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Endoscopic Intracranial Imaging

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1. Introduction

The fundamental aim of the chapter is to create awareness in the general medical community about the benefits of neuroendoscopy imaging for prompt and effective diagnosis and treatment of lesions within or adjacent to fluid-filled intracranial cavities.

Neuroendoscopy is a surgical diagnostic and therapeutic modality that has suffered an oscillating course in history, regarding its indications and applications. At present, it enjoys another thrust of popularity, which may be evident by the increasing number of publications and academic events world-wide related to this discipline. It has been evolving continuously, allowing for new indications, applications, and results.

Neuroendoscopy is not a novel technique. According to a large number of articles and books, the application of lenses to observe internal parts of the body without a wide exposure, was initiated in the 19th century, and such technology was soon applied to the intracranial space. Very primitive equipment was used to explore the ventricular system and to excise the choroid plexus. Since the beginning of this new technology, it has suffered continuous modifications that have improved optical quality and surgical capability, resulting in better surgical outcome (1).

As a typical example of a minimally invasive neurosurgical technique, neuroendoscopy has led to improvement in diagnosis, therapy, and prognosis in many intracranial lesions. Practically all intracranial compartments may be reached with an endoscope, whether it is rigid or flexible, and indications have increased dramatically. It is now possible to diagnose and treat through direct observation intraventricular, as well as subarchnoid and parenchymal lesions.

Hoping to avoid a shunt placement and its complications, third-ventriculostomies were initially adopted as promising procedures for most cases of hydrocephalus. Although it has not been associated with the postoperative results that were hoped for, it has today very clear indications. Hypertensive and obstructive hydrocephalus due to different pathologies in the cerebral aqueduct, the posterior part of the third ventricle, or the fourth ventricle, may be some of the ideal cases for a third-ventriculostomy. Although some factors may vary when performing a third ventriculostomy, such as early age, a final word has not been said in this regard, since the controversy continues. Shunt systems, nevertheless, continue to be an important part of the instruments needed in the treatment of hydrocephalus.

Congenital cysts in or adjacent to the ventricular system acting as space occupying lesions and hydrocephalus may be another clear indication for endoscopic exploration and cavity communication, sometimes requiring a shunt system. Although not as frequent as the

previous case, septum cavum pellucidum cysts have been other clear indications for endoscopic fenestrations, either with mechanical means (like the endoscope itself) or with laser beams. In such cases raised intracranial pressure is normalized and symptomatology slowly resides.

Catheter placements and revisions may represent frequent indications for endoscopic shunt revisions, given the large number of shunt operations that take place daily throughout the world, so dysfunction of these systems are to be expected. The causes for shunt dysfunction are many, but may not be evident with image studies (CT or MRI scans), therefore intraventricular endoscopy offers a direct diagnostic method which may yield clear images in real time. It also allows the opportunity to apply therapeutic measures during the same operation.

Haematoma drainage, membrane fenestrations, tumour biopsies and resections, and open neurosurgical assistance, may be other common procedures that may be assisted with the endoscope. Although indications may vary according to the local neuropathological illnesses and diagnostic capabilities, it is largely dependent on the neurosurgeons experience.

As published elsewhere (2), there is a need to stress that precise diagnosis is a key factor for a correct planning of a successful neuroendoscopic procedures, since conventional image studies may be deficient in resolution. This is certainly the case in modest medical facilities, where computed tomography (CT) and magnetic resonance imaging (MRI) scanners may not be available or updated. This fact may represent a high proportion of primary medical care systems world-wide, and it is certainly true for hospitals of our community. To demonstrate this fact, the results obtained in our series of endoscopy cases, preoperative image studies (CT and MRI) have yielded unparallel results compared with those obtained with endoscopy in roughly half of the cases. This is especially true in the beginning of the case recollection, because image studies were more primitive than the images obtained from more modern machines, and the images were more modest in resolution.

Neuroendoscopy may yield high quality images which may confirm or discard diagnostic possibilities during the surgical procedure, making often times in-situ modifications necessary. Derived from the previous statement, and because the original preoperative diagnosis was different from the intraoperative endoscopical image, the surgical treatment that was finally performed was different from the one originally planned in about a third of the cases. In this context, other surgical procedures, including open procedures, were avoided, and therefore additional risks and costs to the patient were reduced.

