Kyphotic Deformity of the Spine in Ankylosing Spondylitis

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It is well known that severe flexion deformities of the spine may occur in patients suffering Marie–Strümpell spondylitis and ankylosing spondylitis associated with psoriasis. The prevention of these deformities by early recognition of the disease process, by adequate medical treatment and all the measures of prevention that are available to us, should still be the main aim of the medical profession in handling patients with specific spinal involvement.

However, despite the recognition of this basic concept, we still see all too often, patients with advanced kyphotic deformities of the trunk who are very grossly disabled, and who present a major problem for definitive surgical correction of their deformity.

INDICATIONS FOR SURGICAL CORRECTION

The indications for surgical correction of deformity related to the spine are variable and depend on the extent of the deformity, the degree of functional embarrassment, the general condition of the patient, the age of the patient, the feasibility of correction, and perhaps above all else, the morale and earnest desire of the patient to accept the risks and rehabilitative measures required for correction.

ASSESSMENT OF THE DEFORMITY

In assessing these patients for possible surgical correction it is most important that we recognize the primary site of their deformity. It is true that we may occasionally compensate to a degree for deformity in one area by correction carried out a little removed from it, if the deformity is not too severe. However, there is no doubt that if any major correction is to be carried out, then the correction must be done in the area of the main deformity. If this is not done, disturbance of balance and the ability to walk and stand upright could be very materially affected. Patients who present, or who are referred because of apparent spinal deformity may in reality have their main deformity in the hip joints, or it may be in the lumbar spine, the thoracic spine, or it may be primarily cervical in situation.

Figure 1 shows a 57-year-old woman who was referred for consideration of correction of her "spinal" deformity. The distance between her nose and the floor measured 32 inches, and she had been a woman of reasonable height. She had been held rigidly in this position for a period of 16

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FIG. 1. Lateral of a 57-year-old female referred for correction of spinal deformity. She had been rigidly in this position for 16 years. The distance between her nose and the floor was 32 inches.

years. Her knees were held rigidly together in adduction and as a result of the impingement of one against the other, she wore a protective pad on her right knee. It is true that she had a forward curvature of her lumbar spine, her thoracic spine and to a degree her neck. However, her spine and hip joints were both solidly ankylosed (Fig. 2) so that she could be moved up and down in a teeter-totter fashion by either lifting up on her extremities or pushing down on her head. It is also evident that her main flexion deformity was at the fused hip joints, and if her lower limbs were placed below her, in line with her remaining trunk, then her main deformity would be corrected and she would undoubtedly be able to cope with the residual deformity of her spine. This woman was not treated by spinal osteotomy, but by bilateral total hip replacement arthroplasties, mobilizing her hips and correcting her hip flexion deformities, placing her lower limbs in more normal alignment below her trunk. Following this, she was able to stand and look ahead (Fig. 3). She is now able to get in and out of a chair, and manages her own home. As far as she is concerned, her main problem has been relieved.

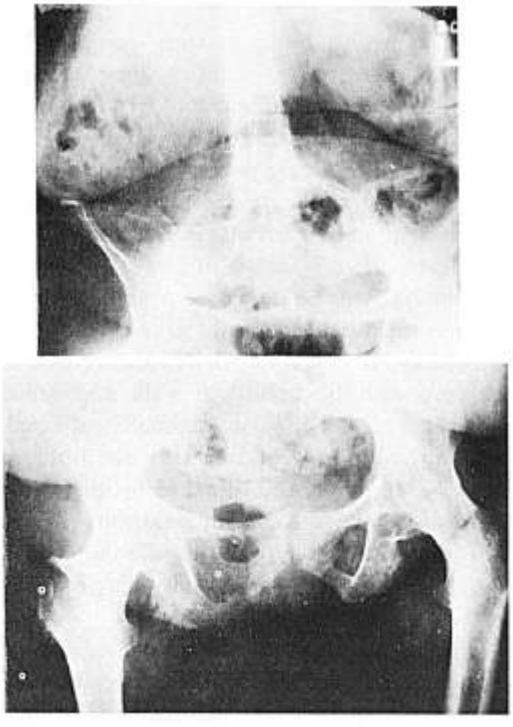

FIG. 2. Anteroposterior radiographs showing ankylosis of spine (top) and hip joints (bottom).

