ORIGINAL ARTICLE

Surgical treatment of post-traumatic syringomyelia

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Study design: A retrospective study.

Objectives: To review the outcome of 40 patients with post-traumatic syringomyelia treated with laminectomy and reconstitution of the spinal subarachnoid channels.

Setting: Birmingham, United Kingdom.

Method: A retrospective study of patients undergoing surgery between 1996 and 2007 was carried out. All 40 patients underwent a laminectomy with the creation of a cerebrospinal fluid (CSF) conduit.

Results: A total of 18 (1 in 2) patients had long-term stabilization of symptoms after laminectomy and creation of a CSF conduit alone. Later, 17 patients underwent supplementary procedures. Overall, surgical treatment resulted in 27 (2 in 3) patients with continued stabilization of symptoms and 13 (1 in 3) experiencing worsening of symptoms in the long term (mean follow-up was 64 months). Radiological review at 6 months revealed a reduction in the size of the syrinx in 21 out of 33 (2 in 3) patients.

Conclusions: Laminectomy for syringomyelia, with reconstruction of the spinal CSF channels alone, resulted in a reduction of syrinx size by 6 months, with half of all patients experiencing stabilization of symptoms in the long term. When additional techniques are taken into account, two in three of patients achieved long-term stabilization of symptoms.

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Introduction

The earliest descriptions of post-traumatic syringomyelia date back to the late-nineteenth century when the link between spinal trauma and progressive deterioration in neurological function, caused by cystic degeneration of the cord, was identified at post mortem.¹ Today, magnetic resonance imaging (MRI) makes the condition easy to detect, if it is suspected clinically, and specific imaging protocols allow more extensive evaluation to be carried out.

Post-traumatic syringomyelia affects somewhere between 0.3 and 3% of the population of spinal cord injury victims.^{2–7} It is widely held that the pathogenesis centres on impaired cerebrospinal fluid (CSF) circulation in the spinal subarachnoid channels at the site of injury, caused by post-traumatic fibrosis, which is usually evident during surgical exposure. There are no clear predictors of development of syringomyelia in individual spinal cord injury patients, although some papers have suggested that onset is earlier in older patients, in those with displaced fractures and if spinal instrumentation is used without decompression.⁷ A close surveillance of

all spinal cord injury patients allows for earlier detection and treatment of post-traumatic syringomyelia.

Several different surgical treatments have been advocated for the treatment of post-traumatic syringomyelia. Some of these, such as omental grafting,² are now seldom carried out. The two most commonly used strategies are direct drainage of the cavity and reconstruction of the spinal subarachnoid channels. Syrinx cavities may be drained into the spinal subarachnoid channels or into the pleural or peritoneal cavities. Direct drainage is, however, associated with a high rate of blockage of the tubing used, necessitating revision procedures.² Such operations also require a myelotomy to be performed and this will result in loss of dorsal column function in an individual who retains some lower limb neurological function. In addition, syringomyelia cavities are often septated and it may prove difficult or impossible to pass a drainage catheter sufficiently far to drain the cavity adequately. Finally, even if a syrinx can be well decompressed, the patient remains liable to develop new cavities alongside the original one, unless the underlying filling mechanism is disabled.

Reconstruction of the subarachnoid channels aims to re-establish cerebrospinal fluid flow, thereby addressing the underlying cause of the syrinx formation. When effective, this procedure can lead to complete or near-complete and

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long-term collapse of the syrinx cavity. The surgical exposure also permits the insertion of a drainage tube into the syrinx at the same time, if the surgeon wishes to adopt a 'belt and braces' approach to treatment. Indeed, it is likely that some of the successes that follow primary insertion of drains into syringes may result from the surgical exposure required to do this, that is, the laminectomy and the opening-up of spinal CSF pathways.

Overall, the results of surgery for post-traumatic syringomyelia are not nearly as reliable as those after surgery for hindbrain-related syringomyelia. Functional improvement is never substantial or dramatic but even modest improvement, or simply arresting a progressive neurological deterioration, may be of great value to the patient.³

In our unit we have carried out a number of different types of operation for post-traumatic syringomyelia but have generally favoured the creation of a CSF conduit in most cases. This paper reviews our results, using this method.

Materials and methods

We conducted a retrospective case note review of all patients surgically treated for post-traumatic syringomyelia in this unit between August 1996 and October 2007.

