Controversies in Neurology

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Preface

This volume brings together specialists in areas of neurology and neurosurgery where there are presently no clearcut guidelines for management. In their discussions of controversial subjects that require further evaluation, such as the place of manipulation therapy in the conservative management of cervical problems, emphasis is placed upon recent developments in the field in question and an attempt is made to reach a consensus on the optimal approach to treatment.

Topics discussed include the surgical approach to the management of spondylosis and stenosis, the management of cervical disc disease with and without fusion, and the problems of managing stenosis of the carotid arteries with anticoagulant and antiplatelet treatment. Metastatic spinal cord tumors and tumors of the brain are discussed in considerable detail, and a variety of interesting cases are presented. Concluding with guidelines for the management and treatment of arteriovenous malformations and aneurysms, this volume will be of interest to all neurologists, neurosurgeons and orthopedic surgeons.

R. H. Thompson, M.D.
J. R. Green, M.D.

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Cervical Spine Disease: Conservative Management and Manipulation Therapy

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The use of manipulation in the treatment of cervical discs has received little attention from the medical profession. This form of therapy has not been ignored by the public who seek this form of treatment from nonmedical practitioners with increasing frequency. There is a small group of physicians in the United States who use such techniques, however they generally are ignored or ridiculed by their colleagues. On the other hand, many physicians, including myself, have been less than happy with the results of the present treatment for patients with so-called whiplash injuries, cervicoscapular pain, or chronic cervical pain. The present treatment is prolonged and expensive, and the results in a large number of cases are less than optimal. After a few weeks of medical treatment, many patients seek out a lay practitioner, usually a chiropractor, for a more definitive treatment which almost invariably includes manipulation.

There are four different schools of thought concerning the use of manipulation to treat musculoskeletal disorders.

1. *Osteopathy*. Today, most osteopathic physicians in the U.S. receive training not unlike that received in U.S. medical schools. Osteopathic students are no longer taught that all maladies are due to disease of the spine and its nerves, as was claimed in the past. Osteopathic treatment for musculoskeletal disorders is based on the theory that there is reduced spinal mobility. Treatment attempts to restore a full range of motion to the spinal joint (1,4,5).

2. *Chiropractic theory*. The basis of chiropractic treatment is the theory that all disease, including musculoskeletal problems, is due to malalignment of vertebral bodies. Their treatment attempts to shift the vertebrae back into place. Physicians have deplored these practices for decades, and rightly so. Needless to say, chiropractors have been very successful in convincing the federal government, industrial insurance companies, and the legislatures of all 50 states of the merits of their particular health care delivery system. By ignoring the use of manipulation, the medical profession has, by default, left its use to nonmedical practitioners, particularly to the chiropractic profession.

3. *Oscillatory techniques*. Originally described about 160 years ago, oscillatory techniques now have a wide following among physiotherapists in this country. Their

foremost advocate is Maitland. The method of treatment uses small, repetitive movements of the involved joint to restore complete mobility.

4. *Neuro-orthopedic methods*. The neuro-orthopedic methods of Dr. James Cyriax[1] (2,3) are based on the theory that most pain in the cervical area is due to displacement of a fragment of a disc. Under certain conditions, the disc fragment may be manipulated back into place. All manipulations are carried out under strong manual traction with an assistant holding the patient's legs, after a complete neurological examination as well as a complete examination of the mobility of the cervical spine. I shall confine myself in this chapter to Dr. Cyriax's methods, since I believe his techniques of evaluating patients, and the criteria he uses in deciding for or against manipulation, have much merit.

In addition to a complete neurological examination, a careful evaluation of the mobility of the cervical and thoracic spine is carried out. The reason the thoracic spine and shoulders are examined is that upper thoracic pain can be referred to the cervical spine and vice versa. Likewise, pain originating from the shoulder, such as an acute bursitis, can radiate down an arm as far as the wrist and up as far as the side of the neck. If the origin of the pain is the shoulder, treatment should be directed there. Manipulation of the cervical spine in that situation is useless.

