INTRACTABLE HEADACHE AND CERVICO-BRACHIALGIA TREATED BY COMPLETE REPLACEMENT OF CERVICAL INTERVERTEBRAL DISCS WITH A METAL PROSTHESIS

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The relief of severe disabling neck pain owing to cervical spondylosis, with its common complications of brachialgia, and recurrent or sometimes continuous headache, both in the suboccipital and retro-orbital regions of the head, is frequently a surgical problem, when the usual conservative measures fail.

Cervical Spondylosis

Cervical spondylosis is very common and is the cause of symptoms in a large number of people over the age of 45. Kellgreen and Lawrence, as quoted by Lord Brain,[1] found radiological evidence of disc degeneration in over 80% of persons after the age of 55 in a large series of cases investigated.

He states specifically 'Headache is one of the commonest presenting symptoms in cervical spondylosis'.

Raney *et al.*[2] described headache as the outstanding symptom in numerous cases of cervical disc prolapse, and Smith and Robinson[3] also record that disc degeneration is a cause of 'occipital and hemicranial headaches'.

Some of the symptoms of cervical spondylosis can be explained on an anatomical basis.

(a) *Paracentral osteophytes,* arising from the Luschka and zygapophyseal (paravertebral) joints, encroach on the intervertebral foramen and give rise to pain in the neck and brachial radiculitis. If compression of the nerve root is severe, then wasting and weakness of the muscles of the arm and hand, associated with paraesthesia and reflex changes, will occur.

(b) *Centrally placed posterior osteophytes or bars.* These can interfere with cord function, with the production of spastic paraparesis. As myelopathy increases, the patient will become progressively incapacitated, with increased muscular tonus and hyperflexion, absent abdominal and cremasteric reflexes, and a positive Babinski sign. The patient gradually loses control over his legs although muscle power is at first interfered with only slightly.

(c) *Degenerative changes in the intervertebral disc.* The nucleus pulposus may either be absorbed and desiccated, or herniated backwards, where it can cause symptoms by direct pressure on the cord or nerve roots. When there is marked loss of disc height the bony rims of adjacent vertebral bodies actually come into direct contact with each other, and can pinch the annulus fibrosis, which is exceedingly pain-sensitive and contains sympathetic nerve endings supplied by the sinu-vertebral nerve. This direct weight-bearing and friction between the vertebral rims, which should be well separated by the internal pressure of the normal nucleus pulposus, is a likely cause of the osteophytes which form around the periphery of the disc in advanced cases. Apart from the well-known symptoms of brachialgia or brachial neuritis and pain in the neck, these changes are an exceedingly common cause of intractable headaches, which are often labelled 'congenital migraine' and treated as such.

Characteristically, the cervical spondylotic headache awakens the patient from sleep, often at a constant time in the early morning, is dull and starts in the suboccipital region but frequently spreads to the back of the eyes, where it can become throbbing in nature and of unbearable severity. It may be completely unilateral, and then resembles a typical 'classical migraine' or hemicrania. At first the attacks are intermittent or paroxysmal, but in long-standing cases the headache and neck pain are sometimes continuously present. Most patients will note that they are reasonably well while upright, but symptoms commence soon after lying down and they cannot get the head and neck in a comfortable position on a pillow. The mechanism of producing headache owing to disc degeneration is unknown. We have seen severe frontal headache of many years' duration completely cured by surgical treatment to a single disc as low as C7 - D1 level.

(d) *Vertebral artery compression or irritation.* Hutchinson and Yates[4] drew attention to the effect of narrowing of the vertebral artery upon the cerebral circulation as a whole. In spondylotic spines osteophytes from the Luschka joints project laterally and can interfere markedly with the cerebral circulation. The occurrence of brain stem infarction with a fatal outcome after osteopathic manipulation has been recorded many times.[5] Involvement of the vertebral artery must be suspected in all cases of tinnitus, vertigo, deafness and unsteadiness on the feet, owing to interference with the blood supply to the labyrinth. Attacks of unconsciousness, 'drop attacks', transient visual disturbances, homonomous hemianopia and transient weakness of one or other side of the body can be explained by the direct effect of a mechanical reduction of vertebral blood flow in the cerebral circulation. Kovacs[6] has demonstrated that compression of the vertebral artery by subluxation at the paravertebral joints is a frequent cause of severe headache. Our treatment of choice in these cases, is the vertebral artery decompression operation, as described by Jung.[7]