Our procedure consisted of performing a three- to four-level laminectomy, opening the theca and breaking down intradural, arachnoid adhesions at the site of injury. Dural edges were hitched up laterally, with non-absorbent sutures, with particular attention paid to the upper and lower limits of the opening in the thecal sac. The aim was to create an artificial conduit for CSF flow. In the earlier part of the series, this was achieved without the use of a dural graft. Instead, a T-tube was laid dorsal to the cord and the wound closed. The T-tube was intended to exert an effect not only as a stent, in the manner described by Williams,² but also to allow CSF to 'auto-irrigate' the subarachnoid channels postoperatively, thereby removing blood products and other proteinaceous material that might otherwise accumulate and provide a substrate for new adhesions to develop. The tube was removed within a few days to minimize the risk of infection. Over the period covered by this audit, we developed a perception that the initial collapse of the syrinx was not maintained in the longer term. Latterly, therefore, some of our patients underwent dural closure in the form of an augmentive duroplasty, using a patch of synthetic dural substitute, in the hope that this would prevent ingress of blood products and lessen the likelihood of new arachnoid adhesion formation. T-tube drainage was not used in these cases.

Patients

Our study identified 40 patients, 38 men and 2 women, of mean age 32 years (range 17–61). Mechanisms of injury were 29 road traffic accidents (11 motorcycle), 9 falls, 1 football injury and 1 stabbing. The mean time interval from the accident to surgery was 6 years but with a wide range, extending from 2 months to 24 years. There were 14 cervical vertebral injuries and 23 thoracic but 3 patients had no

Table 1 Surgical procedures carried out before this study period

Previous surgical procedures	Number of procedures (n = 13)
Anterior cervical fusion	6
Anterior thoracic fusion	2
Posterior stabilization	3
Laminectomy for syringomyelia	2
Laminectomy and omental grafting	2

Some patients underwent more than one previous procedure.

Table 2 Operations carried out after the creation of a CSF conduit

Procedure	Number of procedures (n = 17)
Revision of creation of a CSF conduit	5
Lumbar peritoneal shunt	12
Ventriculoperitoneal shunt	1
Myelotomy	1
Syringopleural shunt	3
Syringosubarachnoid shunt	2
Syringoperitoneal shunt	1
Percutaneous syrinx aspiration	1
Anterior cervical fusion	1
Total	27

Abbreviation: CSF, cerebrospinal fluid.

Some patients underwent more than one supplementary procedure.

radiological evidence of bony injury. In all, 24 patients (3 in every 5) had functionally complete spinal cord injuries and 16 (2 in 5) were incomplete.

All 40 patients had a laminectomy with the creation of a cerebrospinal fluid conduit, although two of these patients had undergone a similar procedure previously in another unit. A total of 13 patients had previously undergone other operations related to their spinal injury (Table 1). In addition, 17 patients underwent 27 additional surgical procedures, subsequent to that what was the subject of this study (Table 2).

All patients were reviewed either in our dedicated syringomyelia clinic or by their spinal injuries unit, according to their domicile and travel facilities. Limb power and sensation, bladder and bowel function and overall functional status were assessed in terms of symptom improvement, stabilization or deterioration. In addition, long-term clinical outcome was assessed by telephone questionnaire, for which there were 36 respondents. Changes in radiological appearances on MRI were assessed at 6 months. The results of these were available in 33 patients.

Results

In terms of operative findings, we observed pathological arachnoid fibrosis in 35 of 38 cases of our laminectomy operations. This was considered sufficient to obstruct flow along the spinal CSF pathways.

All patients were followed up, although the intervals varied because of the wide geographical area from which the patients originated. Documented follow-up was available in

Figure 1 Overall outcome after surgical treatment for post-traumatic syringomyelia.

Figure 2 Outcome according to surgical procedures, carried out for post-traumatic syringomyelia.

the case records for 29 patients at 6 weeks, 25 patients at 6 months and 16 patients at 1 year after surgery. At 6 weeks, 16 out of 29 patients described improvement in symptoms, 1 reported no change and 12 experienced mild deterioration. At 6 months, 11 out of 25 patients had maintained clinical improvement, 6 were in the same state as preoperatively and 8 were worse than before surgery. At 1 year, 5 out of 16 patients reported improvement of symptoms, 5 were same as before surgery and 6 were worse than before surgery (Figure 1).

In all, 23 patients required no further surgery beyond creation of the CSF conduit. Of these, 18 patients reported continued stabilization of symptoms, when followed for

Table 3 Radiological outcome at 6 months after laminectomy and creation of CSF conduit

Syrinx size	
Increase in size	6
Reduction	21
No change	6
Total	33

Abbreviation: CSF, cerebrospinal fluid.

