In considering hemangiomas of the vertebral column one should, perhaps, make a distinction between the asymptomatic lesions that are encountered as incidental findings at autopsy and those that cause clinical symptoms. In several large autopsy series with a specific search directed to the spine, Schmorl and coworkers noted an incidence of 10–12 per cent. The majority of these lesions, however, had no clinical significance and were not demonstrable roentgenologically. Putschar questioned the nature of the asymptomatic lesions, stating that they represented, for the most part, mere focal areas of capillary angiectasis, rather than true hemangiomas. If the former were excluded, hemangiomas of bone in general would have to be regarded as a rather uncommon condition. Lichtenstein and also Jaffe held similar views.

Actually, Cocchi in 1953 was not able to find more than 140 case reports of hemangioma of bone in a review of the literature. Bell collected only 64 instances of vertebral hemangioma with associated dysfunction of the spinal cord. In a recent report, Robbins and Fountain described a case of cervical hemangioma with compression of the spinal cord and stressed the infrequent occurrence of these tumors in the cervical spine, of which they found only 10 examples.

In view of the rarity of compression myelitis caused by vertebral hemangioma and the importance of early recognition and adequate treatment in the prevention of permanent disability, it appears justifiable to report another case of recovery from compression of the spinal cord following laminectomy and roentgen therapy and to discuss the pathological, roentgenological, and clinical aspects of this condition.

It was felt that a comprehensive review of the subject might be timely with particular emphasis on the controversy concerning the best form of treatment, irradiation alone or the combined surgical and radiological method.

Case Report

A 26-year-old college student was admitted to the Neurosurgical Section of the Bronx Veterans Administration Hospital on Dec. 2, 1957 with a diagnosis of spinal cord tumor. He had experienced sharp retrosternal pain 3½ months previously and, 2 weeks later, interscapular pain which radiated in a band-like fashion around the chest. Initially the latter pain occurred intermittently but soon became constant; it was aggravated by lying on his side or by flexion of the trunk, with relief of pain when in the supine position. Three months before admission he noted impaired coordination of his legs and he fell when attempting to run. The lack of coordination became worse progressively and he began to experience "electric shock"-like pain along the medial aspect of both thighs and calves which persisted. Function of bowel was normal but micturition became difficult in the 3 weeks before admission. In the last 2 weeks he noted loss of ejaculatory function although he still had normal erections.

Examination. The gait was spastic, "scissors-like" and unsteady, with the right knee held in extension. Hypalgesia and hypesthesia were present below the T4 segment bilaterally. Sense of position in the toes was impaired but more so on the left side. Vibratory sense was impaired in both feet, the knees and iliac crests. Heel-to-knee motion was impaired bilaterally but more so on the right. Romberg’s test was positive. Tendon reflexes were hyperactive and equal in the lower extremities with positive Babinski’s sign bilaterally.
profuse bleeding from these structures with each bite. In addition, abnormally large vessels were present in the paravertebral soft tissues feeding the abnormal bony structures, and very large epidural veins likewise caused profuse bleeding. Control of hemorrhage was an arduous task throughout the procedure.

Pathological Diagnosis. Cavernous hemangioma (Fig. 3).

Course. Radiotherapy with a tumor dose of 2400 r was administered. The patient recovered the function of his legs gradually while receiving physical therapy. During January 1958 he began to walk with assistance. Pain present previously in the area of the tumor on coughing or motion disappeared. By Feb. 23, 1958 the level of hypalgesia had descended to T7. After termination of roentgen-ray therapy in early March the patient walked better progressively with Canadian crutches and then with the help of a cane, although his gait remained slightly spastic and ataxic. On March 22, 1958 the sensory level was found at T10.

Following his discharge on April 11, 1958 the patient was re-examined at regular intervals, demonstrating a gradual disappearance of neuro-

Abdominal reflexes were absent. There was slight symmetrical weakness of the extensors of the toes bilaterally. Extensors of the knees were approximately 60 per cent of normal strength with the hamstring muscles rated as normal. There was tenderness to percussion over the 4th thoracic vertebra.

