TRANS-ORAL APPROACH TO THE UPPER CERVICAL SPINE

A REPORT OF 16 CASES

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We report 16 cases in which the upper cervical spine was approached through the mouth for operative decompression and stabilisation, with or without removal of diseased tissues. The indications are discussed and the technique is described. Results are compared with those of other reported series. We believe that this operation has a place in the treatment of certain conditions affecting the upper part of the cervical spine and the foramen magnum, with or without involvement of the medulla and spinal cord.

The uppermost part of the cervical spine has usually been approached surgically from the back, though the limitations imposed by this approach are well known. In particular, difficulty is experienced in dealing with lesions in front of the medulla and spinal cord. Stabilisation by the method of McGraw and Rusch (1973) is quite easily achieved, but this is more difficult when it is necessary to include the occiput in the fusion. Simmons and Du Toit (1978) described an anterolateral approach to the uppermost part of the spine, but this dissection is very difficult.

Southwick and Robinson (1957), in their paper on operative approaches to the vertebral bodies, described a case in which a large osteoma was removed by the trans-oral route from the front of the second and third cervical vertebrae. Thomson and Negus (1948) quoted Coakley as saying that "the majority of cases [of retropharyngeal abscess] can be opened through the mouth with perfect safety".

It was left for Fang and Ong (1962) to establish the place of the trans-oral operation. They described six cases in which the upper cervical vertebrae had been approached through the mouth; in three of these there was traumatic dislocation or fracture-dislocation of the atlanto-axial joint, in two there was recurrent dislocation of unknown cause, and in one there was tuberculous infection of the upper two vertebrae. Five of these patients did well, but one died from infection following damage to the vertebral vessels. In 1970 Thompson reported the results of trans-oral operation in six patients, using cancellous bone to promote fusion. In the same year Bonney reported his results in four cases—those of the first four patients in the present series.

We feel that this procedure has a definite place in the treatment of patients with disease in the anterior part of the uppermost cervical vertebrae, in whom there is evidence of compression of the medulla and spinal cord. In such cases the removal of the diseased area by a posterior approach would be difficult or impossible, while the direct anterior approach had been found by GB to be easier than Simmons' and Du Toit's anterolateral method.

INDICATIONS

The indications for decompression and fusion by the direct anterior approach are considered to be:

1. Disease of the anterior elements of the uppermost cervical vertebrae.
2. Anterior compression of the medulla and spinal cord not susceptible to relief by a posterior approach.
3. Affection of the medulla and spinal cord recurrent after, or not relieved by, posterior decompression.
4. Instability which could not be treated by posterior operation because of disease or absence or inaccessibility of posterior elements.

MATERIAL AND METHODS

Operations are reported on 16 patients—seven men and nine women—between 1965 and 1982 (Table I); their ages at the time of operation ranged from 17 to 66 years (mean 47 years). Thirteen patients showed signs of affection of the spinal cord varying in severity from slight tetraparesis to virtually complete tetraplegia. The primary reason for operation was: in 12 cases, to relieve pressure on the medulla and spinal cord; in three to remove a tumour of the axis, and in one to provide simple stabilisation.

Technique of operation. In all cases a throat swab was taken for the identification of organisms in the pharynx and an appropriate parenteral antibiotic was given before operation and for at least a week after it. Skull

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Table I. Clinical, operative and follow-up details of the 16 patients

