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Osteotomy of the Spine

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Smith-Petersen planned and literally "blueprinted" the lumbar spinal osteotomy, which was a dramatic success in providing a compensatory lumbar lordosis for the rigid dorsal kyphosis in ankylosing spondylitis or rheumatic spondylitis. It was the final addition to a series of operations that he performed in cases of rheumatoid arthritis, including: Vitallium mold arthroplasty of the hip; temporomandibular arthroplasty by excision of the condyle of the mandible; excision of the acromion process, radial head and lower end of ulna in corresponding joint involvement; and the correct use of joint and tendon synovectomy, now widely practiced.

Smith-Petersen devised his spinal operation as a one-stage procedure that could be repeated at more than one level if necessary. La Chapelle later achieved a similar type of correction using both a posterior and an anterior approach. In La Chapelle's procedure, the ossified anterior ligaments of the spine are divided, but in the Smith-Petersen technic correction is achieved by manual osteoclasis.

The purposes of performing the lumbar spinal osteotomy include:

1. enabling the patient to resume a more erect posture,
2. relief of compression of the upper abdominal viscera by the rib margin,
3. improvement of diaphragmatic respiration, on which these patients frequently depend entirely, and
4. broadening of the operative field for upper abdominal surgery.

OPERATIVE TECHNIC

With the patient in the prone position (although the lateral position can be used) and receiving endotracheal anaesthesia, the skin and musculature in the region of the lumbar spinous processes are infiltrated with local anaesthetic to which a few minims of adrenaline have been added to improve hemostasis.

An incision is made over the spinous processes and the muscles are stripped laterally by subperiosteal dissection to expose the laminae, ossified ligamenta flava, interspinous ligaments and the ankylosed intervertebral joints.

The level chosen for the osteotomy is determined by the least degree of ossification anteriorly, and part of the spinous process of the vertebra below this level is resected, corresponding to the degree of correction required. With gouges and bone-nibbling forceps bone is removed from the ossified ligamenta flava to expose the theca and cauda equina centrally in the spinal canal. At 45-degree angle from the sides of this space to the frontal and coronal planes, the bone is divided across the pedicles into the intervertebral foramen (Figs. 1 and 2). Fine osteotomes and bone-nibbling forceps are used and care has to be taken of the dura that frequently adheres to the bone. The osteotomy lines must be clean-cut with parallel margins 2–3 mm apart and when the intervertebral foramen is reached some bleeding from the vertebral veins will be incurred. Care has to be taken not to injure the nerve root.

On the bony surfaces of adjacent laminae and spinous processes, flaps are raised for fu-

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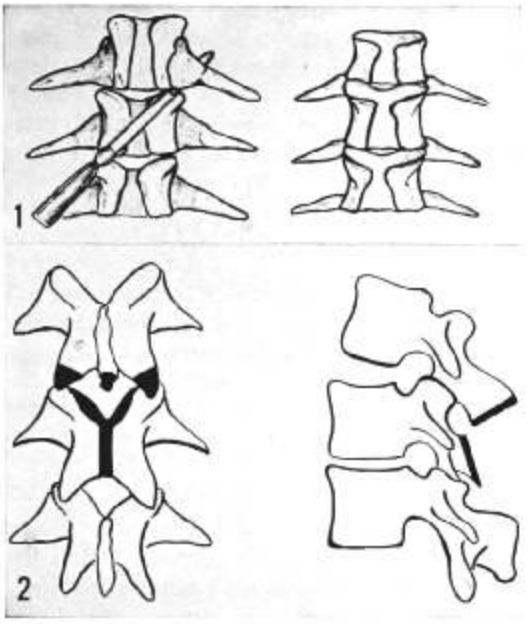

FIGS. 1 and 2. 1, Direction of oblique bone section in lumbar spinal osteotomy (after Smith-Petersen).

2, Area of bone section in lumbar spinal osteotomy (after Smith-Petersen).

sion using bone gouges. Then by elevating the head and pelvic ends of the operating table, the spine hinges at the level of the "V" or "butterfly-shaped" osteotomy, snapping the anterior ligament audibly and palpably. The spinous process above is brought onto the remains of the spinous process below to give a stable relationship, and the actual osteotomy lines close completely at the same time, effecting good hemostasis. Bone that had previously been resected is then reintroduced on the raw bone surfaces in the form of cancellous bone chips, and with the patient held steady in the corrected position wound closure can be carried out. The oblique direction of the osteotomy lines provides perfect lateral stability and the apposition of the spinous processes achieves anteroposterior stability. In recent years, further stability has been achieved by internal fixation of the spinous processes using 2 Wilson plates and screws, fixing 2 spinous processes above and below the level of the osteotomy. Local antibiotic is introduced into the wound and the muscles are firmly sutured before the subcutaneous tissue and skin. After dressing the wound a plaster of paris cast is applied in the form of a jacket, a posterior shell (an anterior shell is made later for turning purposes) or a short double spica.