REASONS FOR ATTEMPTING ARTHROPLASTY OF CERVICAL SPINE

The only certain method of relieving all pain in a degenerated joint anywhere in the body, is excision and bony fusion, but the two penalties which must always be paid are the loss of movement at the joint and the effects of considerable additional strain, which is then imposed on adjacent joints. The most typical example is in the case of the hip joint, where the satisfactory relief of pain after arthrodesis is so often marred by the onset of lumbar backache, especially in patients past middle age and with a slight degree of lumbar spondylosis already present. In the cervical spine the Cloward or the Smith and Robinson type of anterior fusion is a procedure which is gaining in popularity all over the world, but the same problem arises —if the patient is young and only one level is fused the prognosis is excellent, but when the patient is over 45 and 2 or more levels require fusion, then the excellent immediate relief of pain is often followed by relapse later owing to the very considerable increased strain imposed

on adjacent levels (Fig. 1).

The incidence of satisfactory results following anterior cervical fusion has been shown to diminish rapidly as the number of levels fused increases. Harris and Smith[8] state 'Of the 25 one-level fusions, results were excellent in 13, good in 4, poor in 8. An additional anterior fusion was done at another level in 6, with unsatisfactory results in all. Two-level fusions were done on 13 patients, with excellent results in only 4. Additional anterior fusion at another level was undertaken in 4 patients graded poor, and the result was unsatisfactory in all.'

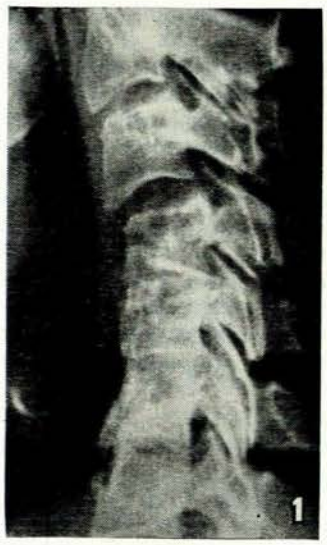


Fig. 1. Firm bony fusion at all 3 levels where anterior interbody fusion had been performed and a marked forward subluxation at the first level above the fusion.

Robinson *et al.*[9] also note a rapid decline in satisfactory results with the increase in number of cervical levels fused. In taking excellent and good results together as one figure, they claim 91% following one-level fusions, 73% after two-level fusions, and only 50% after three-level fusions. Cloward[10] has published X-rays of a case in which fusion at one level at C4 - 5 was followed by 'recurrent neck, shoulder and arm pain due to fresh rupture of C5 - 6 disc demonstrated by discography', and X-rays of another case of fusion at two levels from C4 to C6 where 'progressive degeneration of C6 to C7 disc necessitated later fusion of this joint'.

Harmon[11] was the first to replace lumbar intervertebral discs with a spherical prosthesis in 1957, but he abandoned arthroplasty in favour of interbody fusion by the anterior route.

Fernström[12] has replaced more than 100 lumbar intervertebral discs with a spherical metal prosthesis, using the posterior approach. We have both visited Fernström in Uddevalla, Sweden, and have been favourably impressed by his results.

Operative Procedure

The vertebral bodies and discs are exposed by the Cloward routine anterior approach, which we have had the opportunity of seeing Cloward perform. The entire nucleus pulposus and annulus fibrosis are then curetted out and excised until the coarse longitudinal fibres of the posterior longitudinal ligament are plainly visible. The symptom-producing osteophytes are removed, and in cases with Luschka joint osteophytes and vertebral artery symptoms, the artery is completely released from its bony rings and retracted laterally before these osteophytes can be excised.

A completely spherical metal-ball prosthesis is then inserted into matching excavations in the vertebral bodies, and the size of the prosthesis is carefully chosen.

The degree to which a flattened disc should be restored, is sometimes a difficult problem. It can often easily be restored to its normal height by inserting a large enough sphere, but this may not be in the best interests of the zygapophyseal joints, which may have adapted themselves to the loss of disc space occurring slowly over a period of many years.

The first and most obvious criticism of the procedure is usually that the surface area of end-plate in contact with the sphere is too small to allow full weight-bearing without collapse of the bone owing to pressure. Some degree of intrusion of the spheres into the bone does undoubtedly occur, but usually this has been exceedingly little, even in lumbar implants that have been in position for more than 2 years. In only two of our cervical cases have we noted a distinct intrusion of the sphere into the bone, but in both the clinical result remained excellent, with no recurrence of headache or neck pain.

The reason why intrusion of the prosthesis into the bone has nearly always been minimal, may be the fact that the prosthesis does not take the entire load—a large proportion is taken by the zygapophyseal joints and by the scar tissue that forms between the vertebral bodies around the prosthesis. It probably sinks into the bone only until these other structures begin to take their share of weight-bearing.