Neuroendoscopy in our hospitals has been performed by the same neurosurgeon in 102 procedures. With its limitations, it has demonstrated benefits, as well as drawbacks. Among the former, accuracy in diagnosis of lesions that were subject to several differential diagnosis, especially when they were based on low definition image studies. Full details of our cases can be observed in table 1.

Endoscopy equipment, in our experience, has changed through different times. Initially, a pediatric cystoscope was used and procedures were limited to observations and few cystic perforations. Septostomies also were commonly performed. Most of these procedures were not recorded in image documents. The same was true for a second generation of instruments, which included a semi-rigid, 2mm diameter fibroscope, a new light source, but no camera or video-recorder. Our present endoscope is a 4mm rigid Richard Wolf, with three working channels, a video system and a high definition screen.

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
1	**30**	**M**	RICP, SD.	Global Hydrocephalus. No visible cause.	Adherence of the catheter to choroid plexus.	NO	NO
2	**19**	**M**	RICP.	Supratentorial hydrocephalus. Cysticercal ependymitis. 3rd ventricle calcifications.	Ventriculomegaly with NO ependymitis or calcification.	NO	YES
3	**17**	**M**	RICP.	Supratentorial hydrocephalus. Ependymitis. Intra-ventricular septi and/or 3rd ventricle cysticerci.	Ventriculomegaly with NO ependymitis, cysticerci or septi.	NO	YES
4	**43**	**M**	RICP; Dementia.	Parenchymal calcifications. Global hydrocephalus.	Ventriculomegaly.	YES	NO
5	**26**	**F**	RICP, SD*.	Hydrocephalus. Thalamic tumour with 3rd. ventricle infiltration and shunt involvement.	Ventricular compression with NO tumour infiltration. Catheter in inter-ventricular septum*.	NO/ NO	YES/ YES
6	**26**	**F**	RICP.	Supratentorial hydrocephalus. 3rd ventricle tumour invasion.	3rd ventricle tumour invasion with ventriculomegaly.	NO	NO
7	**39**	**M**	RICP.	Global hydrocephalus. Cysticercal basal arachnoiditis.	Multiple ependymal calcifications. Ventriculomegaly.	YES	NO
8	**30**	**M**	RICP.	Left ventricular cyst.	Septum in ventricle without cystic lesion.	NO	YES
9	**42**	**F**	CSF fistula, SD.	Pneumocephalus with hydrocephalus.	Ventriculomegaly with pneumocephalus.	YES	NO
10	**34**	**M**	RICP.	Supratentorial hydrocephalus. Cerebellar tumour with 3rd ventricle invasion.	Ventriculomegaly with NO 3rd ventricle invasion.	NO	YES
11	**57**	**M**	RICP, Dementia.	Supratentorial hydrocephalus.	Ventriculomegaly.	YES	NO
12	**18**	**F**	Epilepsy.	Mild global cortical atrophy.	Determination of callosotomy extent.	YES	NO

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
13	**28**	**M**	RICP, SD.	Global hydrocephalus.	Ventriculomegaly. Multiple intraventricular adherences*.	NO/ NO	NO/ NO
14	**31**	**F**	RICP.	Global hydrocephalus.	3rd ventricle septum. Ventriculomegaly.	NO	YES
15	**29**	**M**	RICP, Dementia.	Supratentorial hydrocephalus. Porencephalic cyst NOT communicated with ventricles.	Partial communication of cyst to dilated ventricles.	NO	YES
16	**32**	**F**	Seizures.	Right parietal lobe cystic tumour with septi.	Parietal tumour with independent cysts.	YES	NO
17	**17**	**M**	RICP, SD.	Supratentorial hydrocephalus. Two ventricular catheters.	Fibrosis of 3rd ventricle floor with one catheter. Adherence of second catheter to choroid plexus.	NO	YES
18	**21**	**M**	RICP.	Hydrocephalus. Thalamic tumour.	Ventriculomegaly. Callosotomy assistence*.	YES/ YES	NO/ NO
19	**54**	**F**	RICP; Dementia.	Occipital tumour with ventricular deformation. Hydrocephalus.	Extrinsic 3rd ventricle dysplacement. Ventriculomegaly.	YES	NO
20	**60**	**M**	RICP, Hemiparesis.	Subacute subdural hematoma with septi.	NO septi in hematoma.	NO	YES
21	**52**	**M**	RICP, SD, Infection.	3rd and left lateral ventricle hydrocephalus. Purulent ependymitis.	Ventriculomegaly and abundant adherences* No purulent ependymitis.	NO	YES
22	**43**	**M**	RICP.	Global hydrocephalus. Septum in right lateral ventricle. Pineal calcification within the 3rd ventricle.	NO septum. Pineal calcification not visible.	NO	YES
23	**46**	**M**	RICP.	Hydrocephalus. Cortical cyst.	Ventriculomegaly.	YES	NO
24	**46**	**M**	Stroke with dysartria and hemiparesis	Hydrocephalus. 3rd ventricle displacement by arachnoid cyst.	Discrete 3rd ventricle with adherences in the lateral ventricle. Ventriculomegaly.	NO	NO