KYPHOTIC DEFORMITY OF THE LUMBAR SPINE

This was the first type of deformity corrected surgically in arthritic disease of the spine as initially reported in 1945 by Smith–Petersen, Larson and Aufranc.[23] The initial procedure as described by them was performed with the patient under general anesthesia and lying prone. This has been further reported by La Chapelle,[8] Herbert,[5,6] Nunziata,[16] Wilson,[25] Law,[9,11] and others.[3,4,7,13–15,17] In all of the series reported, including Law's, with 100 cases, the operative mortality has approached 10%.

Some have recommended a 2-stage procedure or double exposure procedure with surgical division of the longitudinal ligament anteriorly. This is not usually required. In most instances, correction can be done from the posterior approach alone. The double exposure technique has the drawback of extending the operative procedure and anesthetic time.

There are a number of problems which are encountered when trying to place a patient with a gross kyphotic deformity of the spine in a face down position, to allow an operative procedure on the back. Adams[1] has circumvented these problems by operating with the patient lying on the side and he uses a 3-point rack to manipulate the spine and allow correction. There are still frequent major complications, however, when operating on the spine of a patient with fixed deformity due to ankylosing spondylitis when the operation is done under general anesthesia. These patients usually have a rigid neck and intubation itself is a difficult undertaking. Postoperatively, the patients are not able to cough well and accumulation of mucus with respiratory complications presents a real hazard.

One of the major complications or problems in straightening the spine by lumbar osteotomy is gastric dilatation and associated abdominal ileus. As the spine is extended, the superior mesenteric artery is stretched over the third part of the duodenum, and this predisposes to gastric dilatation. If this hazard is not anticipated, patients may vomit a large amount and with a stiff, rigid neck, particularly when lying on the back, the danger of aspiration of vomitus is very real. As a result, it is wise to have a duodenal tube in position preoperatively with suction drainage until intestinal motility is established. The irritation of a duodenal tube and the accumulation of secretions caused by it, may also contribute to pulmonary complications, particularly under general anesthesia.

The initial recommendation of Smith–Petersen *et al.*[2,3] was to carry out a posterior resection osteotomy of the midlumbar spine in a v-fashion with manipulative fracturing of the anterior longitudinal ligament. The spinous processes were resected and cut into small strips to be used for grafting. The level of osteotomy was identified and an elevator inserted beneath the lamina and

FIG. 3. Postoperative lateral standing view of patient showing main skeletal deformity corrected.

the inferior articular facet, bringing it out through the intervertebral foramen laterally. Osteotomy resection was carried out through the superior articular facet of the vertebra below and the inferior articular facet of the vertebra above. The osteotomy was made in an oblique fashion, its angle being approximately 45° with the transverse plane. The obliquity of the osteotomy was to ensure locking of the vertebrae following correction in an effort to prevent serious displacement. The technique of osteotomy, as recommended by Smith–Petersen, is sound and requires little alteration. However, it is undoubtedly an easier and safer procedure when done with the patient lying on the side, and particularly when done under local anesthesia.

Concerning general anesthesia, Kallio[7] states that "anesthetization is no easy task." Emneus[3] felt that general anesthesia was contraindicated with the prone position at operation, the completely rigid thoracic cage and the difficulty with intubation. He per-

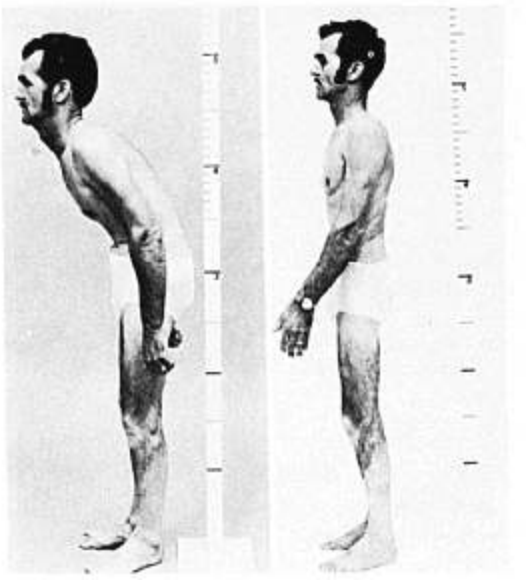

FIG. 4. (left) Preoperative standing lateral photograph of patient indicating extent of flexion deformity of lumbar spine, and the angle of correction which will be required to straighten the deformity. (right) Postoperative standing lateral view indicating correction achieved following removal of calculated wedge of bone, indicated by preoperative deformity.

