Longitudinal Myelotomy for Spasticity

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VARIOUS patterns of spasticity occur according to the level of total or partial lesions of the brain stem and spinal cord. Stated simply, spasticity occurs because spinal reflex arcs are separated from the controlling influences that normally reach them from higher in the central nervous system. Sensory impulses may then produce either an exaggerated stretch reflex which results in spasticity or an exaggerated flexor withdrawal reflex which results in flexor spasms. Furthermore, in partial lesions a voluntary effort to move a limb may increase the activity of motor units and thus contribute to uncontrollable spasm.

In some patients the considerable degree of spasticity and tendency to violent flexor spasms have a serious effect upon rehabilitation. These patients have difficulty in carrying out such procedures as transferring to and from a wheel chair or in wearing braces. They are also more liable to develop permanent deforming contractures. Excoriation and ulceration are more common, and in certain circumstances the violent muscular spasms may be painful. In certain paraplegic, quadriplegic, or paraparetic patients, this problem negates all efforts at rehabilitation.

Many procedures have been tried over the years to combat this spasticity, and the multitude of procedures indicates that none are entirely satisfactory.

In 1913, Foerster advocated division of the posterior roots of L-2, -3, and -5, and S-1 in order to interrupt the afferent sensory component of the reflex arc. This procedure was usually followed by relief of spasticity for some time, but it eventually returned. This was presumably due to some afferent impulses still finding their way to the ante-

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In their paper in 1962, Tön尼斯 and Bischof reported 20 cases.\textsuperscript{11} All patients had initial relief of spasticity but it returned in five cases. Two of these five had repeat myelotomies with lasting benefit. It was considered that 17 of the 20 patients experienced successful alleviation of spasticity. The patients were followed from 2 to 8 years, the majority of cases for 4 to 5 years. Of the 20 patients, 18 had been confined to bed before operation; only three remained bed patients after operation, and four were able to walk after a fashion.

Bischof and Tön尼斯’ chief interest has been the preservation of voluntary bladder function or a satisfactory reflex bladder function, and they reported some cases of significant improvement of bladder function due to relief of hypertonia of the bladder muscles. As with the limbs, bladder difficulties seemed more troublesome in cases of partial rather than total cord lesions. Furthermore, there is some preservation of motor and sensory functions of the legs if this was the status before operation. Bischof and Tön尼斯 also point out that it is usually very difficult to assess the amount of potential voluntary movement in the presence of severe spasticity so that relief of spasticity may reveal greater motor function than had been anticipated. Nevertheless, they do not feel that this myelotomy should be carried out on patients who can walk at all well.

This type of myelotomy is performed through a laminectomy of T-11, T-12, and L-1 and made sufficient to expose the lumbar segments and the conus medullaris. After the dura is opened, the lumbar and sacral segments should be identified with a nerve stimulator. The largest root is usually S-1, and this leads the surgeon to the first sacral segment of the cord. Localization may be confirmed by electrical stimulation. After identification of the other appropriate nerve roots and related segments, the cord is rotated slightly and an incision made in a longitudinal plane (Fig. 2) from the T-12 to the S-1 segment, approximately in line with the attachment of the dentate ligaments (Fig. 3). A special knife may be used for this purpose, and a straight needle passed through the cord helps establish the correct plane. Hemorrhage from the procedure is usually minimal and is readily controlled by

\begin{figure}
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\includegraphics[width=\textwidth]{fig1.png}
\caption{Operative diagram of longitudinal myelotomy. Incision is made into the cord with the dentate ligaments grasped by forceps and the spinal cord rotated slightly.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig2.png}
\caption{Operative diagram of longitudinal myelotomy. Incision is carried through the cord in a horizontal plane.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig3.png}
\caption{Operative diagram of longitudinal myelotomy. The horizontal incision into the cord extends from L-1 to S-1, with the optional extension on one side to approximately the S-5 level.}
\end{figure}
local pressure for a short time. The use of the operating diproscope may, in the future, effect a more delicate, gentle division of the spinal cord.

This procedure has been carried out on a few patients by each of several Canadian neurosurgeons. Since the experience of each was limited, we felt that there would be some merit in pooling individual experiences. This paper represents the effective results.

**Case Material**

There were 21 patients in the combined group: 11 male and 10 female. Of these, 10 had involvement of the cervical cord, and 11 of the thoracic cord. Thirteen patients had complete paralysis; however, even the eight with incomplete lesions could only function very poorly. None of the patients could walk independently.

Trauma had been the cause of the lesion in 13 patients, while six had multiple sclerosis or a comparable disease; five of the latter patients were women. One patient had an arteriovenous malformation of the thoracic cord and one a massive centrally extruded thoracic disc.

The basic longitudinal myelotomy already described was used in most cases without the lower sacral extension. All patients showed initial relief from spasticity. Four had some return of spasticity. One of these had lasting complete relief after an upward extension of the myelotomy, and another had satisfactory results after peripheral neurectomy. Nothing further was done to the other two and they were considered to be significantly better than before operation.

We have not concentrated on the effect of bladder function as did Tönns and Bischof; therefore, assessments of bladder function such as cystograms were not extensively carried out. Where these were done they confirmed the reduction of bladder tone. Four of our patients had some bladder control preoperatively, and three regained partial control postoperatively. In one patient bladder control seemed worse postoperatively.

The results are summarized in Table 1.

**Discussion**

The theoretical benefits of the procedure are substantiated by our results, and there is no question that relief of spasticity can be achieved in a high percentage of patients by means of a longitudinal myelotomy. However, our follow-up studies are relatively short and the percentage of good results may fall as time passes. We do not hesitate to recommend the procedure for patients who have complete or nearly-complete cord lesions with intractable flexor spasms.

It is our feeling, however, that in its present form the procedure is crude. In the case of incomplete lesions some function of the long tracts can be preserved, but their relative integrity is undoubtedly jeopardized. Some crossing fibers carrying pain and temperature sensation are also destroyed, producing additional sensory deficits in these modalities. While those patients who have had voluntary bowel and bladder control have usually been able to maintain this control, they have had greater difficulty in doing so after the procedure and one patient out of four lost voluntary bladder function. These risks must be explained to the patients and should be carefully weighed against the probable benefits of relief of flexor spasms. A number of our patients, after such a discussion, have declined the operation. We are hoping to overcome some of these disadvantages by modifying our present technique.

There seem to be no contraindications other than the general condition of the patient. The procedure is obviously safest and most valuable in patients with complete cord lesions. Each case must be evaluated separately. Localized or minor degrees of spasticity may be treated by less radical surgical procedures, by medication or by other conservative methods of rehabilitation. The general condition or life expectancy of some patients may indicate that intrathecal injection is preferable. However, we feel that if a patient is in generally good condition but has a complete cord lesion and severe incapacitating flexor spasms that have not been alleviated by non-surgical means, the best procedure available is a longitudinal myelotomy.

**Summary**

We have presented the results of nine Canadian neurosurgeons in performing longitudinal myelotomy (Bischof) on 21 patients with severe intractable flexor spasms. Of these 21 patients, 19 had good results. Two
<table>
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<th>Age and Sex</th>
<th>Surgeon</th>
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<th>Neurological Deficit</th>
<th>Bladder Control</th>
<th>Date of Operation</th>
<th>Post-operative Relief of Spasticity</th>
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Patients were improved but not completely relieved of their flexor spasms. We have some reservations about carrying out the procedure on patients with incomplete cord lesions but believe it is the best procedure at present available for patients with complete cord lesions.

**Acknowledgment**

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References