It can be argued that, given enough time, the natural resistance of the children would have succeeded in eliminating the streptococci from the infected tonsils, and that, even if the infection persisted indefinitely, there is no direct evidence that a tonsillar carrier of pathogenic streptococci suffers any disturbance in health. In the three instances in which there is certain evidence of the date of the original infection it could be shown that this had persisted for from four to five months and that the cocci were still present in large numbers at operation. We have no definite information as to the duration of infection with types other than Type 2. But since from four to eight weeks usually elapsed between the recommendation for operation and its actual performance, and in most cases symptoms had been present for weeks or months before operation was advised, the presumption is that if these symptoms were due to streptococcal infection of the tonsils spontaneous cure had not occurred.

Chronic tonsillar carriers of diphtheria bacilli do not suffer any apparent ill effects from continued absorption of toxin if it occurs. Such evidence is also lacking in regard to chronic streptococcal infections of the tonsils, apart from their debatable relation to rheumatic conditions. Group A streptococci produce erythrogenic toxin *in vitro*, whether they are commonly associated with scarlet fever or not, though there is a certain amount of direct and indirect evidence that strains of types commonly causing scarlet fever are more powerful toxin producers (Allison, 1932). The chronic nasal diphtheria carrier often has a persistent sanguineous nasal discharge, usually without any noticeable constitutional upset. Perhaps the child with chronic streptococcal tonsillitis suffers a roughly comparable inconvenience. Were the chronic diphtheritic rhinitis curable by as simple an operation as tonsillectomy the indication for such treatment would be strong, from the point of view of both benefit to the child and elimination of a carrier. Chronic streptococcal carriers must menace the health of other children, and we know of instances where they have been the origin of cases of scarlet fever. It would be premature to recommend tonsillectomy on these grounds alone, except in special circumstances.

The preceding remarks refer only to the children—from a half to a third of the total—from whose tonsils streptococci were isolated. It has been urged by various writers that not only are a number of tonsillectomies carried out when the symptoms are in reality due to sinusitis, but, further, that the chronic infection of the tonsils is caused by reinfection from the sinus secretions. We wish only to discuss whether such a process could account for the high proportion of streptococcal tonsillar infections in this series. Simultaneously with this investigation of the tonsils, McInnes, at these laboratories, has been studying the bacterial flora of acute and chronic infections of the maxillary antrum. Out of 100 consecutive cases haemolytic streptococci were isolated on only five occasions, and only two of the five strains belonged to Group A. It is unlikely, therefore, that the tonsillar infection with streptococci is secondary to streptococcal antral infection.

The above should not be construed as a panegyric on routine tonsillectomy. In Melbourne about 17 per cent. of children of school age have lost their tonsils, as compared with 50 per cent. in the English "public" schools, and of these 17 per cent. probably not more than a third could ever have been classed as streptococcal carriers. The deductions from the data form a working hypothesis for further investigations on these lines, in which we shall attempt to correlate the clinical, bacteriological, and histopathological findings.

Summary

Group A haemolytic streptococci were isolated from 50 per cent. of a group of tonsils removed at operation in Melbourne, but from only 4.5 per cent. of throat swabs from healthy children and adults.

Haemolytic streptococci of others groups (B, C, G), which are rarely the cause of serious human infections, were recovered from 22 per cent. of the tonsils and from 13 per cent. of the throat swabs of the healthy group.

The significance of these findings is discussed in relation to the indications for tonsillectomy.

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RETROPULSION OF THE NUCLEUS PULPOSUS

A CRITICAL REVIEW

BY

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There should be a close season for the writing of articles. This would provide a breathing space in which the new ideas could be digested and the new operative procedures considered thoroughly from their theoretical aspects before embarking on the practice of them. Orthopaedic surgery is in great need of this close season. With the change from the use of hands and simple apparatus to the use of pneumatic hammers and mechanical marvels of rare alloys—a change, as it were, from the white coat to the boiler suit—there has resulted a flux of articles, mostly advocating some bolder, and therefore better, operative procedure. I, fortunately, have had enough leisure to examine in some detail the claims of a new procedure.

Before operating I decided to solve certain questions. These were: Can retropulsion of the nucleus pulposus cause symptoms? If it can, is laminectomy the only treatment? Are the results of laminectomy such as to justify operation? A study of the main articles on the subject revealed certain surprising facts which are the subject of this essay. The articles under review are:

- I. Mixer and Barr (1934). *New Eng. J. Med.*, **211**, 210.
- II. Mixer and Ayer (1935). *Ibid.*, **213**, 385.
- III. Barr (1937). *J. Bone Jt. Surg.*, **19**, 323.
- IV. Barr, Hampton, and Mixer (1937). *J. Amer. med. Ass.*, **109**, 1265.
- V. Mixer (1937). *Ann. Surg.*, **106**, 777.
- VI. Barr (1938). *British Medical Journal*, **2**, 1247.
- VII. Live and Camp (1937). *J. Bone Jt. Surg.*, **19**, 776.