formed the operation on 3 patients using local analgesia and, subsequently, on 2 other patients using extradural analgesia. When all the reported results of lumbar osteotomy under general anesthesia are reviewed, it is noted that the mortality varies from 8 to 10% and that neurological deficit of some degree, including paraplegia, has an incidence of 30%. In analyzing the causes of mortality, ⅔ would appear to be related to the use of general anesthesia. As a result of experience with the correction of kyphotic deformity of the cervical spine under local anesthesia, the author has investigated the possibility of carrying out correction in the lumbar spine under local anesthesia, and has found it to be a safe, reliable and practical procedure.[22]

MATERIALS AND METHODS

TECHNIQUE OF OPERATIVE CORRECTION

The patient is admitted a few days prior to proposed surgery. Careful medical assessment is carried out including pulmonary function tests and electrocardiography. A physiotherapy program of deep breathing activities and extremity exercises are given, as will be used in the postoperative interval. Psychological preparation includes preoperative visits by the anesthetist, as well as the surgeon, to explain the whole procedure to the patient and gain their confidence. The patient must understand that total relief or awareness of occasional discomfort during the operative procedure may not be possible, and they are required to cooperate by notifying the anesthetist and the surgeon of any discomforts or paresthesias during surgery, and that this is an important part of the monitoring process.

A long acting narcotic, usually morphine, is given by intramuscular injection an hour preoperatively. The operation is carried out with the patient lying on whatever side they would normally find most comfortable for sleeping. The patient is positioned on a table with a transparent top, to allow easy insertion of a radiographic plate during the operative procedure to allow radiographic localization of the level. Routine monitoring of pulse, blood pressure and respiratory rate is done throughout the procedure, the anesthetist relaying any information from the patient as to any particular discomforts or neurological symptoms in the lower extremities. The patient is allowed to enjoy the music of a transistor radio. An anesthetic gas machine is available along with a fibro-optic bronchoscope and a standby tracheostomy set. Innovar is a very potent and effective drug and is ideally suited to supplement local anesthesia. Its fentanyl component is a synthetic opiate calculated to have 100 times the analgesic potency of Demerol. Its other component droperidol, is a powerful tranquillizer and a strong antiemetic. Any tendency which droperidol may have to lower the blood pressure can be counteracted to a degree by tilting the table. Oxygen at 5 litres per minute is administered by a nasal catheter. Fentanyl may be given separately in additional amounts or other analgesics, such as morphine or pantopon, may be given in small increments as indicated.

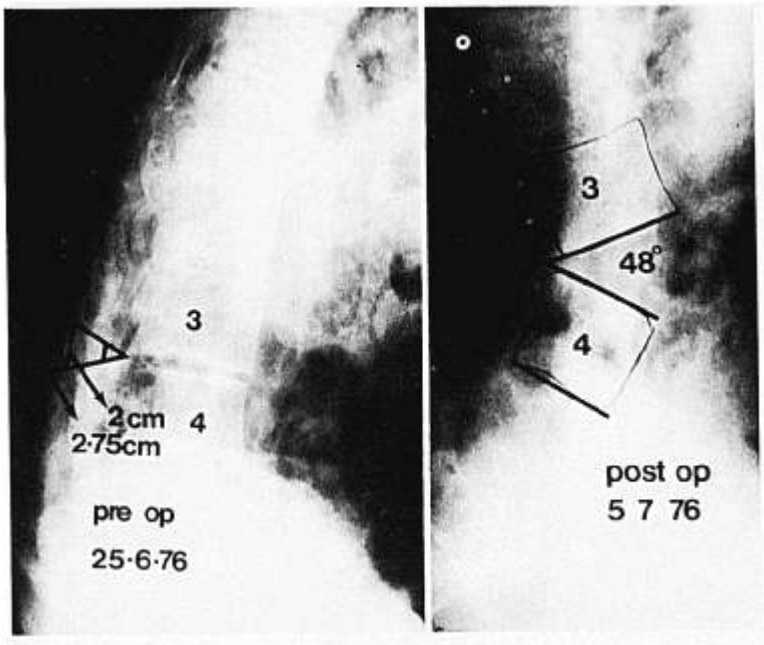

FIG. 5. (left) Lateral preoperative radiograph of same patient showing angle of correction and amount of bone to be removed. Two centimeters of bone removal is required on each side at the level of the fused posterior joints, 2.75 cm at the level of the laminae and 5 cm at the level of the tips of the fused spinous processes. (right) Postoperative lateral radiograph showing angle of correction obtained following closure of defect posteriorly and anterior osteoclasis through L3-4 disk space.