With internal fixation the patient can be ambulatory in a plaster jacket in 2 or 3 weeks. Fusion occurs readily as a rule and may be sufficiently sound in 3 to 4 months for a brace to replace the plaster cast. The brace is worn

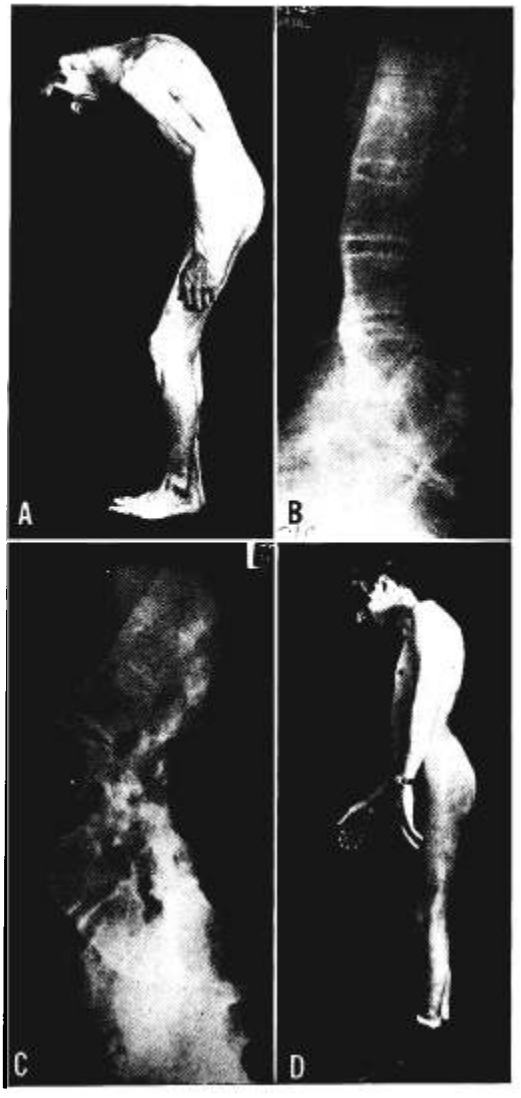

FIG. 3 A–D. A, Preoperative photograph of patient.

B, Preoperative roentgenogram of lumbar spine. Radiograph showing correction after osteotomy.

C, Roentgenogram of postoperative correction.

D, Postoperative photograph of patient.

for about 6 months while consolidation is completed, and has been observed to take place anteriorly between the vertebral bodies which have been opened up as well as posteriorly between the laminae and spinous processes.

Smith-Petersen aimed at a correction of 20 to 30 degrees and was prepared to carry out a similar osteotomy at a higher or lower level if more were required. Today, a 40-to-50° correction is commonly achieved at any level and at the lower part of the lumbar spine a correction of as much as 80 to 90° has been achieved without injury to the cauda equina or nerve roots. By following the Smith-Petersen technic closely the surgeon can obtain an excellent compensatory lumbar lordosis with perfect stability under direct vision and the benefit to the patient both functionally and cosmetically is dramatic (Fig. 3 A–D).

Cervical spinal osteotomy has been developed along the same lines to treat cases of severe, rigid cervicodorsal kyphosis (Fig. 4 A–D), but the direction of the bone resection is more horizontal—across the ossified ligamenta flava and fused intervertebral joints (Fig. 5). Twenty to 30° correction is safe and internal fixation (Fig. 6) can also be used in addition to a Minerva plaster jacket or a posterior shell with a headpiece. After 3 to 4 months the plaster is changed to a collar that should be worn for at least 6 months.