Roentgenograms revealed the characteristic alteration of the trabecular pattern of the body of T3 with vertical striations and also involvement of the adjacent facets and laminae, consistent with the diagnosis of hemangioma (Fig. 1). Lumbar puncture on Dec. 5, 1957 yielded clear colorless spinal fluid without cells; the spinal fluid protein measured 490 mg. per cent. Manometric studies revealed a partial block and subsequent Pantopaque myelography demonstrated a block at T4 (Fig. 2).

Operation. On the same day, decompressive laminectomy of T2 to T4 was performed and replacement of 1,500 cc. of blood was required during surgery. The laminae and spinous processes of T3 and of T4 appeared thickened and were riddled with large venous channels. There was
logical symptoms and signs. By June 1959, 17 months postoperatively, he showed slight imbalance on turning, with an otherwise normal gait. Motor strength was unimpaired; only standing on the right leg was slightly unsteady. Function of the bladder was normal except for occasional hesitancy, and sexual function was apparently unimpaired except for delayed ejaculation. Sensory examination revealed normal responses for all modalities. On the last examination on Dec 1, 1959 the patient was found to be entirely normal. Several months after his discharge he had begun to work as a draftsman and has continued to work since.

DISCUSSION

Virchow in 1867 made the first brief comment on “myelogenous telangiectasis” encountered in two widely separated vertebral bodies of a 72-year-old woman at autopsy. He noted the replacement of osseous tissue by large saccular vessels with preservation of some extremely thick, sclerotic trabeculae. However, the first case report of vertebral hemangioma with resultant paraplegia did not appear until 1895, when Gerhardt published his observation made at necropsy. Hitzrodt in 1917 described the first roentgenogram of a hemangioma in the head of a humerus. Perman is credited with the earliest demonstration of the characteristic roentgenologic changes of vertebral hemangioma in 1926. His report is based on the observation of his own case in which laminectomy had been performed successfully and also on a case reported previously by Gold, in both of which compression of the spinal cord existed. Nattrass and Ramage, motivated by the dismal early surgical experiences (Table 1), introduced roentgen therapy as the primary and sole method of treatment in 1930. Their patient recovered completely from all symptoms of compression of the spinal cord.

Hemangiomas of the spinal column are benign, slow-growing tumors of cavernous or capillary structure. They occur in an age

<table>
<thead>
<tr>
<th>TABLE 1</th>
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| Vertebral hemangioma with compression of spinal cord or cauda equina. Results of laminectomy, alone or combined with radiation therapy, from a review of the literature, including case of authors |

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Recovery</th>
<th>Improved</th>
<th>Combined</th>
<th>Doubtful</th>
<th>Unimproved</th>
<th>Death/Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1924-1930</td>
<td>7</td>
<td>3 = 42.9%</td>
<td>—</td>
<td>42.9%</td>
<td>—</td>
<td>—</td>
<td>4 = 57.1%</td>
</tr>
<tr>
<td>1931-1940</td>
<td>32</td>
<td>19 = 59.4%</td>
<td>4 = 12.5%</td>
<td>71.9%</td>
<td>2 = 6.2%</td>
<td>4 = 12.8%</td>
<td>3 = 9.4%</td>
</tr>
<tr>
<td>1941-1950</td>
<td>11</td>
<td>8 = 72.7%</td>
<td>—</td>
<td>72.7%</td>
<td>—</td>
<td>2 = 18.2%</td>
<td>1 = 9.1%</td>
</tr>
<tr>
<td>1951-1960</td>
<td>20</td>
<td>13 = 65%</td>
<td>4 = 20%</td>
<td>83%</td>
<td>—</td>
<td>3 = 15%</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>43 = 61.4%</td>
<td>8 = 11.4%</td>
<td>72.8%</td>
<td>2 = 2.9%</td>
<td>9 = 13.9%</td>
<td>8 = 11.4%</td>
</tr>
</tbody>
</table>