The examination recommended by Dr. Cyriax includes active and passive range of movement as well as resistive movements in the evaluation of the musculoskeletal system. The same evaluation is carried out whether the pain is in the lumbar, thoracic, or cervical area.

RANGE OF MOTION

Normally, the range of motion of the cervical vertebrae is as follows: (a) flexion and extension—80°, (b) lateral rotation—80 to 90°, (c) side flexion—60°.

Naturally, in elderly people, there may be considerable limitation in the range of motion whether they are symptomatic or not.

Active Range of Motion of the Neck

The patient is asked to turn his head as far as he can in the following six planes:

a) head right
b) head left
c) side flexion right
d) side flexion left
e) head back
f) head forward

The physician asks the patient which, if any, of these maneuvers alters the pain in any way. The patient's responses are duly recorded.

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Passive Range of Motion of the Neck

Passive range of motion of the neck is then tested and is carried out in the same six planes. The patient relaxes his neck muscles while the range of movement of the neck is ascertained by the physician gently moving the neck in the same six planes. The active and passive range of movements should be the same. The examiner must note the type of resistance he feels at the extreme range of motion. This is what is called the "end feel." The common types of end feel noted during passive movements are as follows:

a) Bone-to-bone, such as one normally notes on extreme passive extension of the elbow. If the end feel is bone-to-bone, manipulation is useless.

b) The capsular feel, which is not unlike a piece of leather being stretched. It is this type of end feel that must be present if manipulation is to work.

c) Muscle spasm, when suddenly it is noted that severe muscle spasm occurs and the neck will not move. If this is present, manipulation is contraindicated as it will not work since the pain is of muscular rather than bone-cartilage origin.

d) The empty feel, in which the patient has severe pain long before normal range of motion is obtained. There is no bone-to-bone resistance, yet the patient is obviously in severe pain. Usually this type of end feel indicates metastatic neoplasm or possibly a localized infectious process in the cervical vertebrae. Manipulation is therefore contraindicated.

Resisted Range of Motion

The patient is asked to push his head against the physician's hand in the same six planes. The physician applies counter pressure so that no movement occurs. If the patient's problem is muscular in origin, one or more of the resistive movements will increase his pain. If the origin of the pain is in the cervical spine, there should be no increase in pain since the vertebrae should be immobile during this part of the examination.

Commonly in pain due to a cervical disc derangement, the following phenomena will be noted: The pain will be increased during the active and passive movements of the neck in two, three, or four movements of the six neck maneuvers, and will be unaffected by four, three, or two movements. Active rotation to the side of the pain will invariably hurt. Usually, one or both side flexions will also hurt. The pain is increased by the same two, three, or four movements in both the active and passive maneuvers in cervical disc lesions. The pain is somewhat more severe on passive range of motion; likewise, the range of motion is slightly more than the active movements. The resisted movements should not alter the pain since there is no movement of the cervical vertebrae. If active, passive, and resistive movements all hurt, the patient's problem is usually non-organic.

Examination of the thoracic spine consists of the following maneuvers. The patient stands with his back facing the examiner. The physician notes any changes in the normal anatomy of the thoracic and lumbar spine. The patient is then tested for the following active, passive, and resistive movements:

a) adduction of the scapula, which will tend to pull on nerve roots T1 and T2,
b) abduction of the scapula,
c) elevation of the shoulders,
d) left lateral side flexion,
e) right lateral side flexion,
f) flexion of the thoracic spine,
g) extension of the thoracic spine,
h) right lateral rotation, and
i) left lateral rotation.

Shoulder examination is carried out in the active, passive, and resistive range in the following maneuvers:

a) elevation of the shoulder,
b) scapulohumeral range of abduction (normal range is 85° to 110°),
c) lateral rotation of the shoulder,
d) medial rotation of the shoulder,
e) flexion of the forearm, and
f) extension of the forearm.