Cervical spinal osteotomy is performed to:

1. enable the patient to see ahead by elevating the chin from the sternum,
2. prevent atlantoaxial subluxation and dislocation, liable to result from the weight of the head being carried forward as a result of increasing kyphosis,
3. relieve tracheal and esophageal obstruction that cause dyspnea and dysphagia, and
4. to relieve nerve-root traction and spinal

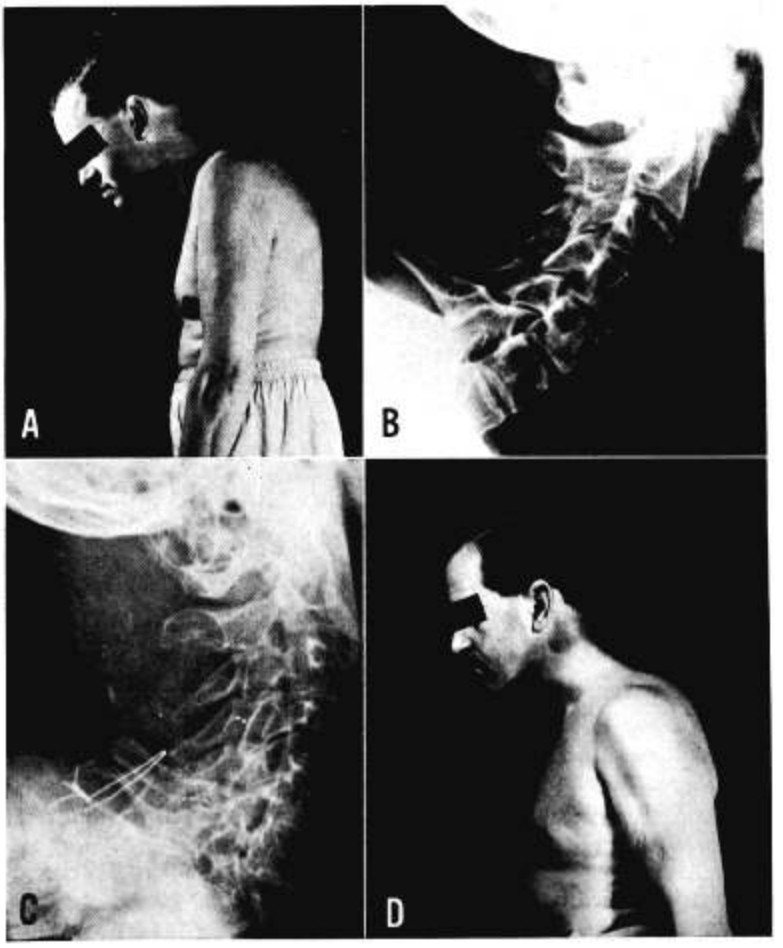

FIG. 4 A–D. Cervical spinal osteotomy. A, Preoperative photograph of patient.

B, Preoperative radiograph.

C, Postoperative radiograph showing wire fixation of spinous processes.

D, Postoperative photograph of patient.

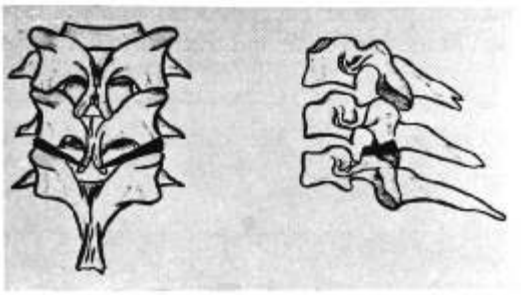

FIG. 5. Area of bone section in cervical spinal osteotomy. Lumbar spinal osteotomy.

cord compression with accompanying lower and upper motor neuron disturbance.

Osteotomy can also be carried out in the dorsal region but technically is much more difficult, as the fused costovertebral joints require resection and the relatively smaller space in the spinal canal allows far less correction. As a rule, either lumbar or cervical spinal osteotomy, and in some cases both (Fig. 7 A–F), can give all the compensatory correction required.

RESULTS

FATAL COMPLICATIONS

Smith-Petersen in his small series of cases had few complications, but in a series of 120 lumbar and 20 cervical spinal osteotomies fatal (Table 1) and nonfatal complications have been encountered. Cortisone shock or possiby cerebral anoxia accounted for 3 deaths, one of which was formerly considered due to accidental suffocation. The danger of turning a rigid patient into the prone position on soft pillows is obvious, and on the operating table a head-down position may produce venous congestion with anoxia of the vital centers. Postmortem examination revealed no cause for death and there was no evidence of fat embolism or chest disease. Spinal cord injury occurred in 2 patients—the result of soft vascular bone collapsing as the osteotomy correction was being completed. Further bone resection did not relieve the paresis and death occurred from terminal bronchopneumonia after 4 weeks and 8 months respectively. In a third case, fracture-dislocation of the cervical spine at the sixth-seventh level occurred at some stage during the operation, either during the anesthetic intubation, in transportation, at the time of hinging the spine for the correction or while the plaster was being applied. In a fourth case, an acute psychosis rendered the patient maniacal and he removed his cast and threw himself out of bed. The upper vertebra at the osteotomy site was displaced forward and thrombosis of the spinal cord vessels resulted in flaccid paralysis, pressure sores and bronchopneumonia. He died 4 months later. Acute abdominal complications of perforated ulcer and gastric erosion caused deaths from peritonitis and severe hematemesis respectively. An ulcer adherent posteriorly may be endangered by a high lumbar osteotomy; therefore, in patients with symptoms of gastroduodenal upset prior to operation appropriate investigations should be carried out.