When the surgeon is ready to fracture the anterior longitudinal ligament and correct the deformity, the patient is advised that the decompression is complete and that the spine is ready to be straightened. The patient is given 100% oxygen for 5 minutes and then breathes nitrous oxide, 8 litres per minute and oxygen 2 litres per minute through a face mask until drowsy. The spine is then manually fractured by extending the hips and pelvis, the surgeon pushing forward in the midlumbar spine and an anesthetist or assistant pushing backward on the upper thoracic spine until the spine fractures. Following correction of the spine, the patient again breathes 100% oxygen until fully conscious. The patient is able to cooperate when being turned over onto the face, a pillow support being put under the upper chest and the pelvis to assist with extension of the lumbar spine. Following wound closure a posterior plaster shell is applied with the patient awake. The patient is then rolled over onto the back in the shell and an anterior plaster shell is applied. They are nursed postoperatively on a circo-electric frame. Both shells are applied and secured firmly for turning, the uppermost shell then being removed for skin care.

The amount of bone to be resected is calculated from the preoperative radiographs and an assessment of the degree of the patient's deformity. The angle of correction which will be required to straighten the deformity is calculated and transposed to the X-ray, indicating the amount to be resected (Figs. 4 and 5). The proposed osteotomy site is confirmed radiographically. Usually the L3 - 4 level is selected as the site where correction should be carried out, but even with radiographs and markers on the apparent fused posterior elements, the area above or below often turns out to be the one where the resection has been done, due to the confluent nature of the spinous processes, ossified ligaments, laminae and ligamentum flavum. Symmetrical amounts of bone must be removed from either side of the spine and the fused posterior elements to allow symmetrical closure of the defects following correction. The surfaces are slightly bevelled so as to come into accurate apposition following extension at the osteotomy site.

The procedure is performed with the surgeon sitting. The skin and paravertebral muscles are infiltrated with 1% lidocaine and epinephrine 1/200,000. A midline exposure is made, the level identified and resection carried out. Bone is removed with rongeurs and a power burr, allowing one to slowly cut through the fused elements towards the spinal canal which is

FIG. 6. Postoperative radiograph showing closure of posterior v-shaped areas of resection, and encircling wire.

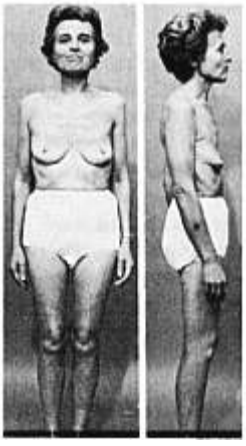

FIG. 8. Postoperative anterior view (left) and lateral view (right) showing complete correction of deformity. The patient enjoyed an excellent correction of her deformity with restoration of a normal life pattern despite transient postoperative hypertension.

opened. The dura is protected with cottonoid patties. The technique of resection described by Smith-Petersen is followed. The bone is removed obliquely from the midline going cephalad and laterally through the fused area of the posterior joints. The slot is gradually widened depending on the amount of correction desired. Drill holes are placed in the spinous processes above and below the defect and a loop of 20 gauge stainless steel wire is passed through them. The patient's spine is then fractured in front. The patient is turned onto the face with the spine hyperextended. The 2 portions of the spine are wired together under tension, and the osteotomy site is then grafted with the removed bone added as a fusion mass. Suction drainage is used (Fig. 6).

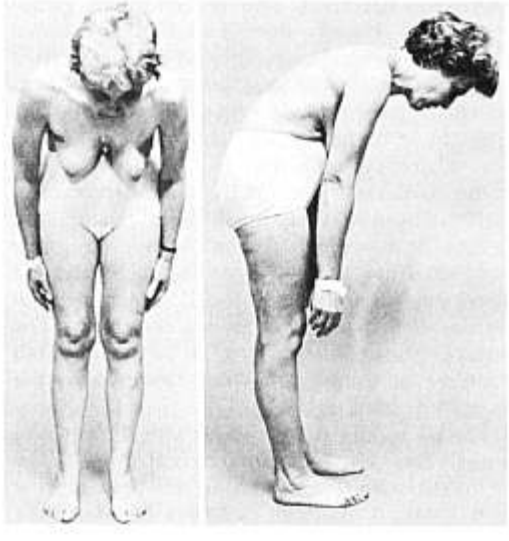

FIG. 7. Anterior view (left) and lateral view (right) of a 51-year-old female showing a severe kyphotic deformity of the thoracolumbar spine.