The matching hollows made after removal of the hyaline cartilage endplate does not weaken the vertebral body, because this surface, which lies inside the bony rim, is not covered by any cortical bone whatsoever. When the cartilage is scraped away, the open pores of the cancellous bone of the vertebral body can be seen quite clearly, except when there is subchondral sclerosis from gross disc collapse.

The second objection to the procedure has been the danger of posterior prolapse of the prosthesis into the spinal canal. When the front of the disc is forcibly spread open it is clearly seen that the posterior ligaments prevent the separation of the adjacent posterior surfaces of the vertebral bodies for more than one-sixteenth of an inch, and this barrier, plus the fact that the spheres are usually well recessed into the bones, make posterior displacement of the sphere virtually impossible.

The dramatic relief of pain that we have seen following this procedure probably results partly from reducing the abnormal load imposed on the zygapophyseal joints by the collapse of the disc space, and the absolute prevention of anterior and posterior gliding between the vertebral bodies, which is usually described as subluxation, listhesis, or spinal instability and is generally accepted as an abnormal movement which strains the elongated ligaments and zygapophyseal joints alike. The restoration of at least some of the lost disc height is also of vital importance (Figs. 2 - 5).

Neck-halter traction is the commonest conservative treatment and often produces excellent relief of pain, but this is sometimes only temporary. The mechanism of this effect is probably simply a restoration of disc height with relief of direct bony pinching of the annulus between the vertebral bodies, and relief of direct pressure on the nerve roots in the intervertebral foramina as well as a possible relief of nerve root ischaemia and of venous congestion. This theoretical restoration of disc height by traction is so slight that it cannot generally be demonstrated radiologic-

ally. After the insertion of the ball prosthesis, however, very considerable restoration of disc height is clearly seen in the lateral views (Fig. 4b), and the problem has actually been to avoid overdoing this restoration. In the majority of our cases, there was obvious degeneration of the discs as seen on plain lateral films, but it must be stressed that several cases showed no disc degeneration and no cervical arthrosis whatsoever on routine X-ray examination and the symptom-producing levels were only identified by discography, without which it would have been quite impossible to establish which levels required operative treatment.

ILLUSTRATIVE CASES

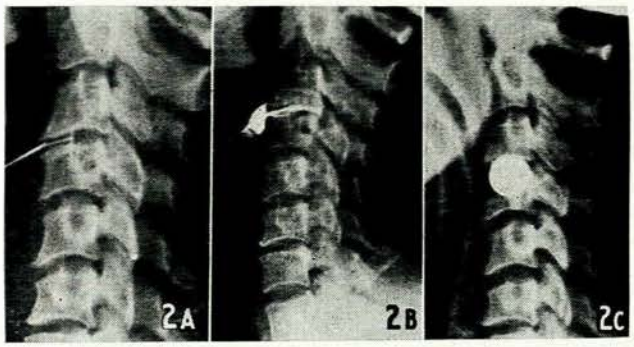
Case 1

Mrs. M.M.M. Aged 50 years. Chronic headache and neck pain for many years. Anterior interbody fusion at 3 levels performed on 10 May 1963. The patient obtained complete relief of headache, but this lasted less than a month and then recurred as severely as before. X-ray taken on 13 May 1964 (Fig. 1) shows firm bony fusion at all 3 levels, and a marked forward subluxation owing to excessive strain at the first level above the fusion (C3/4). An illustration of a case with identical appearance has been published by Cloward.[10]

Case 2

Mrs. F.J. Aged 33 years. Involved in a riding accident 18 years ago. Unilateral right-sided occipital and frontal headaches started soon afterwards. Pain spread to the right side of the face, and during the past 3 months became very severe and radiated down the right arm. Neurological examination including cerebral angiogram and air encephalogram, was negative.

Discogram needle centred in C3/4 disc is shown in Fig. 2a. There is loss of disc height and slight anterior osteophyte formation at several levels.



Figs. 2A, B, C. See text.

Injection of radio-opaque water-soluble fluid showed degeneration and instantly reproduced her typical unilateral frontal headache and pain in the face (Fig. 2b). Injection of other levels showed degeneration but did not reproduce her pain.