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
25	**77**	**F**	Headache, seizures.	Hydrocephalus. Multiple parenchymal calcifications and cysts.	Ventriculomegaly with adhesive ependymitis. NO cysts.	NO	NO
26	**77**	**M**	RICP, coma.	Supratentorial hydrocephalus.	Ventriculomegaly with a small viable cysticercus in choroid plexus.	NO	YES
27	**18**	**F**	RICP.	Compressive septum pellucidum cyst.	Dilated, isolated and hypertensive septum pellucidum cyst.	YES	NO
28	**29**	**F**	Epilepsy.	Dilated left temporal ventricle.	Dilated left temporal lateral ventricle.	YES	NO
29	**65**	**M**	RICP, coma.	Parenchymal haemorrhage in frontal lobe.	Parenchymal haemorrhage in frontal lobe.	YES	NO
30	**19**	**M**	RICP, SD, infection.	Supratentorial hydrocephalus.	Severe adhesive 3rd ventricle ependymitis.	NO	NO
31	**32**	**F**	Epilepsy.	Loss of white-gray matter interface in left temporal lobe. Normal ventricles.	Narrow left temporal ventricle.	YES	NO
32	**37**	**F**	RICP.	Supratentorial hydrocephalus. Right supra- infratentorial arachnoid cyst.	Ventriculomegally. Right supra-infratentorial arachnoid cyst.	YES	NO
33	**27**	**M**	Dementia.	Hydrocephalus. Porencephalic cyst.	Cyst independent from dilated ventricles.	YES	NO
34	**30**	**M**	RICP, SD. Left hemiparesis	Supratentorial hydrocephalus. 4th ventricle cyst.	Ventriculomegaly with extensive intraventricular fibrosis.	NO	NO
35	**50**	**M**	RICP, social neglect.	Supratentorial hydrocephalus.	Ventriculomegaly.	YES	NO
36	**35**	**M**	RICP, signs and symptoms of infection.	Supratentorial hydrocephalus with ependymitis.	Ventriculomegaly with NO ependymitis. Abundant fibrosis in 3rd (with small compartments) and lateral ventricles*.	NO/ NO	YES/ YES

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
37	**46**	**M**	Epilepsy.	Left temporal lobe atrophy.	Intraventricular electrode placement control. Ventriculomegaly.	YES	NO
38	**21**	**M**	Epilepsy.	Left temporal lobe epileptogenic focus.	Narrow ventricle. Failed endoscopy.	--	--
39	**41**	**F**	Arnold Chiari and RICP.	Ventriculomegaly.	Ventriculomegaly.	YES	NO
40	**46**	**M**	Brain injury sequels.	Ventriculomegaly.	Turbid CSF poor visualization.	--	--
41	**19**	**M**	RICP.	Supratentorial hydrocephalus.	Ventriculomegaly. Granular ependymitis.	NO	NO
42	**23**	**M**	RICP.	Universal hydrocephalus.	Fibrous bands and ependymitis with Monroe obstruction.	NO	YES
43	**45**	**M**	Chiasmal syndrome.	Hypophyseal macroadenoma.	Bloody tumour bed.	--	--
44	**35**	**F**	Acromegaly	Supratentorial tumour.	Bloody tumour bed.	--	--
45	**42**	**M**	Vague neurological symptoms.	Universal hydrocephalus. HIV +.	Hypertrophic ependymitis with fibrous deposits in the III ventricle floor. Generalized tissue paleness.	NO	YES
46	**27**	**M**	Postra-umatic hydro-cephalus.	Dilated independent supratentorial ventricles.	Normal pressure ventriculomegaly due to Munro foramen obstruction.	NO	YES
47	**23**	**M**	Postra-umatic hydro-cephalus.	Supratentorial ventriculomegaly.	Three ventricle dilatation with thin 3rd ventricle floor.	YES	NO
48	**26**	**F**	Amenor-rhoea, galactor-rhoea, and mild headache.	Hydrocephalus, Lateral ventriculomegally with sellar arachnoidocele.	Ventriculomegaly, Munro foramen obstruction due to arachnoid membranes.	NO	YES
49	**47**	**M**	Epilepsy, dementia.	Hydrocephalus, Multiple cerebral cysticerci.	Viable cysticerci with scolex contained in turbid fluid* (both endoscopies).	YES/ YES	NO/ NO

