Advantages of Neuroendoscope-Assisted Microneurosurgery in Spina Bifida

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ABSTRACT

Objective: The efficacy, safety and advantages of endoscope-assisted microneurosurgery were evaluated in radical operation for spina bifida.

Methods: The neuroendoscope (2 mm-diameter rigid endoscope) was applied during microsurgery in fifty cases of spina bifida that were operated upon at King Hussein Medical Centre between January 2006 and January 2008. It was used prior to the incision of the sac in cystic cases and after the dura was opened in non-cystic cases. The cases included nearly all types of spina bifida.

Results: The neuroendoscope showed pathology with clarification of surgico-anatomical structures and defined its relation to the normal structures. There were no technical difficulties or complications. It was of value in assessing the type of lipoma, the extent of cord involvement, identified the roots at exit from the cord invaded by lipoma and reduced both manipulation and retraction. It gave an excellent view of the anterior part of the malformed cord with detailed view of nerve roots and vessels before the surgical intervention. Filum terminale and sacral roots were visualized in all cases of tethered cord making resection of the spinal lipoma easier and safer. There was no increase in infection rate, no effect on the primary surgical procedure, no bleeding or nervous tissue injury

Conclusions: Application of the neuroendoscope to microsurgery of spina bifida is very useful in showing the pathology with more clarity and its relation to normal structures. It can enhance surgical quality and reduce possible complications, allowing meticulous and more complete resection while preserving neurological function. There was a highly magnified panoramic view of the anatomy and pathology through the neuroendoscope.

Key words: Microneurosurgery, Myeloschisis, Neuroendoscopic observation, Spina Bifida, Spinal Lipoma.

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Introduction

Visualisation in spina bifida surgery is crucial; cord, roots, and vessels are hidden behind or within the lesion. Identification of these structures allows meticulous and safer resection of the lesion. Spina bifida surgery aims to prevent worsening of the patient and/or improving neurological function. Microsurgery is the standard technique in spina bifida surgery. Operative microscope allows better visualization of pathology and normal anatomy. However, it is limited by the fact that the field of view achieved is restricted to the line of sight from the lens to the lesion of interest. The surgeon cannot look around lesions to see normal structures, identify roots, and blood vessels which are frequently obscured by pathology.[1-6]

The endoscope offers several distinct advantages over the operating microscope and this makes it a good adjunctive tool during microsurgery.[7-10] High

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Table I. Patients' Diagnosis

Case No.	Age	Gender	Diagnosis	SBNS	
				Pre-op	Post-op
1	3 days	M	Myelomeningocele	11	11
2	2 days	F	Myelomeningocele	6	6
3	3 days	M	Myelomeningocele	11	11
4	7 days	F	Myelomeningocele	11	11
5	10 days	F	Myelomeningocele	3	3
6	14 days	F	Myelomeningocele	5	5
7	5 days	F	Myelomeningocystocele	4	4
8	3 months	M	Lipomeningocele	8	8
9	5 months	F	Lipomeningocele	7	7
10	6 months	F	Lipomyelomeningocele	11	11
11	9 months	M	Lipomyelomeningocele	11	11
12	10 months	F	Lipomyelomeningocele	10	10
13	11 months	F	Lipomyelomeningocele	11	11
14	5 months	M	Lipomyelomeningocele	5	5
15	3 months	M	Lipomyelomeningocystocele	6	6
16	4 years	M	Spinal lipoma (Caudal)	15	15
17	5 years	F	Spinal lipoma (Caudal)	15	15
18	6 years	F	Spinal lipoma (Caudal)	15	15
19	4 years	M	Spinal lipoma (Caudal)	14	14
20	7 years	F	Spinal lipoma (Caudal)	14	14
21	6 years	F	Spinal lipoma (Dorsal)	15	15
22	5 years	F	Spinal lipoma (Dorsal)	13	13
23	5 years	F	Spinal lipoma (Dorsal)	15	15
24	7 years	F	Spinal lipoma (transitional)	15	15
25	6 years	F	Spinal lipoma (transitional)	14	14
26	5 years	F	Spinal lipoma (transitional)	14	14
27	3 years	M	Spinal lipoma (transitional)	13	13
28	2 years	M	Spinal lipoma (transitional)	15	15
29	1 year	F	Spinal lipoma (transitional)	14	14
30	5 years	F	Spinal lipoma (Filar)	15	15
31	3 years	F	Spinal lipoma (Filar)	15	15
32	2 years	F	Spinal lipoma (Filar)	15	15
33	1 year	M	Spinal lipoma (Filar)	15	15
34	4 years	F	Spinal lipoma (Filar)	15	15
35	3 years	M	Spinal lipoma (Filar)	14	14
36	6 years	F	Spinal lipoma (C+T)	12	12
37	5 years	F	Spinal lipoma (C+T)	13	13
38	8 years	F	Spinal lipoma (C+T)	11	11
39	5 years	F	Spinal lipoma (D+T)	14	14
40	4 years	F	Spinal lipoma (D+T)	13	13
41	2 years	F	CDS	15	15
42	1 year	M	CDS	15	15
43	3 months	F	CDS	11	11
44	2 months	M	CDS	11	11
45	4 months	F	CDS	11	11
46	6 years	F	CDS	15	15
47	5 years	F	CDS	15	15
48	3 months	F	CDS	11	11
49	2 years	M	CDS	15	15
50	6 months	F	CDS	11	11