In 20 cases of cervical osteotomy there has been 1 death for which no cause was found, although the patient was extremely debilitated

FIG. 6. Radiograph showing internal fixation method that can be used in cervical spinal osteotomy.

and death suddenly occurred 3 weeks after surgery, possibly due to delayed cortisone shock or anoxic encephalopathy. Another patient died as a result of thrombosis of spinal cord vessels. In a recent case, an excessive correction produced tracheal and esophageal pressure effects necessitating reduction of the correction and tracheostomy.

Nonfatal Complications

Compression of the cauda equina with flaccid paralysis in the lower limbs occurred

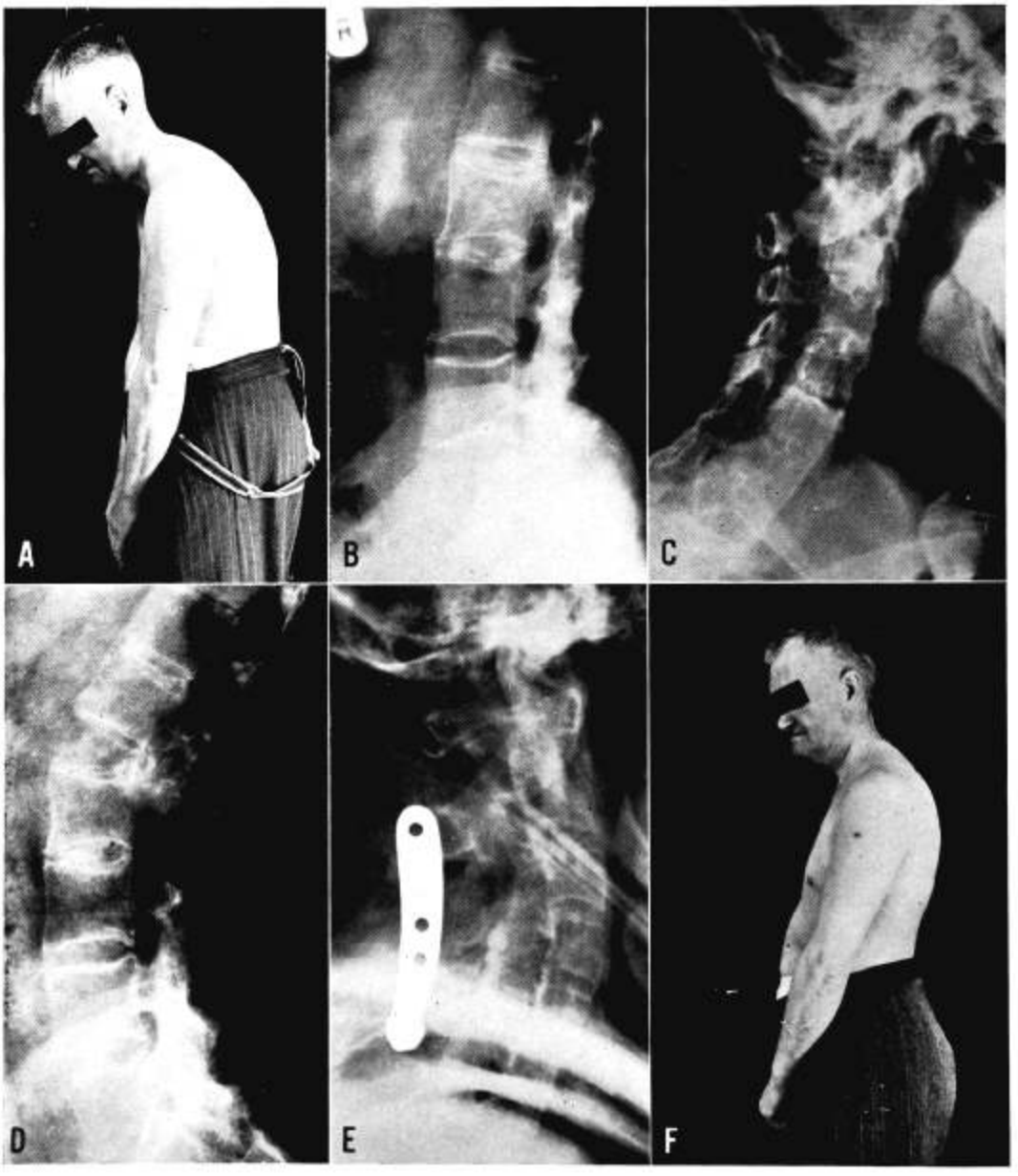

Fig. 7 A–F. Combined lumbar and cervical spinal osteotomy. A, Preoperative photograph of patient. B, Radiograph of lumbar spine. C, Preoperative radiograph of cervical spine. D, Correction after lumbar spinal osteotomy. E, Correction after cervical spinal osteotomy. F, Postoperative photograph of patient.