If only the thoracic and/or shoulder maneuvers reproduce or aggravate the pain, then the patient is not a candidate for manual traction. If the neck signs are normal and the shoulder signs are positive, then the origin of the pain is in the shoulder and referred to the neck. Since the neck is immobile during the shoulder and thoracic maneuvers, any reproduction or enhancement of the pain must be coming from the shoulder since this is the only part that is moving.

INDICATIONS AND CONTRAINDICATIONS FOR MANIPULATION OF THE CERVICAL SPINE

After a complete neurological examination and assessment of the results of the standard neurological examination, as well as the examination of the musculoskeletal system, the physician determines which bony part is the origin of the pain. If it appears to be the cervical spine and an articular pattern is present, the patient may be a candidate for manipulation.

Contraindications for manipulation are (a) evidence of any long-tract signs, (b) a history suggestive of basilar artery insufficiency, (c) anticoagulant use, (d) significant weakness of a muscle or group of muscles in the upper limbs, (d) the absence of articular signs on the six active and passive movements of the neck, (f) evidence of gross deformity of the cervical vertebrae on X-ray, (g) increased pain down the arm or the production of long-tract signs during an attempt at manual traction (which is then discontinued), (h) spasmodic torticollis, and (i) rheumatoid arthritis of the cervical vertebrae.

Indications for manipulation are the absence of the contraindications and the presence of a partial articular pattern.

In brief, patients with the following symptoms (and in whom a partial articular pattern is present) do well with manipulation: pain in the back of the neck, radiating

to the scapula and/or shoulder without any arm or forearm pain; unilateral scapular and root pain above the elbow; and absence of increasing pain with neck movements.

Patients with the symptoms below may or may not benefit from manual traction: unilateral scapular and root pain with increasing pain with neck movements; bilateral scapular and arm pain with minimal evidence of an articular pattern during active and resistive range of motion of the neck; questionable evidence of muscle weakness; and brachial pain that begins in the forearm with paresthetic fingers.

Manipulation is never carried out under anesthesia because one can never assess how much relief of pain the patient has had after each manipulation. If the patient were to develop neurological signs, one would be unaware of this during general anesthesia. Manipulation is a painless procedure.

All cervical manipulations are carried out under traction with the physician using his full body weight. X-ray evidence has shown that between each cervical vertebra, there is an additional 2.5 mm of space between the discs when a force between 100 to 140 kg is applied by the examiner.

It is felt that manual traction works for the following reasons:

a) The pressure in the displaced cartilaginous portion of the disc eases, and therefore the pain abates.

b) The vertebra interspaces are enlarged.

c) The facet joints are disengaged and, thus, more movement is possible at the intervertebral joint.

d) The suction effect of manual traction may help to cause the disc fragment to move back into place.

While the patient lies on a flat table elevated 36 inces, straight manual traction with the neck in slight extension is carried out. The physician has an attendant hold the patient's feet and uses his body weight as leverage until he feels the neck muscles relax. Once this has occurred, the appropriate movement is carried out until a small click is heard. The patient is then asked to sit up and to move his neck in the same six directions, while the range of motion and the amount of pain the patient is experiencing after manipulation are assessed. The standard manipulations for patients who meet the criteria are:

a) Straight horizontal traction. As the neck muscles relax, slow rotatory movements from side to side are carried out. This maneuver is repeated as long as it seems to give some relief of pain.

b) Traction with less than full range to the side which does not hurt. This maneuver is repeated as long as the pain recedes. When it stops improving, then one goes on to the next maneuver.

c) Rotation to full range to the painless side.

(d) Rotation three-quarters of the way to the side that hurts.

e) Full rotation to the side that hurts.

f) Side flexion toward the painless side.

g) Lateral or anterior-posterior (A–P) glide with gradual rocking of the head from side to side or flexion and extension.