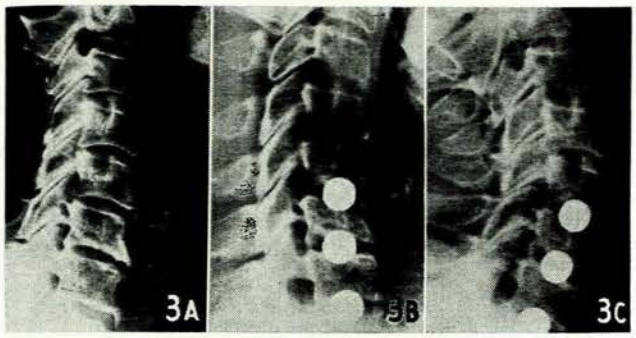
Lateral view X-ray taken at operation on 18 November 1963 showed spherical prosthesis in position (Fig. 2c).

16 days after operation the patient wrote on her own initiative, 'Today I have packed crockery for my move to a new house, done some Christmas shopping, all over shocking roads, without any pain at all. To me it is a miracle, after over 12 years of constant pain'. She was last interviewed on 28 May 1964, and was still completely free of pain, and stress X-rays showed a good range of movement at the arthroplasty.

Case 3

Mrs. H.H. Aged 62 years. Pain in the neck and right arm and severe headaches for 3 years. Pain practically continuous for past few months. Clinical examination was essentially negative, but neck movements were exceedingly painful. Arthroplasty at 3 levels performed on 18 December 1963, with immediate complete relief.

Lateral view X-ray before operation showed marked loss of disc height and anterior sharp beak-like osteophytes, at 3 levels (Fig. 3a).



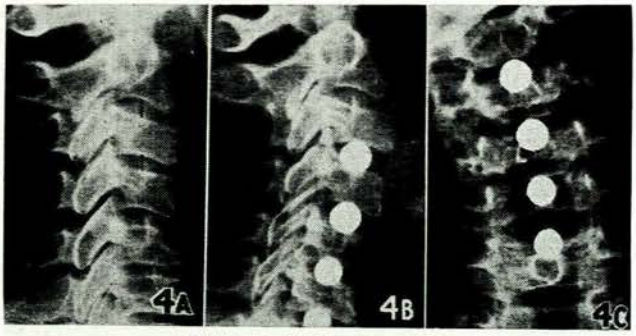
Figs. 3A, B, C. See text.

Stress views in flexion and extension taken on 25 May 1964 are shown in Figs. 3b and c. Note the increase in disc height especially at C6 - 7 level. The separation of the tips of the spinous processes in flexion, compared with that in extension, increased by 5 mm., 9 mm., and 5 mm. respectively at these 3 levels, indicating a fair range of movement at the prostheses. She is still completely free of headache and all neck and arm pain owing to the cervical spondylosis.

Case 4

Mrs. A.N.G. Aged 45 years. Severe occipital and frontal headaches followed a car accident 5 years ago. For the past 3 years the headache and neck pain were present continuously.

Lateral view X-ray showed gross disc degeneration and large osteophytes at C5/6 and C6/7 only, with a relatively normal appearance at the upper 3 discs (Fig. 4a). Discography



Figs. 4A, B, C. See text.

performed on all 5 cervical discs, produced no pain at the grossly arthritic C5/6 and C6/7 levels, which were probably completely asymptomatic, but instantly reproduced her typical headache both at C3/4 and C4/5 levels. At operation on 25 March 1964 the 4 lower discs were replaced with spherical prostheses.

Well marked increase of disc height is shown in Fig. 4b and a good range of lateral flexibility is demonstrated in Fig. 4c. She obtained immediate relief, and later stated 'When I regained consciousness, I knew something was missing. It was like a fairy story. My headache was gone. For the first time in 5 years I had no pain in the head'.

Case 5

Miss S.M.N. Aged 33 years. In 1960 she was involved in a car accident and sustained a whiplash injury to her neck, as

well as concussion with unconsciousness for half an hour. Severe headaches started immediately afterwards, usually in attacks which lasted continuously for 3 or 4 days. The headaches were at first thought to be due to a post-concussion syndrome. X-ray examination showed no spondylosis and no loss of disc space. Discography immediately reproduced her typical unilateral pain behind the right eye, severely at 1 level and slightly at 2 more levels. This lateral view taken at operation shows the prostheses in position at 3 levels between C3 and C6. She was asked to write out a full description of her symptoms in her own words, which she did immediately before the operation. 'I have been suffering from headaches continuously since my accident 3 years ago. The pain starts at the back of the head (the right side) and spreads to the top of the head and behind the eyes. It burns so severely that on occasions I become bilious. The pain at times lasts for 3 days and I find it very difficult to get comfortable at night. I take no pain pills. The severe pain occurs approximately every 10 days. On occasion the pain is slight. All in all about 2 or 3 days a week I might not have a headache. My neck pains when I turn to either side and also backwards and forwards—the bottom part of the neck, and the shoulders hurt. I also have pain in my arms, and pins and needles and cramp in my right hand. The pain in the arms is just shooting pains. My neck gets very tired and I sometimes feel I cannot hold my head up and have to rest it on my hands. The neck aches particularly on the right side and mostly when I have had a very busy day at work and have not been able to relax.'