This technique of extension osteotomy of the lumbar spine under local anesthesia has been carried out on 19 patients since 1969. The indications for surgery were either inability to see more than a few feet ahead when walking or painful impingement of the rib cage on the iliac crest. There were 13 males and 6 females. The average duration of disease in these patients was 22.3 years. All had moderate to severe restrictive pulmonary disease with 26 - 69% reduction in vital capacity.

Correction of the deformity varied from 30 - 60° with an average of 47°. Eight of the osteotomies were done at the L2 - 3 level, 8 at the L3 - 4 level and 3 at L4 - 5.

It is of interest that there were no major complications in this series of patients. The duodenal tube remained *in situ* for 2 - 3 days postoperatively until bowel sounds returned and the patient was expelling flatus. None of these patients suffered any difficulty with aspiration or postoperative chest complications. There was no mortality and no patient suffered any permanent neurological deficit. One patient developed hypertension postoperatively which was controlled by anti-hypertensive drug therapy. Investigation revealed no abnormality, except a small right kidney which the patient had been known to have for some years. She also

had a family history of hypertension. Her hypertension gradually resolved, and she enjoyed an excellent correction of her deformity and functional result (Figs. 7 and 8). One patient complained of moderate distress in his knee with an associated effusion which was felt to be due to activation of disease in that area. There has been no incidence of pseudarthrosis, although 2 of the 19 patients are still in their postoperative consolidation phase in plaster.

Experience to date would indicate that this concept of resection extension lumbar osteotomy in ankylosing spondylitis is a safe, reliable procedure. It allows easy continual monitoring of the patient's neurological and vascular functions, with the avoidance of major disastrous complications. It would appear to be the treatment of choice in most individuals.

KYPHOTIC DEFORMITY OF THE THORACIC SPINE

A degree of thoracic kyphosis is fairly common in spinal deformity of ankylosing spondylitis, but rarely does it present such major proportions that definitive correction in the thoracic area is demanded and in most situations, corrective compensation has been obtained by osteotomy in the lumbar spine. It is an area of deformity that has been avoided by the orthopedic surgeon.

Severe disabling thoracic kyphosis may occasionally present, requiring a combined attack of anterior and posterior approaches to the spine including skeletal traction techniques.

CASE REPORT

Case J.C. This 32-year-old female had suffered ankylosing spondylitis associated with psoriasis for a period of 14 years. She had suffered iritis and was on steroid therapy for this. She had suffered progressive loss of 6 inches in height, and had gone on to a severe thoracic kyphosis of 116° extending from T2-11. She had gross rib impingement against the pelvis, and an obvious area of destructive spondylodiscitis at the T8-9 region anteriorly (Figs. 9 and 10). She had a sharp angular kyphos with pressure changes and impending skin breakdown over the apex of the kyphos. There was gross restriction of pulmonary function with her maximal voluntary ventilation being approximately ⅓ of normal. Shortness of breath with activity was one of her major complaints. With progressive increase in her kyphos, she had a major risk of increasing pulmonary insufficiency and corpulmonale, as well as a significant risk of paraplegia. She also had a degree of C1 - 2 subluxation.

FIG. 9. Preoperative erect standing lateral view of a 32-year-old female with thoracic kyphosis of 116° extending from T2 to T11.

This type of deformity requires a series of procedures in careful staging, depending on the potential mobility of the thoracic spine.

FIG. 10. Standing lateral radiograph showing kyphotic deformity confined to thoracic spine.

This woman had softening of her thoracic spine and areas of destructive spondylodiscitis indicating the potential for correction with a preliminary period of traction. Accordingly, a period of careful halo-femoral traction was instituted over 3 weeks, her kyphosis responding with a decrease to 68°. Bilateral posterior Harrington compression instrumentation could then be carried out with reduction of her curve to 50°, which is very close to the upper limit of normal. A transthoracic approach to her thoracic spine was then carried out and the areas of destructive spondylodiscitis identified. A trough was cut in the spine anteriorly throughout the involved area of her kyphosis along with cleaning out of the areas of spondylodiscitis. A fibular strut graft measuring 6 inches in length was taken from her right leg and bevelled so as to lock into place in the prepared trough. It was locked into the defect above and below and the area was then reinforced with multiple strips of rib grafting (Fig. 11). The pleura was closed and she was left with a solid strut supporting her spine in front, which would later be incorporated into a solid fusion. Her postoperative course was uneventful. She has progressed very well with maintenance of her correction over the 2½ years since her surgery. Her graft has continued to incorporate anteriorly, and she is now 5 inches taller in height (Fig. 12).