It has been my experience that the straight A–P pull as well as rotation to the side of the pain will usually relieve the pain in 40% of cases. Remember, it is important to repeat any maneuver that decreases the patient's pain until it seems the improvement has stabilized. The physician must have the patient go through the six neck movements after every manipulation so that he can assess the range of movement of the neck and any change in the pain pattern. If the physician finds that one maneuver aggravates the pain, then he shouldn't repeat that maneuver but go ont to the next one.

SUMMARY

In summary, many patients with neck and arm pain but without neurological findings can be readily cured by manipulation. One should carefully select one's cases and be able to carry out a complete neurological and musculoskeletal examination to be certain the pain is coming from the cervical spine and not from the upper thoracic spine and/or shoulder.

Even should manipulation be decided against, Dr. Cyriax's methods of examining the musculoskeletal system are valuable for their improvement of diagnostic acumen and their precision in localizing the site of the pain. It also is an almost foolproof method of separating the neurotic patient from the one who has genuine organic disease without significant neurological findings.

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Surgical Approach to Cervical Spondylosis and Stenosis

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Although radiculomyelopathy due to cervical spondylosis is the most common spinal cord disease after the age of 40, there are as yet many controversies as to when and why decompressive surgery is indicated and how it should best be performed (6). The pathogenesis of cervical spinal stenosis remains unexplained, and the mechanisms of spinal cord and nerve root dysfunction are multiple. Correlation is often poor between radiographic findings and the extent or level of neurological deficit. The differential diagnosis includes degenerative as well as neoplastic disorders. The role of minor trauma is poorly understood, and vulnerability to future problems at other spinal levels is unpredictable. Surgeons must choose and tailor the appropriate anterior or posterior or lateral approach for decompression with or without fusion. Results of surgical treatment are difficult to predict in the individual case, especially with advanced cases of quadriparesis or amyotrophy. Therefore, review of these controversial issues, in the light of recent clinical experience and laboratory research, is of considerable interest to clinicians dealing with cervical spine disorders.

PATHOGENESIS

Stenosis

The dimensions and shape of the cervical spinal canal are known to vary significantly on a developmental basis (3,23,37,56). The sagittal canal diameter may be 70% larger in spines at the upper end of the range of individual variation (11,57). The mean diameter at the C_3 to C_7 levels measured from the center of concavity of the posterior surface of the vertebral bodies to the point of dorsal junction of the two lamina with the spinous process (spinolaminar line) is 17 ± 5 mm (11). Measuring from the vertebral body marginal osteophyte usually reveals the smallest sagittal diameter (Fig. 4A). When the sagittal cervical canal diameter is 10 mm or less, neurological deficit due to compressive myelopathy is inevitable (6). With diameters of 10 to 12 mm, symptomatic entrapment of the cord is probable, but when the bony canal measures 13 mm or more, cord dysfunction due to spinal stenosis is unlikely (71). Measurements show little difference within individual

spines from C_4 to C_7, although normal average values at C_1 are 22 to 23 mm, and at C_2 to C_3 they are 18 to 20 mm (45,79). Sagittal diameters of less then 14 mm are rare, falling below two standard deviations at a given cervical segment (42,45). In two radiological surveys of series of 300 and 200 normal subjects, incidence rates for such cervical stenosis of 0.3% and 1% were found (11,79).

However, although developmental stenosis of the cervical spinal canal is rare, it is a predisposing factor in patients with symptomatic cervical spondylosis (27,52,76). In fact, cervical spondylosis alone is usually a neurologically asymptomatic condition observed incidentally on radiographs in over 50% of individuals over the age of 50 (10,25). Hypertrophic degenerative joint alterations and osteophyte proliferation, then, may not cause neurological abnormalities unless the spinal canal is already narrowed developmentally. Sufficient reserve space should be available, especially since the cervical cord normally measures 8 mm in the sagittal plane by 13 mm in the transverse plane (48). Accordingly, patients with spondylotic myelopathy have an average lower cervical canal diameter which measures 3 mm less than those with spondylosis without myelopathy (3,52).