Case	Sex	Age (years)	Disease	Tetraparesis	Steroids	Graft	Weeks of traction	Immobilisation		
								Type	Months	Follow-up
1	F	54	Myelomatosis, amyloid disease	Present	No	Cortical, tibial	2	Skull traction, collar	3	3 years
2	M	57	Paget's disease, idiopathic steatorrhoea	Severe	No	Cortical, tibial	2	Skull traction, halo	3	10 years
3	F	55	Rheumatoid arthritis	Mild	Yes	Cortical, tibial		Skull traction	—	—
4	F	56	Secondary breast carcinoma	None	Yes	Cortico-cancellous, tibial*	2	Skull traction, collar	3	3 years
5	F	22	Tuberculosis of atlanto-axial joint	Severe	No	Iliac	2	Halo	3	9 months
6	M	58	Charcot's disease (?)	Moderate	No	Iliac	2	Halo	3	2 years
7	M	36	Polyarteritis nodosa with multiple joint changes	Moderate	Yes	Iliac*	2	Halo	3	2 years
8	M	60	Non-union of hangman's fracture	Present	No	Iliac	2	Halo	3	2 years
9	F	63	Rheumatoid arthritis, intrusion of dens	Present	Yes	Iliac	2	Skull traction, collar	3	27 months
10	F	21	Osteoclastoma of axis	None	No	Iliac*	4	Halo	4	4 years
11	M	17	Basilar impression	Present	No	Iliac	Less than 2	Skull traction, collar	3	6 months
12	F	66	Osteoarthritis of atlanto-axial joint	None	No	Iliac	Less than 2	Skull traction, collar	3	4½ years
13	M	63	Secondary undifferentiated carcinoma of axis	Mild	No	Iliac	2	Skull traction, collar	3	5 months
14	M	59	Rheumatoid arthritis, intrusion of dens	Present	Yes	Iliac	2	Skull traction, halo	3	2 years
15	F	48	Rheumatoid arthritis, intrusion of dens	Present	No	Iliac	Less than 2	Skull traction, halo	3	1 year
16	F	19	Post-traumatic non-union of dens	Severe	No	Iliac	2	Skull traction, halo	3	1 year

* Graft rejected with delayed healing; all others had primary healing

Cured neurologically; died from myeloma

Cured neurologically; later recurrence (died of disease)

Died at 36 hours

Stabilised; died from disease

Cured (adjuvant chemotherapy)

Cured

Cured neurologically; died of disease

Cured

Cured neurologically; soft tissue recurrence (nasopharynx)

Alleviated

Cured

Cured neurologically; died of disease

Cured; meningeal infection

Cured; nasal speech from division of soft palate

Cured

Fig. 1

Diagram of a sagittal section to show the method of approach.

calipers, unless already in place, were applied either before or immediately after the induction of general anaesthesia. Traction of about 5 kg was applied. The patient was then laid supine and a bi-cortical graft was taken from the thickest part of the anterior part of one ilium. In the first four cases tibial bone was used.

The patient was then placed in a half-sitting position and a tracheostomy performed, anaesthesia being continued through the tube. The mouth was opened and held with a Boyle-Davis gag (Fig. 1). Care was taken not to damage the posterior pharyngeal wall or to trap the tongue against the teeth. In one or two cases the mouth could not be fully opened; this is always a possibility in cases of rheumatoid arthritis. The soft palate was divided in the midline, the incision then passing to one or other side of the uvula. The parts of the soft palate were stitched forward (Fig. 2). At this stage, levels in the spine were checked by observation with the image intensifier.

The posterior pharyngeal wall was then divided in the midline from the level of the anterior tubercle of the atlas to the disc between the second and third cervical vertebral bodies. Soft tissues were cleared laterally with knife and rugine from the front of the vertebral bodies (Fig. 3). In cases with intrusion of the dens it was necessary also to clear the lower part of the inferior surface of the basi-occiput, and in two cases the front of the spine had to be cleared below the disc at C2–C3. The atlas and axis can be cleared laterally to expose the lateral joints between these bones, but it is necessary to bear in mind that the vertebral artery is very near at this level. When a graft was needed between the atlas and the second, or second and third, cervical vertebrae, in cases with a tuberculous lesion or a tumour of the body of the axis, diseased tissue was removed, the body of the axis was channelled and the anterior arch of the atlas was decorticated.