[Fig. 3. Low-power microphotograph reveals collections of endothelial-lined blood vessels, some containing blood cells, lying in a fibrous stroma, within bone tissue. The appearance is typical of cavernous hemangioma of bone. Similar tumor was present in soft tissue surrounding bone.]
distribution ranging from 12.5 to 76 years, and are slightly more prevalent in women. In general, the condition is observed most often in individuals beyond middle age, yet younger adults appear to predominate in instances of clinical symptomatic. Although the pathological characteristics were described by earlier writers, Schmorl and Junghanns furnished the most comprehensive summary of the pathological aspects of vertebral hemangiomas that occur prevalently in the thoracic and lumbar spine. However, they may be found in any part of the vertebral column, including the sacrum. In the clinical cases the thoracic portion of the vertebral column from T3 to T10 is affected most frequently, particularly T4. The lesions may vary in size; they may be single or multiple, in close proximity or in widely separated vertebrae. Although they usually are encountered in the vertebral body, they may involve any part of a vertebra, simultaneously and singularly. Hemangiomas in other than vertebral bones are less common, although relatively more frequent in the calvarium than in any other bony structure. In one case, the spine, as well as other parts of the skeleton (pelvis, scapula, femur), were involved by a more generalized form of hemangiomatosis; the extensive sclerotic changes and increased density made roentgenologic recognition impossible. Also the skin and internal organs, like spleen and liver, have been mentioned occasionally as the site of hemangiomatic lesions in cases of vertebral hemangioma. Nemours-Auguste reported a case of vertebral hemangioma with simultaneous hemangiomatous of skin and probably of brain.

On gross inspection, the angioma stand out from the surrounding tissue as a dark red area. Histological studies demonstrated that the angiomatous tissue grows independently, thus destroying some of the trabeculae of the spongiosa. The remaining, often thickened, trabeculae which run in parallel vertical rows were regarded by most authors as singularly significant for the pathological diagnosis of vertebral hemangioma. In only 1 case of metastasizing lymphogranuloma was a similar, although less pronounced, change encountered. Watson and McCarthy held similar views, attributing the expansion of tumor to endothelial budding with secondary canalization. These newly formed channels were held to engender the characteristic trabecular arrangement into vertical columns. As to the pathogenesis of compression of spinal cord and nerve roots, most authors suggest that it may be the result of three different causes: (1) the hypertrophy or "ballooning" of the posterior cortex of the vertebral body and/or enlargement of the laminae and facets subsequent to angiomatous invasion; (2) extension of the angiomatous invasion into the regional epidural space; and (3) compression fracture of the involved vertebral body. The latter seems to be a rare event, according to Bell, who found only 6 cases in which this had occurred, although he overlooked additional cases.

The roentgenologic appearance of vertebral hemangioma is rather characteristic, and even considered pathognomonic. The involved vertebra shows a coarse, porous rarefaction, often described as a net-like or honeycombed pattern with a columnar arrangement of sparse but thickened trabeculae which run in the longitudinal axis of the body. Similar changes also may be present in laminae, articular facets, and transverse and spinous processes. In the more advanced stages, there may be evidence of ballooning; the bodies of the vertebrae appear flattened and the walls have a tendency to bulge. It has been noted that after collapse of a vertebra the roentgenologic appearance, at least in an early stage of their evolution. As a result of subperiosteal extension of tumor or hemorrhage, a paravertebral spindle-shaped shadow has been noted resembling changes.
observed in paravertebral abscess or tuberculous spondylitis.\textsuperscript{1, 2, 20, 26, 29, 38, 42}

The neurological symptoms are not characteristic and are similar to those caused by other slow-growing extramedullary tumors. Local, rheumatic-like pain, girdle pain with thoracic lesions and segmental radicular pain or "sciatica" with tumors of the lumbar spine have been described. Pain on percussion or local tenderness on pressure may or may not be present. In many instances, compression myelopathy developed in the absence of pain.\textsuperscript{28, 42} On the other hand, paresthesiae and cramps of muscles in the lower extremities are not encountered infrequently as preceding or concomitant symptoms of compression of spinal cord or cauda equina.

The length and course of the illness vary considerably, although the interval between onset of subjective symptoms and definite signs of compression of neural structures usually extends over a period of 2 to 3 years to several months. In exceptional cases the illness existed for 26, 16, and 9 years.\textsuperscript{11, 22, 25, 42} Total remissions for 1 or 2 years, as well as partial remissions, were reported occasionally.\textsuperscript{1, 23, 38} However, a slow progression to paraparesis and paraplegia is a more common observation. Acute exacerbation may be caused by compression fracture or, as in 1 case of Lang and Peserico,\textsuperscript{23} by an epidural hematoma. Askenasy and Behmoaram\textsuperscript{2} attributed the sudden onset of paraplegia in 1 of their cases to endocrinological disturbances and elevated intra-abdominal pressure in advanced pregnancy. These authors expressed the belief that the neurological complications are not ascribable solely to compression by the expanding tumor but are enhanced by congestion, bleeding within the lesion and additional stasis in epidural veins and subsequent disturbances of spinal-fluid circulation. A pulsating mass overlying the vertebral tumor was observed only once.\textsuperscript{17}