The patient obtained complete relief of headache and arm pain following operation, and she also stated specifically that the extreme tiredness and the feeling that her head was too heavy for her neck was completely relieved. At a recent examination, there was no recurrence and her only complaint was of some fibrositic pain in the trapezius muscles (Fig. 5).

Case 6

Mr. R.W.R. Aged 30 years. Severe low backache and sciatica, unrelieved by laminectomy. After the implant operation on 24 March 1964 he obtained immediate relief and was ambulant within 48 hours.

RESULTS

To date (10 June 1964) we have performed a total of 75 cervical disc arthroplasties with the spherical prosthesis, on 32 patients. We have also implanted the same prosthesis in 19 lumbar discs in 12 patients, for discogenic backache and sciatica (Fig. 6).

This series started in November 1963, which is naturally too recent to enable any final conclusions to be drawn, but we can definitely state that the clinical results so far have been infinitely better than our past experiences over many years with spinal fusion procedures. Intractable headache, sometimes of more than 20 years' duration, has been completely relieved in nearly every instance, and so far no case has relapsed. The majority of cases were ambulant on the first or second postoperative day, and the average postoperative period of hospitalization has been 4 days. Two cases left hospital less than 48 hours after operation, and several patients exhibited a conspicuous euphoria, which is understandable after sudden relief of severe and continuous pain of long standing. A complete review of these cases not less than 2 years after operation will give some indication of the long-term prognosis. Harmon has several 7-year follow-up results after lumbar implantation, with remarkably good function and freedom from pain still present.

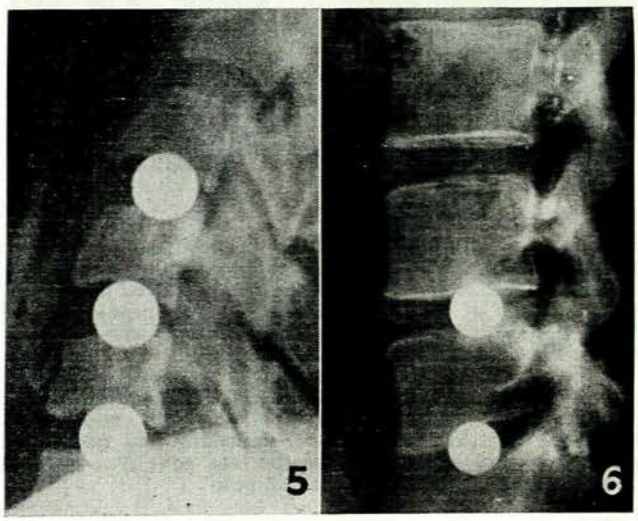


Fig. 5. See text (under 'Illustrative cases').
Fig. 6. See text.

In cases in which pain recurs after a solid bony arthrodesis, the problem is frequently insoluble. Even if multiple levels have already been fused, the only procedure which then remains, and is often done, is the operative fusion of still more levels.

Arthroplasty however, is a much less destructive procedure, and as demonstrated by Coventry[13] in the case of the hip joint, if pain should recur some years later it is exceedingly likely that it can be treated successfully by a comparatively simple surgical revision of the arthroplasty with a larger or better prosthesis, or as a last resort by a localized fusion operation, which is currently the commonest method for the cervical spine.

SUMMARY

1. An arthroplasty of the cervical spine using a spherical metal prosthesis is described which preserves the mobility of the intervertebral joints, thus obviating the inherent disadvantages of all fusion procedures.

2. The operation has been performed on 75 cervical intervertebral discs in 32 cases, without neurological complications and with no signs of irritation or infection at the implants.

3. The immediate postoperative results have been exceptionally good, and in our opinion infinitely better than after arthrodesis.

4. A follow-up study at least 2 years after operation may give some indication of the long-term prognosis.

5. The procedure is much less destructive than an arthrodesis, and if symptoms should recur after several years, a surgical revision of the arthroplasty, as commonly performed in the case of the hip joint, is quite feasible.

6. Discography usually reproduces the patient's typical headache and neck pain and localizes the symptom-producing levels, which are often not the obviously arthritic levels. It is especially valuable in cases with chronic headache with normal, or nearly normal, plain X-ray appearances and relatively little complaint of neck pain and brachialgia.

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