in 1 case, accompanied by corresponding sensory and bladder disturbance. After 48 hours re-exploration was performed, as the internal fixation was loose since the bone was somewhat soft for the bolt fixation. More bone was removed at the osteotomy site to relieve possible pressure and the dura was opened, but only congestion with no evidence of damage to the spinal cord was seen. More adequate internal fixation was achieved and iliac bone grafts were inserted, and the patient made a slow but steady recovery.

Spinal cord irritation from intrathecal hemorrhage occurred in one case resulting in spastic paraplegia. This took place at the mid-dorsal level after spinal osteotomy had been performed at the lubar 2–3 level, and was relieved by prompt laminectomy and decompression, although there has been some residual lower-limb weakness. In one cervical spinal osteotomy a partial quadriplegia resulted from vascular disturbance in the cord.

Nerve-root traction injury occurred in 1 case with an 80° correction at the lumbar 4 level; temporary foot drop resulted. Two other cases had temporary paresthesia with corrections of over 50°.

Superior mesenteric thrombosis occurred in 1 case and fortunately high intestinal obstruction was quickly diagnosed and duodenojejunostomy resulted in complete recovery.

Ileus has been seen in several cases but has always been relieved by medical treatment and the cutting of an upper abdominal window if an encircling plaster cast has been employed.

No serious vascular injury such as rupture of the aorta has been seen although such a complication has been reported elsewhere. However, with high lumbar osteotomies, upper abdominal complications may be more liable to occur and the possibility of an "acute abdomen" must not be overlooked if the patient complains of abdominal pain after operation.

The patient's mental and physical outlooks are frequently suddenly changed by corrective osteotomy in cases of severe deformity, and in the early postoperative period emotional instability may be noted and must be treated sympathetically both by the medical attendants and relatives. Only one patient has required psychiatric treatment.

TABLE 1. Fatal Complications in 120 Cases of Lumbar Spinal Osteotomy

Causes	No. Cases
Cortisone shock or anoxic encephalopathy	3
Spinal cord injury	3
Perforated gastric ulcer	1
Acute gastric erosion	1
Renal failure from amyloid disease	1 (4 months after surgery)
Acute psychosis with spinal cord thrombosis	1 (4 months after surgery)
Total	10

Recurrence of deformity has occurred in 2 cases at the actual site of the osteotomy, probably the result of slow or insufficient bone consolidation and a premature change from plaster cast immobilization to a light spinal support. In 2 cases the dorsal kyphosis has continued to increase above the level of the lumbar osteotomy. This gives rise to a severe, rigid round-back deformity without loss of the main axis of the spine, as the osteotomy still provides a compensatory lumbar lordosis. However, in 1 patient nerve-tract irritation has occurred with signs of early spastic paraplegia, so decompression of the cord in the dorsal spine at the apex of the deformity may be required.

Recently a long-standing successful case of spinal osteotomy developed a cauda equina lesion, probably due to an arachnoidal cyst. Such lesions are occasionally seen in ankylosing spondylitis, possibly linked with adherence of the theca to the bony overgrowth, or possibly as a result of fibrosis and adhesion formation following radiotherapy.

Where the hip joints are involved in the disease, bony ankylosis may be complete, or there may be a considerable flexion deformity which accentuates the spinal kyphosis. Mo-

bilization of the hips and correction of fixed deformity by arthroplasty or pseudoarthrosis should be carried out prior to the spinal osteotomy correction. The degree of osteotomy necessary can then be estimated correctly. Also, with mobile hips at the stage of hinging the spine to close the osteotomy, there is less rigid leverage and less likelihood of damaging soft bone or brittle tissues.

Rupture of aorta has been reported as a complication of this maneuver, but has not occurred in this series of cases.

SUMMARY

Spinal osteotomy has proved helpful to many patients with gross rigid spinal deformity in ankylosing spondylitis and rheumatoid arthritis. With care and experience the incidence of complications should be reduced, although better and earlier diagnosis will also reduce the number of cases requiring such surgery.

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