The first six articles deal with a gradually increasing number of cases under the care of the same group of Boston authors, each article including the previously recorded cases in the series. I propose to refer to statements in these articles, and I shall then give the number of the article, the page, and the column for easy verification.

Can the Retropulsion cause Symptoms?

That retropulsion of the nucleus pulposus does occur is quite true. Andrae, working with Schmorl, found it in 15.2 per cent. of all spines. It must therefore be shown

conclusively that the retropulsion actually causes the symptoms and is not merely an incidental finding.

AETIOLOGY

The condition is supposed to be traumatic in origin. In the first series there were nineteen cases, eight (41.2 per cent.) with a history, five of them of recent trauma (I, table opposite page 210). In the second series the percentage was 41.2—that is, fourteen out of thirty-four, seven having a recent trauma (II, page 386, column i). In the third series, which, of course, included the first two, the percentage had unaccountably risen to 77.5—that is, thirty-one out of forty, twenty-one having a recent trauma (III, 328). The percentage was given as about 80, with 50 per cent. of recent trauma, in the fourth article (IV, 1265, ii); became “about 60 per cent. of these cases will give a history of trauma at, or shortly before, the onset” in the fifth (V, 777); and returned to 80 per cent., with 50 per cent. of recent trauma, in the sixth article (VI, 1248). Love and Camp do not believe trauma to be an important aetiological factor, and give no details of its incidence in their cases.

AGE OF PATIENTS

Mixter and Barr's average was 39.3 years (I, table, 210). The second article does not give an average, but states that the youngest patient was 20, the oldest 64, and that two-thirds were between 30 and 50 (II, 386, i). Barr, in his series, while including the previous cases, seems to have forgotten the patient of 64, for he gives the ages as varying from 20 to 58, with an average of 37 (III, 327). The next article has the same average of 37 (IV, 1266, i). The ages are not stated in the next two articles. Love and Camp give the average age of their patients as 39.8. We may therefore take it that the average age of all the patients was about forty years. This is of great significance, because at this age, or even many years before, it is rare to find a “normal” disk among “normal” people if we take the adolescent spine as the “normal” (cp. Beadle (1931), *Med. Res. Cncl. Spec. Rep. Ser. No. 161*, p. 32). This must raise doubts again as to whether any disk lesion may not be incidental rather than causative of symptoms.

SYMPTOMS AND SIGNS

The main symptom is pain, but pain differing in no way from the ordinary case of “sciatica” or “low back ache.” It has a certain remarkable peculiarity: the distribution bears no relation to the nerve root alleged to be pressed upon. All cases had pain in the postero-lateral area of the thigh—that is, the second sacral dermatome (III, 329). “The areas of referred pain were identical no matter whether the fifth lumbar or first sacral nerve was involved” (III, 330). Where there was loss of sensation this also did not occur in the expected dermatome. In view of Foerster's work one would not expect to find any loss of sensation in pressure on a nerve root. Once again, is the incidental finding being mistaken for the causative factor?

Muscular weakness and paralysis were found in the first series (I, table, 210). The authors of the second paper say that the “weakness is more apparent than real, due to the protective spasm. Yet flaccid weakness and rarely paralysis were definitely observed in six patients, a unilateral foot-drop being a rare but striking finding” (II, 387, i). Still more striking were the cases of Barr: “In one instance one foot was essentially flail. In one case the gastrocnemius was the only muscle involved” (III, 332). On anatomical grounds it would be difficult to explain how pressure on a nerve root could cause a flail foot; it would be even more difficult to explain how it could cause an isolated muscle paralysis.

If symptoms are due to pressure on a nerve root it is difficult to conceive of its causing intermittent symptoms. “Symptoms have remained unilateral and have been intermittent over a period of months or years, the patient

enjoying relatively good health between attacks” (II, 387, ii). Barr (III, 329, and VI, 1248) says that 40 per cent. have remissions. “Almost half had a history of remissions and exacerbations” (IV, 1265, ii). “The pain comes in attacks and there may be long remissions” (V, 778).

The only significant change in the tendon reflexes is a loss of the ankle-jerk in 40 to 50 per cent. of cases—no matter which nerve root is affected. Mixter and Ayer say that “occasionally the knee-jerk was sluggish” (II, 387, i). Barr included these cases in his later series, yet says that the knee-jerks were normal in every instance (III, 331).