M: Male F: Female

magnification gives greater definition of blood vessels, roots, nervous tissue and pathology. This magnification is achieved through the lens system, proximity to the lesion, presence of clear cerebrospinal fluid (CSF) and better illumination of structures which facilitate identification of normal structures, and specially the anatomical and pathological plane of division (relation of pathology to normal structures). The endoscope also allows looking around corners and behind structures giving an extra eye for the surgeon and reducing the need for retraction and manipulation. Three dimensional

aspects become clear with endoscope usage.[11-13]

Endoscopic and endoscope-assisted surgery has been used in cranial surgery. It has proved of value in surgeries of pituitary, base skull tumours, trigeminal nerve microvascular decompression, aneurysms, and others.[14-26]

In this study we will explore the feasibility, safety, limitations, benefits and advantages of the neuroendoscope as an auxiliary aid in microneurosurgery for spina bifida.

Methods

Patient Population

A prospective study included fifty cases that underwent radical surgery for spina bifida, between January 2006 and January 2008, at King Hussein Medical Centre. Diagnoses spanned over the whole spectrum of spina bifida. (Table I). Patients' ages ranged from one day to eight years, average of 45.9 months and 35 were females and 15 were males. Follow up ranged from three months to two years with average of eight months.

Endoscopic Instrumentation

A rigid neuroendoscope, with high resolution imaging and free hand manipulation, was used.

Surgical Procedure

Routine pre-operative workup and operative preparation included plain x-rays of the spine, lumbo-sacral 3D CT scan and MRI. Patients were operated in the prone position. Operative procedure was performed in the usual fashion including the parts of macrosurgery and microsurgery. The neuroendoscope was applied according to pathology; in cystic cases the endoscope was used prior to surgical incision, a small stab wound in the upper lateral part of the sac was used as an entry point, extra care was taken to preserve CSF. Upper lateral approach to the sac helps in reducing CSF loss and gives space to manoeuvre the free hand held endoscope. In cases with no cystic part, the endoscope was introduced when the dura was opened and an entry point achieved. Saline provided sufficient replacement to lost CSF to keep the endoscope immersed in a fluid surrounding.

The endoscopic exploration started with identification of anomalous anatomy; conus, roots, vessels, and filum terminale in the malformed structure. Tracing roots backward from the exit foramina made identification easier. It was essential to explore all sides with proper mental recall of the anatomical and pathological findings. The endoscope was recalled whenever there was, doubt, or need to assess completeness or safety of resection.

Results

The neuroendoscope was used with no technical difficulties in the performance of the procedure. No extra workup or preparation was needed. Peri operative setting of the endoscope by assistant did reduce the extra time needed for using the endoscope to only the actual time of its usage in the procedure which was in average five minutes. This further helped in reducing the time spent in microscopic exploration to identify structures.

The use of thr neuroendoscope did not affect the spina bifida repair adversely. There was no increase in infection rate (no infection in all cases). There was no nervous tissue injury; the Spina Bifida Neurological Scale (SBNS) values for all cases remained unchanged post-operatively. No bleeding during the endoscope use was registered. The retraction and manipulation of the cord and roots was reduced by the use of the endoscope

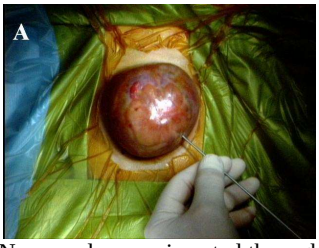
In spinal lipomas the neuroendoscope showed clearly the type and extension into the conus. The line of separation between the lipoma and the nervous tissue was identified. Roots were visualised and their relation to pathology determined. This allowed safer and more meticulous resection of the lipomas.