KYPHOTIC DEFORMITY OF THE CERVICAL SPINE

There are few patients with ankylosing spondylitis in whom kyphotic deformity of the spine occurs primarily in the cervical region. This deformity can be severely disabling and may progress to the point where it actually interferes with opening of the mouth. The possibility and technique of correction of kyphotic deformity of the neck is less well understood. It is fraught with considerably greater hazards. A complete review indicating the results of all attempts to carry out osteotomy of the cervical spine under general anesthesia is not available. Verbal communication would indicate that isolated attempts made in various centers have resulted in a high rate of disastrous complications leading to fatality. For the few severely afflicted patients with this particular problem it is important that the principles related to its possible correction and the indications should be clearly established.

Over the last 10 years, the author has had opportunity to carry out surgical correction of severe kyphotic deformity of the cervical spine associated with ankylosing spondylitis in 45 patients.[18-20] The results in the first 42 patients of this series have been reported.[21] The technique that has been followed has allowed a most consistent satisfactory and to a degree dramatic correction, which has been maintained, with somewhat surprising minimal amount of morbidity or complication. The following principles of treatment have evolved to obtain these goals. After the recommendation of Urist,[24] it is felt that operation should be done under local anesthesia with the patient in the sitting position.

FIG. 11. Operative view showing 6 inch fibular graft locked into place in the prepared trough reinforced with rib grafting.

In the first patient of the author's series, the anesthetic service felt that this was hazardous and, on one occasion, attempted unsuccessfully to intubate the patient. When this was not possible, it was mutually agreed upon to carry out the procedure in the sitting position under local anesthesia, which was done quite successfully, and all operations were done subsequently in the same fashion. The level between the seventh cervical and first thoracic vertebra is selected for correction of the deformity. As Mason[12] and Urist[24] indicated, this interspace is more receptive to surgical treatment than any other level in the cervical region. The spinal canal is relatively wide. The cervical cord and eighth cervical nerve roots have good flexibility in this area. Any weakness caused by injury to the eighth cervical nerve root would likely cause less disability than other roots, although a gross eighth nerve root lesion will cause significant loss of function in the hand. Fortunately, the vertebral artery and veins usually pass in front of the transverse process of the seventh vertebra and enter the transverse foramen at the sixth vertebra (Fig. 13). The position of these vessels above the level of the first thoracic vertebra protects them from serious injury during osteotomy at the C7-T1 level. An adequate excision is carried out posteriorly with subsequent fracturing of the anterior longitudinal ligament extension of the spine at the cervical–thoracic junction.

FIG. 12. (left) Standing radiography of spine 2½ years postoperatively showing correction of kyphotic deformity. (right) Standing lateral view 2½ years postoperatively showing correction of kyphotic deformity. The patient is 5 inches taller in height.