In the cervical cases of Mixter and Ayer there was a dynamic block in the cerebrospinal fluid in seven out of the eight cases, but it was “always partial and sometimes very slight indeed” (II, 389, ii). Yet this series contained Mixter and Barr's cases in which there was one complete block (I, table, 210). A co-ordination committee appears to be required in Boston.

The first significant pathological finding is a raised protein content of the cerebrospinal fluid. “Every fluid showed an elevation of its protein content. The amounts were between 56 and 91 mg. per 100 c.cm.” (II, 387, ii). Perusal of the table in the first article raises doubts as to whether this is completely accurate, while the later articles reveal a normal protein content in from 12.5 (III, 334) to 15 per cent. (VI, 1248) of cases. The following point must be stressed: “The causes of a total protein content above normal limits need further investigation. We have records of twenty-one unoperated-upon cases that were subjected to lipiodol examination with negative findings. In four the total protein was below 40 mg. per 100 c.cm. and in seventeen the elevated protein content has not been explained satisfactorily” (V, 779). Is the raised protein in the operated-upon cases also a coincidence?

The direct radiograph is of no value. Intrathecal lipiodol examination reveals deformation of the dorsal sac shadow in the Boston series, but “a broadening of the nerve root shadows or displacement or deformity of the nerve root shadows” is looked for by the Mayo Clinic authors—Love and Camp. The true appearance of a disk lesion is therefore not clear. Whether the pictures reveal real pathology or merely incidental markings is even less clear.

DIFFERENTIAL DIAGNOSIS

Love and Camp sum up this question by saying that “there are no physical, neurological, or orthopaedic signs which are found alone in protrusions of the intervertebral disks. All of the known signs may also be found in other conditions.” Other conditions were, however, considered. Thus we find Mixter and Ayer stating that “in several [cervical] cases a diagnosis of multiple sclerosis was considered until the demonstration of block [by lipiodol] made that diagnosis untenable” (II, 390, i). Lest it be thought strange that there should be any confusion between multiple sclerosis and pressure on a nerve root or on the spinal cord, I must add that Love and Camp also seem to have found difficulty even in their lumbar cases, for they write: “Usually there is a paucity of neurological findings in cases of protrusions of the disks, but in some there is definite and well-marked evidence of disease of the spinal cord. In some of these cases the clinical picture may be that of syringomyelia or multiple sclerosis. In one of our cases at the clinic, because of an associated severe diabetes mellitus, the diagnosis of diabetic neuritis was entertained until fluoroscopic study with lipiodol settled the question.” We are not told how this confusion between pressure on a nerve root and the symptoms and signs of disseminated sclerosis or the dissociated anaesthesia, etc., of syringomyelia can arise.

Thoughts about the danger of confusing causative factors with incidental findings are bound to arise when we consider certain cases. Mixter and Ayer, for example, found matting of the roots of the cauda equina in one of their cases; Love and Camp found two cases of tumour

in addition to the retropulsion. Again, Love and Camp had six cases of multiple lesions: one case had lesions of all disks between the eleventh dorsal and fifth lumbar vertebrae. We are not given the symptoms and signs in these cases, so we cannot discover which disk was responsible for symptoms and which were incidental findings. Case 5 of Mixter and Barr's series (I, table, 210) is that of a woman aged 53. There was no history of trauma. She complained of numbness and stiffness of the legs. She had incontinence and a complete motor and sensory paraplegia. There was a partial dynamic block of spinal fluid. The total protein in the cerebrospinal fluid was 37 mg. per 100 c.cm. A direct radiograph showed calcification in the disk between the fourth and fifth dorsal vertebrae. Lipiodol examination was not performed and operation was not allowed. She died later, and necropsy revealed calcification in a posteriorly prolapsed nucleus pulposus at the expected level. The patient, however, died of pernicious anaemia. Could this have really been a case of subacute combined degeneration of the cord, and the retropulsion merely an incidental finding—one of the 15.2 per cent.?

Treatment and End-results

Mixter and Ayer, in the second paper, report negative findings at laminectomy after negative lipiodol examination; yet Barr, while including these cases in his series, says that at operation the retropulsion was found in all cases. The next paper, however, states: "One exploration after a positive roentgenological diagnosis and six after a negative diagnosis gave negative results" (IV, 1268, ii). Mixter mentions these seven cases, but says: "In only two of these cases did the roentgenological findings suggest a ruptured disk" (V, 782).

There is one important point to consider about the actual operative technique—the question of spinal fusion. Barr states that spinal fusion and complete removal of the nucleus is desirable to prevent further extrusion (III, 337). "We believe that this lesion tends to weaken the spine and that exploration of the spinal canal will weaken it still further. Therefore we plan our approach to preserve the strength of the spine as much as possible and follow laminectomy by a bone graft if the patient does heavy work" (IV, 1268, ii). Fusion operations were done in 40 to 50 per cent. of the cases (IV, 1270, ii). Can the time in bed and the absence from work or the fusion itself have caused the relief of symptoms?