In tethered cord, due to thickened filum terminale and filar type lipomas, the sacral roots were localized and eventually the filum was clearly isolated and resected under direct vision dorsally and ventrally. In lesions associated with cystic portion, the endoscope showed the pathology clearly. Status of the roots and the presence of lipoma were determined.

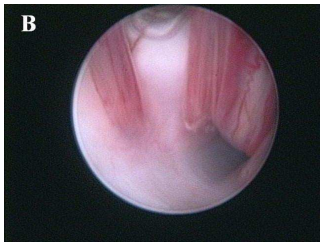
Illustrative Cases

Case 1

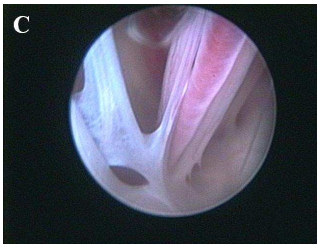
Seven-day-old neonate with a myelomeningocele in the lumbar region, his SBNS was 8/11 (motor (M):4/6, reflex(R):3/4, bladder-bowel (BB):1/5 [infant]). Repair was done through combined microscopic and endoscopic use. The endoscope used prior to incision of the sac showed the placode, nerve roots and vessels. (Fig. 1 A-E).



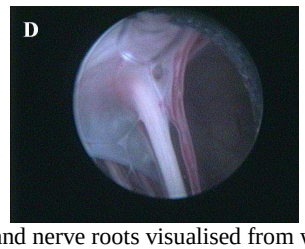
A: Neuroendoscope inserted through a stab wound laterally



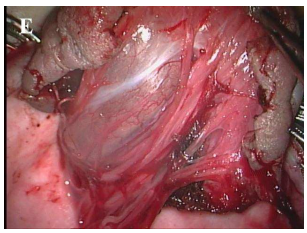
B: Endoscopic view of the bifid spina canal with roots extending upwards towards the placode



C: Nerve roots and vessels arising from floor of bifid canal

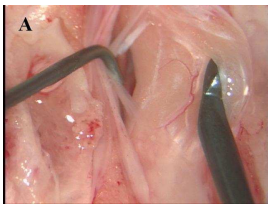


D: Placode and nerve roots visualised from within the sac

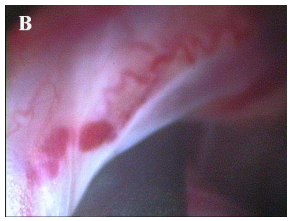


E: Microscopic view of the myelomenigocele sac after dissection

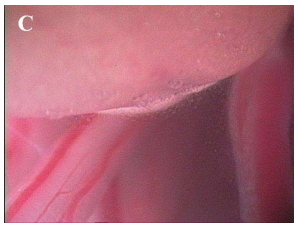
Fig. 1. Case 1. Images obtained during the repair in a patient with myelomeningocele



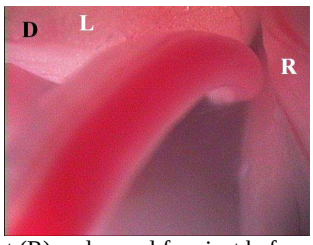
A: Microscopic view of the lipomatous thickened filum terminale



B: Filum viewed by endoscope showing Sacral root attached to ventral part of filum



C: Sacral root freed from the filum



D: Lipoma (L), Root (R) and vessel free just before resection of filum

Fig. 2. Case 2. Intraoperative images obtained in a patient with tethered cord and filar lipoma

Case 2

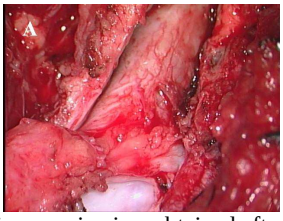
Seven-month-old baby with a congenital dermal sinus. Her SBNS was 11/11 (motor (M):6/6, reflex(R):4/4, bladder-bowel (BB):1/5 [infant]). Lumbosacral MRI showed a thickened lipomatous filum terminale and the conus at L5 level. Untethering procedure was done by endoscope-assisted microneurosurgery. The endoscope showed the filar lipoma, sacral roots were easily visualised and freed. Resection was done under direct vision dorsally and ventrally. (Fig. 2 A-B)

Case 3

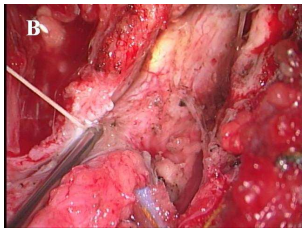
Nine-month-old baby was referred to us with a high sacral dimple and lipomatous mass in the lumbar region. Her SBNS was 11/11 (motor (M):6/6, reflex(R):4/4, bladder-bowel (BB):1/5 [infant]). Lumbosacral MRI showed a tract extending from the dimple to the dural sac within the lipoma which was intra and extradural and involving the conus, (caudal and transitional type). Tract and extradural part of lipoma were dissected and dura opened, the endoscope was used showing nerve roots on both sides of conus, the exact zone of separation of lipoma and conus was determined. Resection proceeded with very satisfactory result. (Fig. 3A-F).