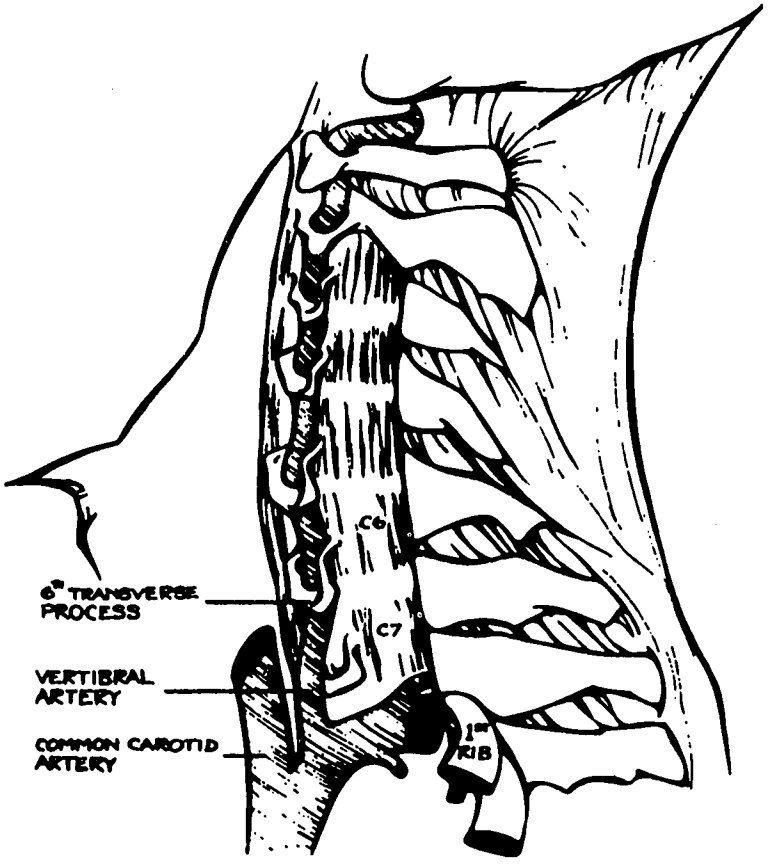

FIG. 13. Lateral anatomical view showing normal passage of the vertebral arteries and veins in front of the transverse process of the seventh vertebra entering the transverse foramen at the sixth vertebra.

TECHNIQUE OF OPERATIVE CORRECTION

Two or 3 days preoperatively, the patient is fitted with a plaster (or light cast) body jacket incorporating the supports for a halo unit. A halo is fitted to the skull. The patient is allowed to adjust to the cast and the sensation of the halo in his head for a day or so, and operation then carried out. Operation is done with the patient in the sitting position. The halo is used to control the head during the procedure and to serve as a basis for stability immediately following the operation. It is suspended with 9 lbs. balanced traction along the axis of the neck.

Exposure is carried out posteriorly under local infiltration. The bifid spinous process of C6 is usually easily identified. If difficulty is encountered, radiographic confirmation of the level is obtained. The C7 spinous process and laminae are completely removed along with the inferior portion of the spine of C6 and the upper portion of T1 with their associated laminae. The inferior portion of the arch of C6 and the upper portion of the arch of T1 being removed. The spinal canal is opened, the dura and cord being protected with cottonoid patties. The eighth nerve root canal is identified and bone is then removed laterally through the fused area of the posterior joints, decompressing the eighth nerve root thoroughly. Generally a centimeter and half to a centimeter and three quarters of bone, or more as required, is removed on both sides laterally. The lines of resection

are slightly bevelled upwards and downwards so that following correction the 2 surfaces will be parallel and in apposition (Fig. 14). The patients are able to assist with operative localization, indicating at any time when the eighth nerve root is irritated, and this is of real value during the course of the decompression. The cord is decompressed above and below posteriorly to avoid any impingement when the neck is straightened. The upper portion of the transverse process of T1 is rongeured away, as is the inferior portion of the transverse process of C7 as required to allow adequate decompression. The C7 pedicles are rongeured away sufficiently and undercut, to avoid impingement or a pincher affect on the eighth nerve root following extension of the spine. Ideally, a recess should be cut upwards into the base of the pedicle to avoid any pressure on the nerve root and to protect it when the neck has been extended.

When the decompression has been completed, the patient is given a small amount of nitrous oxide and Fluothane or an alternate agent. Patient holds the mask and when no longer able to hold it to the chin, the neck is then gradually extended until the spine fractures in front. The gap on each side then closes posteriorly, the lateral masses coming together. The central portion remains open to allow buckling of the dura without impingement. Symmetrical resections are required on each side to allow the opposing bony surfaces to come together posteriorly on each side, and this allows adequate fusion. Routine closure is carried out with suction drainage. The head is stabilized by incorporating the halo apparatus into the supports which have been fixed into the plaster body jacket. The patient is fully conscious almost immediately. He is requested to move all 4 limbs to demonstrate adequate neurological function. At the end of the procedure, the patients are able to stand and walk over to their circo-electric bed with minimal assistance.