One end of the cortico-cancellous graft was forked

Fig. 2

Fig. 3

Diagrams of an anterior view of the pharynx to show the field of operation and the exposure of the uppermost cervical vertebrae.

Fig. 4

Fig. 5

Diagrams of sagittal sections to show the method of stabilisation by graft between the axis and the anterior arch of the atlas. Figure 4—Non-union of fracture of the dens. Figure 5—Tumour of the axis.

Fig. 6

Fig. 7

Fig. 8 ▶

Figure 6—Case 15. Tomogram before operation, showing intrusion of the dens into the foramen magnum. Figure 7—Case 9. Radiograph taken during operation showing the depth of penetration of a high-speed burr. Figure 8—Diagram of a sagittal section to show the method of stabilisation after removal of the dens.

by removal of some medullary bone and it was fitted into the channel in the axis so that the fork embraced the anterior arch of the atlas (Figs 4 and 5). During this insertion, an assistant provided gentle forward counter-pressure on the occipitocervical region. When the graft had been inserted, pressure was removed and skull traction was reduced.

When either the dens had entered the foramen magnum (Fig. 6) or there was irreducible displacement of this part of the bone, the dens was removed by careful use of a high-speed burr, the depth of penetration being checked from time to time by observation with the image intensifier (Fig. 7). Removal of the dens usually necessitated removal of the anterior arch of the atlas, but with extended experience it has proved possible to extract the dens from the foramen magnum using an approach behind the decorticated anterior arch of the atlas. This was done in one recent case which is not included in this series. Rheumatoid pannus between the dens and the posterior surface of the anterior arch can be removed by the same approach.

Adequate removal of bone usually exposed the posterior longitudinal ligament and the dura. Division of the ligament and indeed of the dura is in theory desirable in certain cases, but it is very difficult to open the dura at this level without also opening the arachnoid—and repair of the dura is extremely difficult unless there has been wide removal of bone. It seems undesirable to establish communication between the subarachnoid space and the pharynx, but sometimes this is inevitable. When bone removal seemed to be adequate the situation was reviewed by screening with the image intensifier. The graft is then inserted as described; when the anterior arch of the atlas has been removed, the upper end of the graft must fit on to the basi-occiput (Fig. 8). This does not give as firm fixation as does the “embrace” of the anterior arch.

The field of operation was then sprayed with anti-

biotic powder and the posterior pharyngeal wall was very carefully closed in two layers—muscle and mucosa—with interrupted sutures of an absorbable material and the soft palate was repaired with three layers of interrupted sutures.

Care after operation. Antibiotics were continued. Intravenous feeding was needed for the first 48 hours, after which most patients were able to swallow fluids. For the others, various methods of parenteral nutrition were used, including intravenous feeding by “long line” and, in one case, gastrostomy. A naso-gastric tube was tried but even the improved type of tube seemed to interfere with healing of the pharyngeal incision. It is always difficult to monitor the healing of the pharyngeal wound; the use of the gloved finger is helpful, and in one case a flexible bronchoscope was used to see the nasopharyngeal part of the incision. The cuff of the tracheostomy tube was usually deflated after one week and soon after the tube was replaced by a silver one. The opening was usually allowed to close within two weeks.

The patient was nursed on a “Circoelectric” bed, with skull traction of about 2.5 kg. When it was clear that the wound was healing and that it was possible to discontinue the tracheostomy, the patient was allowed progressively to stand in the bed. A “halo” jacket was then applied. Before the halo jacket was available a plaster halo was used in some cases (Thompson 1962). Later, the operation was done with a halo in position and at the end of the operation the halo was united to a jacket. When this technique is followed the lateral metal rods must be kept out of the line of the x-ray beam, so that it is possible to follow events on the screen of the image intensifier. The halo jacket may be kept on for three months, by which time fusion will have been achieved, or it may be replaced by a moulded polyethylene collar after six weeks. The radiography of this region is not easy and tomography may be necessary to be certain of the situation.