As in the case of lumbar spinal stenosis, the midline and lateral sagittal cervical canal diameter is determined by the height and vertical angle of the pedicles (20,34). The embryological basis for these variations is unknown. The position of the superior facet with respect to the vertebral body, as seen on lateral cervical spine radiographs, provides an indication of the pedicle height and canal diameter (34). Since the superior facet arises dorsally from the pedicle, and it is more easily visualized radiographically, observing its position in the anteroposterior (A-P) plane is useful in estimating the dimensions of the neural canal.

The intervertebral foramina may also vary in dimension on a developmental basis. Normally, they are 5 to 7.5 mm long, 5 to 6 mm wide, and 10 to 13 mm in sagittal diameter (21). Moderate shortening or lateral angulation of the pedicles may narrow the foramina without causing signficant midline canal stenosis. However, since cervical nerve roots measure only 3 to 4 mm in diameter, radiculopathy is rarely if ever seen in stenosis patients who do not have associated spondylosis.

Severe developmental cervical spinal stenosis as a primary cause of myelopathy is rare. It is an easily overlooked cause of progressive neurological deficit since observation of concurrent spondylosis on radiographs does not draw attention to the reduced neural canal diameter. Kessler (42) reported six cases in a retrospective review of 1,174 records of cervical arthritis or laminectomy patients at New York Hospital. Three had no significant degenerative changes, and the others had only small osteophytes. Three of these patients were under the age of 40 and one was 15. In our series of 42 decompressive cervical laminectomies at the University of Arizona Hospitals, there were seven cases in which stenosis was considered to be a more significant pathogenetic factor for myelopathy than spondylosis. This 16% incidence may reflect an increase of awareness and more frequent diagnosis of the problem. As in lumbar stenosis, a striking male preponderance is observed, although one of our patients was a 32-year-old female whose average canal diameter measured 12 mm (Fig. 1) (35,45,50).