Table 4 Early complications after laminectomy for post-traumatic syringomyelia

Dysaesthetic pain	5
Neurological deficit	4
Wound infection	4
CSF leak	2
Posterior fossa subdural haematoma	1
Hydrocephalus	1

Abbreviation: CSF, cerebrospinal fluid.

between 1 and 11 years. The remaining 17 patients underwent further surgery for deteriorating symptoms (Table 2). In this group, nine patients experienced stabilization of symptoms. The remaining eight patients suffered a continued worsening of symptoms. The overall outcome, when the different surgical procedures were taken into account, was 27 (2/3) patients achieving stabilization of symptoms and 13 (1/3) experiencing deterioration of symptoms in the long term (Figure 2). The mean follow-up period for the total patient group was 64 months.

Radiological review at 6 months revealed a reduction in the size of the syrinx in 21 out of 33 patients (Table 3).

The most frequently occurring early complication was dysaesthetic pain. Table 4 shows other complications noted in the postoperative period. All complications were transient in nature.

Discussion

Post-traumatic syringomyelia is a potentially devastating complication of spinal cord injury. The importance of the condition is that it can add significantly to an existing neurological deficit and add considerably to the burden that the spinal cord injury victim already has to bear.

Post-traumatic syringomyelia usually develops insidiously, although there can be considerable variation in the latent interval between the original injury and the first onset of symptoms caused by the syrinx, which is between 6 months and 30 years.³ In most cases, the spinal injury is a major one with significant damage to the vertebral column. Occasionally, syrinx cavities are detected after a relatively minor spinal injury, usually one that does not involve disruption of skeletal elements. Usually, in our experience, such cases have little, if any, motor deficit evident. Such lesions are not well described in the literature and it is unlikely that these cavities will develop into propagating syringomyelia cavities.

Several theories have been proposed to explain the development of syringomyelia.^{8,9} Earlier suggestions of

Gardner¹⁰ and Williams¹¹ were replaced by proposals from Oldfield.¹² The majority of this work has been based on the syringomyelia associated with hindbrain hernias but more recent work by Stoodley¹³ has used specifically the model of post-traumatic syringomyelia.

In the majority of cases, the essential precursor to the development of any form of syringomyelia is the obstruction of the normal channels for flow of CSF in the spinal canal. In post-traumatic syringomyelia this blockage is caused by intradural haemorrhage, which organizes into arachnoid adhesions. Our operative findings lend support to the concept that obstruction to CSF flow in the spinal subarachnoid channels is aetiologically linked with the development of syringomyelia. It is unclear as to what extent compromise of the spinal canal diameter, caused by vertebral fractures, contributes to the pathogenesis.¹⁴

Treatment of post-traumatic syringomyelia is a challenging problem. In addition to the two main strategies of laminectomy, with the breakdown of adhesions and direct syrinx drainage procedures, there are treatments such as corpectomy, omental grafting and neural tissue transplantation.^{6,15,16} Laminectomy with duroplasty is reported as resulting in improvement or stabilization of symptoms in 70–85% of patients and in a continued deterioration of symptoms in 15–30% of patients.^{17,18} Shunting seems to produce less good results,^{2,13} although some may contest this claim.

Our results show an improvement or stabilization of symptoms, in the short to medium term, in two-thirds of the patients who underwent laminectomy with the creation of a CSF conduit dorsal to the spinal cord. This finding is consistent with conclusions drawn in other published series. Difficulties arise, however, when attempting to analyse the success of this procedure in isolation, because several of our patients had undergone previous surgical procedures including, in some cases, previous attempts to create a CSF conduit (Table 1). In addition, approximately half of our patients subsequently underwent further operations (Table 2). In the long term, the number of patients with improvement or stabilization of symptoms falls to half if they underwent laminectomy and creation of a CSF conduit alone, although this response is then sustained for many years and the benefit is retained as improved function for the patient. When the additional benefit afforded by supplementary operations is taken into account, long-term stabilization of symptoms was observed in two-thirds of patients (Figure 2). This study therefore reflects the outcome for patients with post-traumatic syringomyelia, in whom laminectomy and creation of a CSF conduit formed part of their overall surgical management.

The MRI appearances after surgery have been encouraging. We deliberately delayed the MRI scan for at least 6 months to allow a new hydrodynamic equilibrium to be established within the syrinx. The radiological findings may not precisely parallel the clinical outcome but they do provide useful adjunctive information with regard to overall surgical outcome. Postoperative MRI appearances were variable in terms of the degree of syrinx collapse, size of pseudomeningocele and other radiological detail, such that no correlations could be made with outcome.

Conclusion

Half of patients undergoing a laminectomy and creation of a CSF conduit, alone, for post-traumatic syringomyelia, gain a satisfactory outcome in the long term. When this procedure is combined with other surgical techniques, for continued deterioration of symptoms, benefit is extended to two-thirds of patients, which is a reasonable outcome when seen in the context of the functional deterioration afflicting this group of patients.

Conflict of interest

The authors declare no conflict of interest.

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