In a consideration of symptomatology and evaluation of therapy, a classification into distinct categories was adopted among others by Ghormley and Adson\textsuperscript{13} as well as by Bröbeck.\textsuperscript{5} The former subdivided vertebral hemangiomas into four groups: (1) hemangioma with paraplegia; (2) hemangioma with symptoms of compression of the spinal cord, but without paraplegia; (3) hemangioma with local symptoms and signs, but without compression of the spinal cord; and (4) hemangioma without symptoms or signs. Bröbeck suggested an additional subdivision of cases in which compression myelitis occurred as the result of a pathological fracture.

Most writers agree that as long as the lesions remain asymptomatic, treatment should be withheld. If merely local pain or mild radicular symptoms are present, roentgen therapy generally is accepted as the treatment of choice. However, the selection of a preferable therapeutic plan in instances of compression of spinal cord and cauda equina still is a controversial issue. Originally, most authors\textsuperscript{10} favored surgical decompression as the primary method of therapy, limiting the role of irradiation to that of a postoperative procedure. Bailey and Bucy\textsuperscript{2} stated that "the only treatment of any avail is laminectomy." Others expressed the belief that roentgen therapy alone appears inadequate and hazardous\textsuperscript{20} and should never be used since the length of time required for obtaining satisfactory results is so long that irreparable damage to the spinal cord may result during the course of treatment.\textsuperscript{6}

The arguments against laminectomy\textsuperscript{7--9, 29, 45} as the primary method of treatment are based on the prohibitive high rate of mortality in the early surgical experience and on the evidence that improvement often was noticeable after a relatively short latent interval of 1 week to 2 months following institution of irradiation. Subsequent cure was obtained in approximately 60 per cent of the cases\textsuperscript{7} within a period ranging from 1 to 7 months, occasionally extending to 16 months.\textsuperscript{8}

The assessment of results obtained by radiation alone is somewhat difficult since some reviews included cases of only local symptomatology compared with those in which compression of the spinal cord or cauda equina had supervened (Table 2), whereas laminectomy usually was resorted to in the latter group. Furthermore, most
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TABLE 2
Results of roentgen therapy alone in cases of vertebral hemangioma with and without compression of the cord from review of the literature 7-9, 42

<table>
<thead>
<tr>
<th>Cases of spinal-cord compression</th>
<th>Total</th>
<th>Recovery</th>
<th>Improved</th>
<th>Combined</th>
<th>Unimproved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>12 = 60%</td>
<td>4 = 20%</td>
<td>80%</td>
<td>4 = 20%</td>
</tr>
<tr>
<td>Cases with local symptoms only</td>
<td>9</td>
<td>5 = 50%</td>
<td>3 = 33%</td>
<td>89%</td>
<td>1 = 11%</td>
</tr>
<tr>
<td>Mixed group of Cocchi</td>
<td>15</td>
<td>9 = 60%</td>
<td>2 = 13.3%</td>
<td>73.4%</td>
<td>4 = 26.7%</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>26 = 59%</td>
<td>9 = 20.5%</td>
<td>79.5%</td>
<td>9 = 20.5%</td>
</tr>
</tbody>
</table>

