthritic changes. A high degree of block, in some almost complete, was found in five patients, including all those with spondylolisthesis (Fig. 2). In the lateral view the pathological facets produced a defect in the dorsal aspect of the column of oil immediately cephalad to the interspace (Figs. 1 and 2). In the anteroposterior projection, bilateral intrusions of enlarged facets resulted in tapering of the column above the interspace with a waist-like deformity (Figs. 1 and 2).

Electromyography. Positive electromyography in the three patients studied showed an increase in the number of the polyphasic wave forms on volition, with irritability and increased insertional activity at rest. No denervation potentials were found. This study provided added impetus in reaching a decision to operate on patients with little objective neurological deficit but with severe disability.

Operation

Surgical exploration of several levels was often required. The myelographic findings and observations at the time of operative exposure were the principal guides to the extent of laminectomy or laminotomy and facetectomy required. The hypertrophied facets, deformed by thickening of joint capsules and spurs at the articular margins, were the principal causes of foraminal nerve root compression (Figs. 2, 3, and 4). Secondary reactive scarring, with evidence of acute and chronic inflammatory alterations, were present around the involved nerve roots. The intervertebral discs were degenerated but not protruding. Vertebral osteophytes were minimal in size or absent. In unroofing the nerve root far distal to the lateral recess, it was necessary to remove not only the medial overhanging portions of the facets, but to undercut or excise significant parts of the more lateral elements. Complete facetectomy was required in three patients in whom it was mandatory to unroof the foramen by cutting a tract through the entire diseased zygapophyseal joint (Figs. 2 and 3). Instability due to facet removal alone was not observed.

To provide circumferential decompression of the involved nerve roots, degenerated discs in four patients were excised together with small vertebral osteophytes. These were not of major importance. Laminectomy was necessary in those patients with significant degrees of spinal stenosis.

A posterior interbody spinal fusion was performed through the exposure provided by laminectomy in two patients with degenerative spondylolisthesis. The third patient did equally well without fusion.

Results

Results of the surgical decompression were excellent in six patients, with early relief of acute radicular pain and return to normal activity. These patients had minimal back pain prior to surgery. Five were below 50 years of age; one was 65. Five patients had good-to-fair results with moderate incapacitation and residual discomfort. One remained significantly disabled. This patient had extensive spondyloarthrosis at multiple levels, a long history of disabling back pain and advanced muscle atrophy. Symptoms of claudication were relieved in all six patients.
The course of recovery, once the acute radicular pain had subsided, was more prolonged than that encountered after simple disc excision, and supportive rehabilitative care was often needed. Back pain, especially if present for long periods, persisted. However, it was manageable once symptoms of neural compression were relieved.

Discussion

The unusual frequency of arthrosis and slippage at the L4–5 level relates to the higher range of mobility of the fourth lumbar vertebra as compared to all others, the fifth being the next most mobile. This disposition occurs because of the alignment of the facets obliquely to the transverse plane, those at the lumbosacral level being in a coronal plane.\(^1\)\(^,\)\(^10\)\(^,\)\(^\text{14}\)

Developmental variations of the articular processes involving size, shape, and angle of projection occur particularly in the lumbosacral region, but also are encountered at the fourth lumbar vertebral level. Spinal processes that are poorly developed and asymmetrical are predisposed to mechanical instability, ligamentous injury and osteoarthropathy especially where unilateral abnormal motion occurs.\(^1\)

The mechanical disturbance resulting from lumbar disc space narrowing is the most common cause of degenerative arthritis of the posterior facets. In such patients, the vertebral body descends, resulting in anterior or posterior displacement. Instead of the normal rocking movement between the vertebra seen with a normal disc, a backward and forward sliding movement occurs, increasing the destructive effect on the intervertebral disc. This places an extra load on the articular processes, causing degenerative and reactive changes.\(^9\)

Unilateral sacralization of the fifth lumbar vertebra occurs frequently. If unilateral, abnormal strain may be thrown upon the upper facets on the opposite side, resulting in degenerative changes often of advanced degree.\(^12\) The maximum strain normally falling upon the segment at the lowest point of the mobile spinal column is taken up by the fourth lumbar disc with a tendency toward early degeneration and herniation.\(^7\)

Degenerative changes in the facets rarely occur in patients under 40 years of age. Alterations in the articular surfaces develop usually in the upper and medial portions of the facet. Adhesions develop between the capsule and the meningeal covering of the adjacent nerve root. Changes in the synovial membranes include hypertrophic villi, chondrification, ossification, and ulceration. The articular cartilage degenerates, with thinning, fibrillation and the development of osteophytic marginal proliferations.\(^1\) Some of these changes are no doubt inflammatory in origin and may accelerate productive changes in the adjacent neural arches (Fig. 4).

In our previous report\(^4\) of 26 patients 65 years of age and older with discogenic and spondylotic nerve-root compression, nine had significant hypertrophy of the posterior facets contributing to foraminal constriction and neural entrapment. In 29 patients with congenital and developmental stenosis, 14 had similar findings involving the posterior facets.\(^10\)

Teng and Papatheodoru\(^17\) described cauda equina compression in a group of 30 patients with spondylosis. They noted thickening of the lamina and facets in 28. In nine, the facets measured up to 1\(\frac{1}{2}\) inches in diameter. Liberal foraminal decompression and facetectomy were required to fully decompress each nerve root involved.

Intermittent ischemia of the cauda equina due to spinal stenosis and hypertrophy of the facets was described in two patients by Joffe, \textit{et al.}\(^8\) Neurological alterations were minimal, consisting of depressed-to-absent ankle reflexes. Straight-leg raising was unrestricted, a not uncommon finding in such patients.\(^2\)\(^-\)\(^4\)\(^,\)\(^16\) Myelography revealed posteriorly situated defects in the oil column produced by the enlarged facets. Laminectomy and medial facetectomy provided relief of claudication. The intervertebral discs were not remarkable.

Patients with spondylolisthesis at the L4–5 level with intact neural arches may be prone to nerve root compression because of associated degenerative changes in the facets.\(^10\)\(^,\)\(^14\) Shatzker and Pennal\(^15\) described two patients with first degree spondylolisthesis at the L4–5 level in whom laminectomy of the forward slipping vertebra was inade-
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quate to decompress the nerve root. Excision of the superior articular facets of the fifth vertebra was required to relieve the marked narrowing of the lateral recesses and forams. A similar operation was required in a group of patients described by Newman.14

There is still no general agreement as to the need for stabilizing procedures should facets be injured or removed.

To insure relief from neural entrapment in the foramen, facetectomy in varying degree has been mandatory, and no contraindications have been considered in this regard. Adequate evidence exists to support this method.6,7,9–11,12–17

Since little or no motion exists between severely degenerated discs, facet removal in such cases can be done safely with no perceptible increase in mobility.6

Shenkin and Haft16 found facetectomy necessary in operating on patients with hypertrophic spurring and prominent facets. Facet removal, even bilateral, did not result in any postoperative problems and spine fusion was not necessary.

References

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