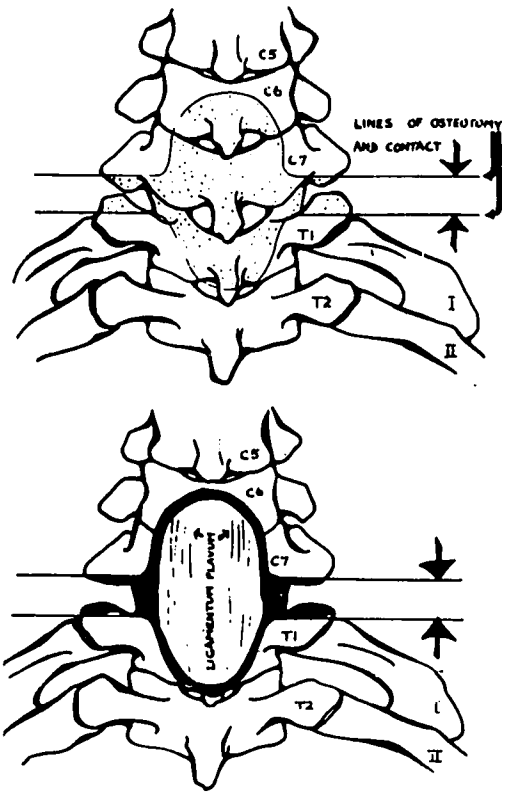

FIG. 14. Diagram showing posterior view of area of resection. The lines of resection are slightly bevelled upwards and downwards so that following correction the 2 surfaces will be parallel and in apposition.

The postoperative course is generally uneventful. The patients are nursed on a circo-electric bed, becoming ambulant within a few days following operation. They are discharged to convalesce at home in their halo cast unit as soon as they are comfortable postoperatively and are ambulating actively. The neck is splinted for 4 months postoperatively, at which time progressing solid union is usually evident radiographically. A cervical brace support is fitted at that time to be worn when up and about for a further 2

FIG. 15. (left) Preoperative lateral view of typical patient. He was unable to drive a car. He had to give up his job, and was unable to sit close to the table for eating. (right) Postoperative view showing correction of the deformity. The patient has a compromise between looking ahead for walking, and being able to work at a desk. His preoperative restrictions have been relieved.

months and discontinued as clinical and radiographic findings indicate.

It is important not to overcorrect the deformity. The patients must have a compromise between looking ahead for walking and being able to work at a desk. By discussion with the patient preoperatively, the ideal position is established so that the patient will be able to look straight ahead while walking and still be able to work quite effectively at a desk (Fig. 15).

The results of application of this technique to 42 patients from October 1967 until August 1976 have been reported. The same technique was applied to the 42 patients without significant modification, and with equal success in 41. Correction has been carried out under local anesthesia. At the end of the procedure, the patients have been able to walk from the operating table to their circo-electric bed.

Union following osteotomy appears to occur fairly readily in most instances, however, in 2 patients non-union occurred. Both of these were very effectively treated by anterior cervical fusion at the C7-T1 level using the Keystone technique, going on to solid union without any postoperative complications. One 79-year-old female with rather extreme deformity went through the operative procedure quite well and was progressing satisfactorily when she suffered a sudden massive pulmonary embolism 19 days postoperatively. She had had a previous fracture contributing to her deformity, however, had gone onto a solid cervical spine. Preoperative halo traction in this woman failed to produce any correction, and the immobilization caused by it likely contributed to her development of pulmonary emboli.

In 36% of the patients, there was evidence of previous cervical fracture and in 31%, the fracture contributed significantly to the final deformity.[2] In the presence of fracture, early recognition and adequate immobilization are essential if the risk of further increase in deformity is to be avoided. If the fracture is still mobile, some correction of the deformity may be obtained through its site. However, if it is solidly united, and the spine fused, the only alternative is correction by surgical means.

One patient, a 61-year-old pharmacist, went through the operative procedure quite well with complete correction of his deformity and no neurological deficit. He progressed well until his third postoperative day, at which time he suffered a massive myocardial infarction and died. One patient progressed well through the initial phase of the operation and at the end of the decompression developed syncope and finally a cardiac arrest. She responded to resuscitation. Aspiration of her heart revealed no evidence of air embolism, and the cause of the arrest was not determined. Since that time a Doppler apparatus has been attached to the patient's chest as part of the monitoring process.

In one patient, re-exploration at 3 weeks postoperatively was required with further resection of the pedicle and decompression of his root on the right side due to a significant compression effect of it.

The experience with the remaining patients has been exceedingly satisfactory with restoration of their neck alignment to the desired position, and the maintenance of the patient's ability to stand and look ahead.

SUMMARY

Patients who present with apparent kyphotic deformity of the spine associated with ankylosing spondylitis may have their main deformity in the hip joints, in the lumbar spine, the thoracic spine, or it may be primarily cervical in situation. If any major correction is to be carried out, then the correction should be done in the area of the main deformity. Deformity in each of these areas is amenable to surgical correction, but this requires a very careful assessment, meticulous preoperative planning, and very precise attention to operative technique to allow reasonably consistent success without major risk to the patient.

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