Discussion

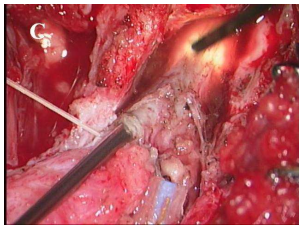
The use of neuroendoscope in spina bifida surgery is feasible and safe; it does not affect adversely the risk, time, or outcome of the original surgery.



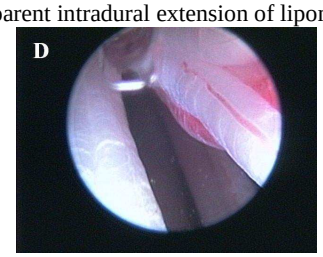
A: Microscopic view obtained after dissection of fibrous tract and lipoma with apparent intradural extension of lipoma



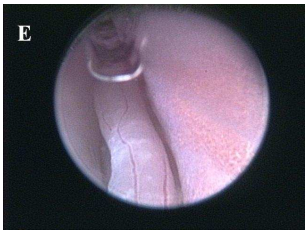
B: Endoscopic exploration of left side of spinal canal



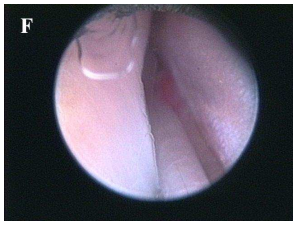
C: Dorsal exploration identify the extension of lipoma



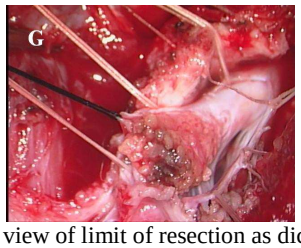
D: Endoscopic view of (B) showing roots free from lipoma



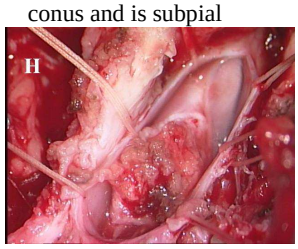
E: Further exploration revealed the lipoma and roots on the left side of spinal canal



F: Exploration of right side of canal revealed same findings as on the left, this implied that the lipoma is expanding the conus and is subpial



G: Microscopic view of limit of resection as dictated by the endoscope determination of line of demarcation between lipoma and conus



H: Final result with good resection of lipoma

Fig. 3. Case 3. Images obtained during the radical surgery in a patient with spinal lipoma-caudal and transitional type

Despite the belief of limitations on the use of endoscope in the spinal canal intradurally, there were no difficulties in using the endoscope in our cases which did cover nearly all the range of spina bifida, spinal lipoma, and tethered cord.

The endoscope did give clearer view of the operative field showing pathology and normal anatomical structures, especially the anterior aspect of the cord, roots, and line of demarcation between the lipoma and the spinal cord.

The value of the neuroendoscope usage varies according to the type of pathology and its complexity, the more complex the pathology the more beneficial. Spinal lipomas were the cases of highest yield of information from the neuroendoscope.

The neuroendoscope is not to replace the microscope. Microsurgery principles and procedures should always be observed and practiced.

The combination of the neuroendoscope and microscope can improve surgical results. The surgeon is no longer limited to the line of sight between the microscope and the pathology, but can visualize details around and behind structures. This reduces traction, manipulation, and offers several different viewing angles. One can trace caudal and cephalic pathology and visualise tissue under greater magnification, better illumination and proximity.

Literature review did not show previous similar trial to use the endoscope in spina bifida surgery, and in open dura. To our best knowledge there is no description of this technique or its similar use.

Conclusion

Application of the neuroendoscope to microsurgery of spina bifida is very useful in showing the pathology with more clarity and its relation to normal structures. It can enhance surgical quality and reduce possible complications, allowing meticulous and more complete resection while preserving neurological function. Through the neuroendoscope there was a new prospect of anatomy with a highly magnified panoramic view of the anatomy and pathology.

The application of this technique coupled with the

use of intra-operative neurophysiological monitoring could enhance the functional outcome.

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