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Case 2. Figure 9—Tomogram before operation, showing the severe deformity of the upper part of the cervical spine and the narrowing of the spinal canal. Figure 10—Radiograph after operation, showing the cortical graft spanning the "bow" of the kyphosis.

ILLUSTRATIVE CASE REPORTS

Case 4 was reported by Laurence in 1969 and the first four cases were reported by Bonney in 1970.

Case 2. A 57-year-old man was referred at the end of 1964 with symptoms of progressive affection of the upper part of the spinal cord. He had extreme kyphosis of the uppermost part of the cervical spine, with marked narrowing of the spinal canal. At operation posterior decompression, including the removal of the posterior margin of the foramen magnum, was carried out; for a time the patient's condition improved. Within months, however, symptoms of cord compression recurred, and by November 1965 there was severe tetraparesis, with urgency of micturition. The patient could not walk. Radiographs showed severe deformity of the upper cervical spine, with much narrowing of the canal just below the foramen magnum (Fig. 9). This progressive deformity of bone was associated with steatorrhoea, but no firm diagnosis of osteomalacia was made.

At operation in March 1966 it was possible to reduce the deformity to some extent by skull traction. A strut of cortical bone was placed between the anterior arch of the atlas and the body of C4 or C5, the gross kyphosis helping to make it possible to cover the large graft. Immobilisation was at first by skull traction and later by halo apparatus. There was primary healing and rapid incorporation of the graft (Fig. 10). The patient made a good recovery from the cord symptoms and by June 1966 was walking well. He remained active until the latter part of 1974, when recurrence and increase of the spinal deformity were accompanied by recurrence of signs indicating compression of the cord. The patient died while arrangements were being made for cervical spinal osteotomy with further decompression.

Case 6. A 58-year-old West Indian man was seen early in 1974 with symptoms of progressive affection of the cervical part of the spinal cord. There was moderately severe tetraparesis, without involvement of the bladder. The VDRL test was positive, but there were no unequivocal clinical signs of neurosyphilis. Radiographs showed subluxation of the atlanto-axial joint with separation of the dens (Fig. 11). It was considered that, though removal of the posterior elements would almost certainly relieve the tetraparesis, stability would be impaired with increased liability to further subluxation. It was decided that the atlanto-axial joint should be stabilised in the first place. At operation in June 1974 a large bi-cortical iliac graft was placed between the atlas and the body of the third cervical vertebra. Skull traction and then a halo apparatus were used.

Recovery was uneventful, with rapid healing and quick fusion and incorporation of the graft (Fig. 12). The signs of affection of the cord diminished steadily, and in June 1976, the patient was walking well and had no symptoms in his arms. In this case the "non-union" of the dens was not associated with any history of injury to the neck. It is possible that the patient was suffering from a Charcot affection of the atlanto-axial joint, but no supporting histological evidence was forthcoming.

Case 6. Figure 11—Tomogram before operation, showing separation of the dens, with marked narrowing of the spinal canal. Figure 12—Radiograph after operation shows large bi-cortical iliac graft between anterior arch of the atlas and body of the third cervical vertebra.

Case 12. A 66-year-old woman complained, in December 1978, of recent onset of constant right cervico-occipital pain, not responding to analgesics. She had undergone mastectomy for carcinoma of the breast in 1963. There were no signs of malignant recurrence in the trunk, but radiography and tomography (Fig. 13) showed changes in the right atlanto-axial joint which could have been caused by a secondary deposit. Her blood count was normal, and her ESR was 26 mm/hr. A bone scan showed markedly increased uptake in the region of the right atlanto-axial joint. Symptoms failed to respond to the use of a collar and operation was considered.

While the evidence was more in favour of degenerative change, the suspicion that there was a secondary deposit remained. Accordingly, a trans-oral approach was planned and at operation in May 1979, the atlanto-axial joints were explored by the anterior route. The changes in the right joint were found to be those of osteoarthritis. The joint was erased and packed with bone chips and an iliac graft was placed between the anterior arch of the atlas and the body of the axis. Histological examination of the tissue removed showed no evidence of carcinoma. Initial immobilisation was by skull traction; later a halo apparatus was fitted and finally a collar was used.