In the first series we find Case 19, a woman of 35, with no history of trauma. Her complaints were pain in the buttocks, anus, and vulva, and down the left thigh posteriorly. She had incontinence of urine and faeces, saddle anaesthesia of perineum and buttocks, and sphincter paralysis. Her legs were "essentially normal." The cerebrospinal fluid had no dynamic block, but 140 mg. of protein per 100 c.cm. X-ray examination showed "no changes of consequence," and lipiodol examination was negative. A lumbo-sacral laminectomy was performed, and a tumour, compressing the lowest fibres of the cauda equina and consisting of annulus fibrosus and nucleus pulposus, was removed. She developed a wound infection and died.

The next paper mentions this death and adds that three other patients in the earlier group had since died, two probably of urinary sepsis, while the cause of death in the third was unknown (II, 391, i). Though his series included all these cases, Barr reports that "two cases have died. One died of uraemia following a complete paraplegia with urinary incontinence due to the disk lesion which was present pre-operatively. The second patient died of pneumonia well over a year after operation" (III, 336). What happened to the other case of urinary sepsis and to the patient who died of wound infection? This latter death appears again in the next paper by Barr, Hampton, and Mixter—"There was one post-operative death. Three other patients have died of incidental causes but were relieved of their pain during their

post-operative life" (IV, 1268, ii, et seq.)—and also in the paper by Mixter (V, 783). Yet in the sixth and latest paper Barr states: "There have been two deaths in our series: both of these patients had severe irreparable nerve damage from large ruptured disks" (VI, 1251). One is tempted to ask Professor Barr his method for the resurrection of the dead.

It is extremely difficult to evaluate results which are classified as cured, relieved, and unrelieved. Doubts as to the value of this method must inevitably arise when we consider certain cases in the first paper—the only one to give individual case histories (I, table, 210).

Case 6.—A woman of 63, with no history of trauma, complained of pain in the legs and around the abdomen, and of inability to walk. She was found to have hyperaesthesia of the legs and abdomen, spasticity of the legs, with increased reflexes; a cerebrospinal fluid protein content of 67 mg. per 100 c.cm., and a partial dynamic block. X-ray examination revealed hypertrophic changes, a narrow disk, and lipiodol block at the sixth to seventh dorsal vertebrae. A dorsal laminectomy was performed and an extradural mass compressing the cord was removed from the intervertebral disk involved. It consisted of nucleus pulposus. She developed a complete motor and sensory paraplegia. Under the column for results she is reported to be "unrelieved."

Case 7.—A man of 42 had no history of trauma. He complained of numbness of legs, of increasing difficulty in walking, and of pain in the back. He exhibited hypaesthesia below the umbilicus, and spasticity of legs with increased reflexes. The cerebrospinal fluid had partial (? complete) dynamic block and 114 mg. of protein per 100 c.cm. No films are reported, and lipiodol examination was not done. A dorsal laminectomy, with piecemeal removal of a mass from the intervertebral disk, consisting of annulus fibrosus and nucleus pulposus and compressing the spinal cord, was performed. This man also developed a complete paraplegia, and he, too, is reported to be unrelieved.

The nucleus pulposus is degenerating notochordal remnants, degenerating because of lack of blood supply; even the rest of the disk has a poor, indirect blood supply. Retropulsed through a fissured disk the nucleus must degenerate more rapidly. Andrae quotes Ribbert as having produced herniations of the nucleus pulposus, and as having found that they are absorbed or become cicatrized and so shrink. Therefore, should not conservative treatment cure the condition without any deaths from wound infection, and without running the risk of reproach for having transgressed the principle of *Primum non nocere*?

Summary

I have made use of a number of articles to clear up doubts concerning a new procedure in an attempt to solve three questions: Can retropulsion of the nucleus pulposus cause symptoms? If it can, is laminectomy the only treatment? Are the results of laminectomy such as to justify operation? The condition of retropulsion of the nucleus pulposus is used as an example in a plea for a more careful consideration of new ideas before their adoption.

In March of this year the British Standards Institution circulated for comment a "Draft British Standard Specification for Haemoglobinometers." The draft was based on the carboxyhaemoglobin (Haldane) method. As a result of circulating this draft the institution has received a number of requests that an acid haematin (for example, Sahli) method, not involving the use of coal gas or carbon monoxide, should also be standardized. Before deciding to proceed with the additional standardization the institution desires further information and has accordingly circulated a memorandum on the subject to medical organizations and individual practitioners known to be interested in the subject. Any reader who would like a copy of this memorandum can obtain one on application to the Director, British Standards Institution, 28, Victoria Street, London, S.W.1.