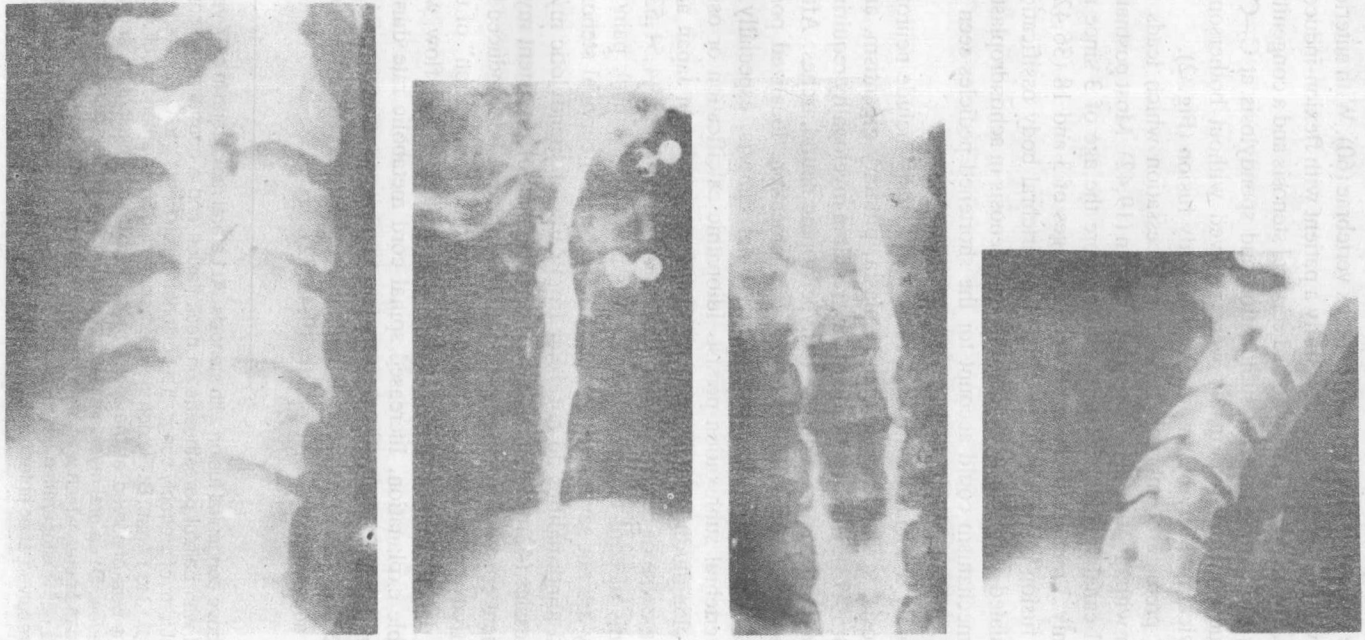


FIG. 1. Cervical stenosis. **A:** Lateral radiograph in a 34-year-old female who presented with progressive weakness and activity-induced incoordination of the right hand, as well as early signs of myelopathy. She had bilateral extensor plantar responses with moderate gait spasticity and a sensory hypalgesia below T_3. Sagittal canal diameter measures 12 mm at C_4–C_5 and C_5–C_6. **B:** Lateral myelogram demonstrating smooth dorsal and ventral canal surfaces due to diffuse stenosis without spondylosis. **C:** Anteroposterior (AP) myelogram documenting cord compression with widening of the cord shadow at C_5 and C_6. **D:** Postoperative lateral radiograph in flexion showing maintainance of spinal stability after wide decompressive laminectomy at C_4–C_6. The patient recovered slowly over 4 months and returned to work as a supermarket cashier.

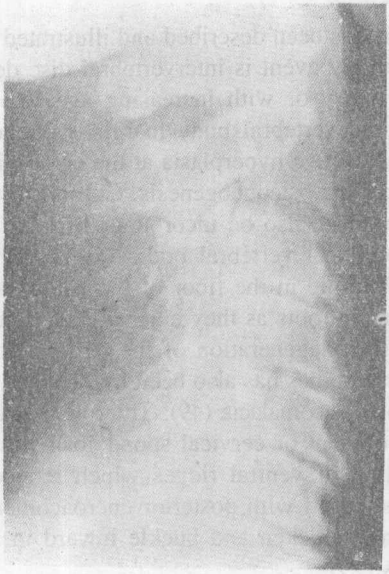
Associated congenital anomalies have been observed. The most common are the Klippel-Feil syndrome and other types of fused or block vertebrae (60). With anterior cervical fusion, we have recently treated successfully a patient with flexion-induced pain, Lhermitte's sign, and leg weakness, who had cervical stenosis and a congenital posterior fusion at C_3 to C_6 with anterior subluxation and spondylosis at C_2–C_3. Symptoms of pain and postural myelopathy were relieved without bothersome additional loss of cervical mobility by an anterior interbody fusion (Fig. 2).

The mechanism of premature embryological growth cessation which leads to spinal stenosis, with or without other anomalies, is unknown (19,42). Most postnatal growth of the cervical canal sagittal diameter occurs before the age of 3 since an average increase of only 3 mm is observed between the ages of 3 and 18 (36,42). Premature closure or fusion of paired neural arch and vertebral body ossification centers has been postulated as the cause of diffuse spinal stenosis in achondroplastic dwarfs (17). Such a mechanism could account for the shortened pedicles seen in developmental spinal stenosis.