By the end of July 1979, there was radiological evidence of fusion of the atlanto-axial joint (Fig. 14), and to the end of 1983, there had been no recurrence of the original pain. Although the suspicion of malignancy was not confirmed, trans-oral fusion produced rapid healing, rapid fusion and good, lasting relief of symptoms. At no stage were there signs of spinal cord dysfunction.

Case 9. A 63-year-old woman had suffered from rheumatoid arthritis for many years, and had had anterior fusion of C5-6 for subluxation in 1975. In June 1977 she developed long-tract dysfunction, and within weeks was severely tetraparetic and unable to walk. Radiographs showed intrusion of the dens into the foramen magnum (Fig. 15). Skull

Fig. 13

Fig. 14

Case 12. Figure 13—Anteroposterior tomogram showing what was later diagnosed as degenerative change in the right atlanto-axial joint. Figure 14—Radiograph three months after operation, showing fusion of the atlanto-axial joints.

Fig. 15

Fig. 16

Case 9. Figure 15—Lateral tomogram, showing intrusion of the dens. Figure 16—Lateral tomogram after operation, showing that the intruding dens has been removed. The graft is seen between the body of the axis and the basi-occiput.

traction was applied, and in July 1977 the intruded dens was removed by the trans-oral route, the central part of the anterior arch of the atlas being removed to improve access. A graft was placed between the body of the third cervical vertebra and the basi-occiput (Fig. 16). Skull traction was continued and halo immobilisation was used later. There was complete recovery of the cord, and the patient was able to walk out of hospital. She lived for a little over two years after operation; her end was hastened by an accidental injury to the cervical spine.

This is probably one of the first cases in which an intruding dens was removed by the trans-oral route. Since that time, methods of removal and of stabilisation have been improved.

RESULTS

Follow-up of the 16 cases (Table 1) ranged from five months to 10 years. In 13 cases the pharyngeal wound healed by first intention; the tracheostomy was discontinued after two weeks in all but one patient. In 12 cases the graft was well incorporated and stabilisation was achieved. In two of the three cases in which there was delayed healing with partial or complete rejection of the graft, stabilisation was eventually achieved. The remaining patient, whose pain had been greatly relieved by operation, died only five months after operation from the malignancy that had caused the destruction of his axis.

Fig. 17

Case 10. Figure 17—Radiograph before operation, showing destruction of the dens and much of the body of the axis by an osteoclastoma.

Control of tumour. In four patients tumours involved the axis or the atlanto-axial region. One had an osteoclastoma (Fig. 17); two had secondary malignant disease and one had a myeloma. The young girl with an osteoclastoma (Case 10) eventually did well. She had radiotherapy

after operation, but later there was a nasopharyngeal recurrence of the tumour, which was successfully removed. The patient was last reviewed four years after the first operation; she had no symptoms relating to her neck or to her spinal cord, there was no clinical evidence of recurrence and radiographs showed a solid mass of bone in the region formerly occupied by tumour.

The patient (Case 4) whose axis had been destroyed by a secondary deposit from carcinoma of the breast (Laurence 1969) lived for three years after operation. The patient (Case 13) whose axis and dens had been destroyed by a secondary carcinoma, probably from the lung, survived for only five months after operation, though during those five months he had almost complete relief of pain. The patient with myeloma (Case 1) who received adjuvant treatment survived for three years.