Authors 8, 9, 29 favoring roentgen therapy reported only single cases and, as Cocchi 7 pointed out, it remains unknown how many cases there were in which the treatment failed. This, of course, is true equally for the surgical group. On the basis of the evidence available, however, it must be conceded that irradiation alone frequently is able to reduce or retard the neoplasm, although the hemangioma, according to Schinz and Uehlinger, 39 is rather resistant to radiation. This may explain the observation of Iacobovici 17 that the pulsating mass overlying the vertebral hemangioma did not respond to roentgen-ray therapy so that sclerosing solutions were used to obliterate the tumor. On the other hand, the argument of a high rate of mortality against laminectomy is out-dated definitely. During the past 10 years, 20 laminectomies for vertebral hemangioma with compression of spinal cord or cauda equina were placed on record without any reported postoperative mortality (Table 1). Lang and Peserico, 35 operated successfully on 2 of their 7 patients who displayed only local or radicular symptoms. In several instances laminectomy still was effective after irradiation had failed. 7, 10, 36 Astonishingly, these facts concerning the safety and efficacy of laminectomy at present, however, have not received sufficient attention. The prevailing attitude towards the treatment of vertebral hemangioma is, perhaps, epitomized best by quoting from the latest edition (1959) of Lichtenstein's textbook: 21 "For their effective control, it does not appear necessary to resort to hazardous laminectomy, and high-voltage roentgen therapy has been recommended by Watson and McCarthy as the treatment of choice, affording complete relief of symptoms." It is our suggestion that laminectomy should precede irradiation in patients with compression of the spinal cord or cauda equina, depending on the degree and rate of progression of neurological symptoms. In instances of less severe signs of compression roentgen therapy should be administered first, under careful neurological control, preferably on a neurosurgical service, to facilitate prompt intervention if necessary. Close cooperation between surgeon and radiotherapist will, in the end, yield the best results.

The omission of postoperative irradiation and failure of adequate spinal support resulted in recurrence of spinal-cord compression in 2 cases, after a symptom-free period of 6 years 13 and 16 months 1 respectively. A re-exploration was unsuccessful in the first patient. However, in the second instance a wider laminectomy followed by radiological therapy again led to a slower but gradual return to normal function within a period of 4 years, in spite of almost complete destruction of the affected vertebra. The authors stressed the need for spinal support by braces and suggested the use of bone grafts at the time of laminectomy as a preventive measure, 15 or in the presence of a partial collapse of a vertebral body as a clear indication for fusion operation, 4 although this apparently was never carried out. A similar suggestion had been advanced previously by Schinz and Uehlinger. 39

Some observations and experiences with laminectomies should be mentioned. Most
profuse and often “furious” bleeding was generally encountered, not only from enlarged foramina of the cortex and large vascular channels within the hypertrophied and cancellous laminae but from abnormal vessels in the adjacent paravertebral soft tissues and abnormally large and numerous epidural veins as well. Hemostasis always was difficult to obtain and occasionally an evacuation of a postoperative hematoma was necessary. In order to prevent excessive hemorrhage, Roith suggested an extensive coagulation of the involved laminae during a first-stage procedure which secured a safe removal of bone during the second-stage procedure a few days later. This method has been used successfully by others.

The early surgical experiences were rather discouraging. The operative mortality, usually from postoperative shock, amounted to 57.1 per cent in the first 7 cases of patients operated upon between 1924–1930 (Table 1). With the availability of replacement of blood and the aid of newer hemostatic agents, laminectomy has become a safe procedure.

SUMMARY AND CONCLUSIONS

1. A case of hemangioma involving the 3rd and, to a lesser degree, the 4th thoracic vertebra associated with compression of the spinal cord is presented. The patient made a gradual but complete recovery after decompressive laminectomy and radiation therapy.

2. The history, pathological, roentgenological, and clinical aspects of vertebral hemangioma are reviewed and discussed. The evidence indicates that the tumor, in most instances, can be recognized easily and that adequate treatment achieves gratifying results.

3. The observations cited underline the importance of several therapeutic principles: First, irradiation should be used as a primary form of treatment in cases of mild, local, or radicular symptoms. In instances of moderately severe compression of spinal cord or cauda equina with slow progression of symptoms a trial of roentgen-ray therapy under careful neurologic supervision for a period of 4–6 weeks should be instituted. Second, laminectomy is indicated in the more severe cases of compression of spinal cord or cauda equina, e.g. if there is a faster rate of progression of symptoms or if roentgen therapy failed. Irradiation, which has been credited to arrest the flattening and ballooning process in the vertebral body, should never be omitted following operation. Third, an indefinite period of observation with clinical and roentgenological examinations at regular intervals is imperative in order to assure early detection of recurrence or progression of the disease. Fourth, vigilance should be exerted in providing the patient with spinal support by Taylor brace or corset, particularly in the presence of persisting local pain and in instances of advanced disease with ballooning and flattening of the vertebral body or when a pathological fracture appears imminent. In cases of partial vertebral collapse fusion operation should be given consideration in the future.

REFERENCES