Other conditions rarely associated with cervical spine stenosis include neurofibromatosis, osteopetrosis, spondyloepiphyseal dysplasia, pituitary gigantism, and Paget's disease (18,33,59,73). Bony overgrowth may result in myelopathy requiring laminectomy to relieve cord compression due to hypertrophic neural arches. After injury resulting in cervical fracture, disc rupture, or dislocation, localized posttraumatic spondylosis may also cause symptomatic spinal stenosis, especially if spinal deformity or vertebral subluxation persist. Idiopathic calcification or ossification of the posterolongitudinal ligament has also been observed in Japan and Western countries as a cause of cervical spinal stenosis and myelopathy (4,51,53).

Clinically, symptoms of cord compression are predominant, and neck pain or cervical radiculopathy are not severe or characteristic features in cervical stenosis patients. Neurological abnormalities do not differ from cases of spondylotic myelopathy. However, Kessler (42) found that sudden development of persistent myelopathy or brief transient episodes of myelopathic symptoms were both induced by increased physical activity in his series of cases. "Intermittent claudication" of the cervical spinal cord due to impaired or transiently inadequate blood flow was suggested as a possible explanation. Increased spinal cord metabolic rate during activity, loss of autoregulation of cord blood flow, and compression of arterial or venous channels have been proposed as contributing factors in patients with intermittent symptoms or acute onset of myelopathy (9,42,72).

FIG. 2. Spondylosis above congenital fusion with stenosis. **A:** Lateral radiograph in a 67-year-old man who presented with painful paresthesias on neck flexion and a normal neurological examination. An unusual form of probably congenital posterior fusion from C_3 to C_7 is noted with sagittal canal diameters of 13 to 17 mm. **B:** Flexion view demonstrating 5-mm anterior subluxation of C_2–C_3. No movement was observed at the lower segments. **C:** AP myelogram showing widening of the cord shadow. **D:** Lateral myelogram suggesting multilevel dorsal but not ventral stenosis to 8-mm sagittal diameter, which was not symptomatic and was not predicted from the plain film measurements. **E:** Postoperative lateral radiograph showing interbody bone graft at C_2 to C_3. All symptoms resolved after anterior fusion, and laminectomy was not performed.



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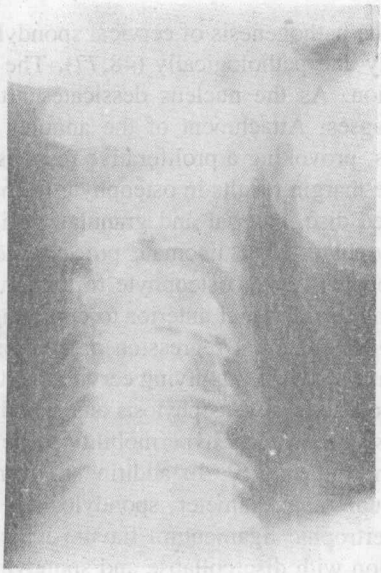

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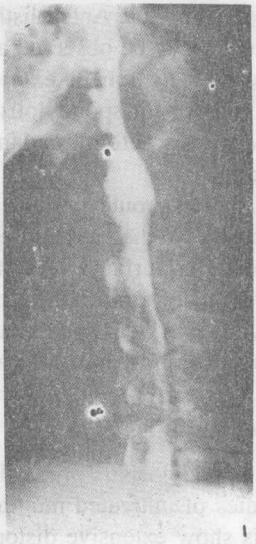

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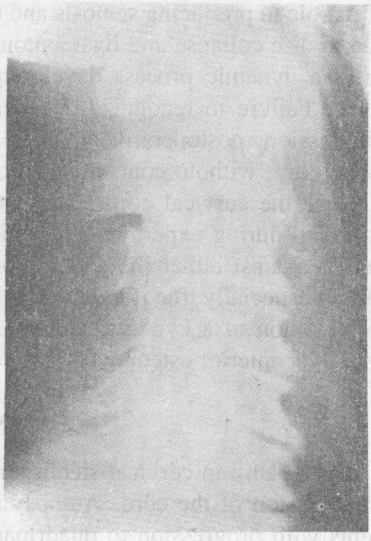

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