Control of other conditions. The patient (Case 5) suffering from tuberculosis did very well after operation with, of course, appropriate antibiotic treatment. So too did the patient (Case 8) who had sustained a fracture through the arch of the axis (Figs 18 and 19). In his case, instability and non-union had followed a prolonged period of traction and every attempt to get him up and about

Fig. 18

Fig. 19

Case 8. Figure 18—Radiograph before operation showing instability of the second on the third cervical vertebra, caused by non-union of a fracture through the arch of the axis. Note the bulge of the posterior pharyngeal wall. Figure 19—After operation. The graft is well shown, the subluxation has been corrected and the vertebrae are stabilised.

caused him to relapse into tetraparesis. He weighed over 100 kg and had a short and massive neck, making it inadvisable to attempt an anterolateral approach to the axis.

Case 12, who had osteoarthritis of the atlanto-axial joint, remains well after four years. Of the five patients treated for intrusion of the dens, three had rheumatoid arthritis, one had basilar impression (Torklus and Gehle 1972) and, in one, intrusion followed non-union of a fracture of the dens. One patient (Case 7) with polyarthritis had severe multiple joint changes; the primary condition could not be controlled, and this led eventually to the patient's death. In Case 2 progression of the disease of bone led to recurrence of tetraplegia and death; Case 3 died soon after operation.

Control of neurological symptoms and signs. Of the 16 patients, 13 showed evidence of affection of the medulla or spinal cord, varying in severity from mild tetraparesis to almost complete tetraplegia. The neurological involvement was relieved completely or partially in all patients

who survived. One patient (Case 7) died prematurely while improvement in cord function was still occurring. In no patient was the affection of the cord made worse; in no case was there evidence of damage to a previously intact cord.

Complications. One patient (Case 3) died within 36 hours of operation. Necropsy revealed no clear cause of death but this may have been related to her long-term steroid therapy for rheumatoid arthritis. Three patients had delayed healing of the pharyngeal wall and in each of them, part or all of the graft was lost. Two of these eventually achieved stability. One failure was due to the upper end of the graft becoming unhitched from the anterior arch of the atlas and slipping forward. In two cases the subarachnoid space was opened during the operation; one of these patients later developed meningitis and the other patient developed hydrocephalus, presumably because of adhesions around the foramen of the fourth ventricle. In the latter case the hydrocephalus was promptly relieved by the introduction of a shunt.

Infection was always a problem in the cases in which the posterior pharyngeal wound broke down, though it is uncertain whether infection or breakdown came first. The division of the soft palate rarely produced problems, though one patient (Case 15) developed nasopharyngeal speech without failure of healing of the palate or other obvious cause. Tracheostomy produced no early or late complications; in particular, there was no case of tracheal stenosis. Complications, and especially infection, were more common in those patients receiving steroid treatment than in the others. One patient died soon after operation, and another seven died a few months to five years postoperatively, most of them from the disease which had caused the cervical disorder, but eight still survive.

DISCUSSION

Trans-oral decompression is not an operation lightly to be undertaken without appropriate indications, or to be undertaken simply as an alternative to posterior operation. The procedure is simple but the risks are high, and the experience must always be distressing for the patient. Prominent among the risks are: infection, damage to the medulla and cord, haemorrhage from a vertebral artery and loss or movement of the graft, with failure of stabilisation. In our series there was no instance of damage to the cord during operation, nor of damage to either vertebral artery. All or part of the graft was lost in three cases.

The rewards of success are very great: relief of tetraparesis, stabilisation by the most direct route and removal of the compressing agent. It is difficult not to believe that the operation is correctly indicated for tetraparesis caused by intrusion of the dens in, for example, rheumatoid arthritis, or for patients with tumour affecting the axis. Certainly too (though neither of us has

seen this rare event), it would be of great use in the case of anterior dislocation of the dens.

In the early cases of this series neither the image intensifier nor the CT scanner was available. The lack of the former made operation infinitely more hazardous; the lack of the latter made it difficult to visualise the situation at and directly below the foramen magnum. In later cases, thanks to these two developments, it has been possible to plan an operation precisely and to carry it out with greatly reduced risk of damage to the spinal cord.

Infection. It seems abhorrent—at least to older orthopaedic surgeons—to approach and to cut bone through a “septic” field. Yet, except in patients on steroid therapy, infection was no great problem. Perhaps the tissues have an acquired resistance to the organisms of the nasopharynx. Those who in former days have removed adenoids will recall how often the curette used to grate on bone. Yet, even in those days before antibiotics, one cannot recall a case of infection of bone. Modern antibiotics are important; certainly it would require a bold heart to enable anyone to undertake this operation without their protection. Meningitis occurred in the two cases in which the dura-arachnoid was opened; in one patient this was overt, in the other its presence was deduced from the occurrence of hydrocephalus. It is perhaps best for orthopaedic surgeons not to open the dura-arachnoid at this site.

The soft palate. It is objectionable to divide the soft palate; other workers (Spetzler *et al.* 1979) have been able to avoid this step by pulling the palate forwards and upwards with rubber slings. We have never found this fully satisfactory, and have always resorted to division. Careful repair of the soft palate seems to be effective in most cases in preventing sequelae such as nasal speech and nasopharyngeal reflux. It appears to be unwise to split the uvula; in the sole case in which this was done repair was followed by necrosis. This is no great loss, for uvulectomy was once practised for the relief of snoring, but necrosis could be the beginning of infection.

Tracheostomy. We were not bold enough to dispense with tracheostomy, and in fact no complications of this were encountered. However, it must be a distressing experience for the patient, and it should be noted that others (Spetzler *et al.* 1979) have found it possible to dispense with this procedure.

The nature of the graft. Crockard and his colleagues preferred to decompress anteriorly and to stabilise posteriorly (Crockard *et al.* 1985) but we have continued to aim at achieving both through a single anterior approach. Certainly the mechanical stability of a well-placed anterior graft is excellent. Will it survive? The answer seems to be that it will, so long as it is well placed and well covered. It was too bold to use tibial bone; the “sandwich” graft of iliac bone is to be preferred. It may be that for a patient on steroid therapy it is best to rely on erosion of the facet joints and medullary chip grafts, rather than introducing a relatively large piece of bone.

We were never bold enough to introduce foreign material, though the idea of fixation with a metal screw is very attractive. Barbour (1971) used internal fixation, but his approach was not through the pharynx.

With the soft palate divided and retracted, access to the back of the pharynx is very good. Haemorrhage from the divided posterior pharyngeal wall is controlled quite easily; identification of level is made certain by the use of the image intensifier. Good retraction of the divided posterior pharyngeal wall is important. A suitable type of long-bladed retractor was once designed by GB but never made. A high-speed burr is very useful, though great care must be exercised with regard to the depth of penetration—this can be controlled by inspection of the area with the image intensifier. Selman, Spetzler and Brown (1981) described a technique for estimating the depth of penetration by the use of the image intensifier after the introduction of contrast medium. The same workers report the use of an operating microscope in this field; clearly, depth of penetration and proximity of the dura would be well checked by this method. It would also make possible the use of microsurgical techniques for the repair of dural injuries.

The monitoring of spinal cord function has been used in this field of surgery (Mirra *et al.* 1981) and is clearly a valuable safeguard. Experience of one case of cord involvement, at a lower level in the cervical spine, suggests that impairment of cord function before operation may prevent the production of tracings, though no such difficulty would be expected in a case with intact cord function before operation.

Although technical advances continue to make trans-oral decompression and fusion an increasingly safe operation, it is likely that its use will remain restricted. In a hospital to which suitable patients were referred by other consultants, such an operation was needed, on average, once a year. Its use will doubtless remain restricted, but in certain circumstances it is the operation that reaches the parts that other operations cannot.

It must be stressed, however, that in this difficult and dangerous field for surgery, all concerned must act with the utmost care and with the most considered judgement if complications are to be avoided. The experience is doubtless distressing for the patient, and he or she has the right to expect full explanation at all stages and care of the highest quality before, during and after operation.

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