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
50	**56**	**M**	RICP.	Hypodense images in 3rd ventricle and basal cisterns.	Viable cysticerci in 3rd ventricle contained in turbid fluid, obstructing visualization of the floor.	YES	NO
51	**42**	**F**	RICP.	Supratentorial hydrocephalus with widened infundibular recess.	Ventriculomegaly with widened infundibular recess.	YES	NO
52	**54**	**M**	RICP, mood changes, episodic fever.	Global hydrocephalus.	Ventriculomegaly.	YES	NO
53	**34**	**F**	RICP, Right frontal cystic tumour	Cystic hypodense tumour.	Cerebral surface cyst wall	YES	NO
54	**15**	**M**	RICP, SD, Arnold-Chiari.	Three ventricle hydrocephalus, corpus callosum agenesis, cephalic catheter in brain tissue.	Ventriculomegaly, ventricular septum agenesis, cephalic catheter in brain tissue.	YES	NO
55	**21**	**M**	RICP, SD, Arnold-Chiari.	Three ventricle hydrocephalus, corpus callosum and septum agenesis, cephalic catheter in ventricle.	Ventriculomegaly, ventricular septum agenesis, granular ependymitis, cephalic catheter in ventricle.	NO	NO
56	**32**	**M**	RICP.	Left and 3rd ventricle hydrocephalus.	Isolated right ventricle	YES	NO
57	**25**	**M**	RICP, dizziness, confusion, dementia, meningeal signs. HIV +	3-ventricle hypertensive hydrocephalus	Turbid dense liquid, pale tissue covering ependymal walls, with adhesive clots and membranes	NO	YES

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
58	**57**	**M**	RICP. Incoherent language, Dizzyness	Hydrocephalus, granular ependymitis.	Ventriculomegaly, granular ependymitis with café au lait spots and verrucae, 3rd ventricle floor stiffness.	NO	NO
59	**39**	**F**	RICP, diplopia.	Triventricular hydrocephalus.	Ventriculomegaly with severe septum lacerations.	YES	NO
60	**33**	**M**	RICP.	Hydrocephalus	Ventriculomegaly, severe septum lacerations, granular ependymitis and verrucae.	NO	NO
61	**44**	**M**	Headache, seizures.	Viable cysticerci in brain parenchyma and cisterns.	Viable parenchymal and cisternal cysticerci.	YES	NO
62	**44**	**M**	RICP, cysticercosis.	Hydrocephalus, 3rd ventricle and cisternal cysticerci.	Ventriculomegaly, 3rd ventricle and cisternal cysticerci.	YES	NO
63	**44**	**M**	Shunt dysfunction	Hydrocephalus.	Ventriculomegaly, cysticercus in shunt tip.	NO	NO
64	**58**	**M**	RICP, ataxia, Parinaud, diplopia.	Hydrocephalus, pineal tumour with possible 3rd ventricle involvement.	Ventriculomegaly, pineal tumour with 3rd ventricle involvement.	YES	NO
65	**44**	**M**	RICP.	Shunt dysfunction.	Cysticercus in shunt tip.	NO	NO
66	**28**	**F**	RICP, left hemi-paresis.	Right frontotemporoparietal cyst.	Cystic breast cancer metastasis.	YES	NO
67	**40**	**F**	RICP. macrocephalus	Severe hydrocephalus.	Ventriculomegaly, fibrous ependymal and cisternal bands, atrophic choroid plexus.	NO	NO
68	**16**	**F**	Headache, dizziness	Hydrocephalus, rare images in 3rd ventricle floor.	Ventriculomegaly.	NO	NO

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
69	**33**	**M**	Headache, dizziness, ataxia.	Hydrocephalus, right hemisphere cerebellar tumour.	Ventriculomegaly.	YES	NO
70	**39**	**M**	RICP, dizziness.	Three-ventricle hydrocephalus, occluded aqueduct.	Ventriculomegaly, prepontine and premesencephalic adherences.	NO	NO
71	**73**	**F**	Sudden dysphasia and headache.	Hydrocephalus and a 4th ventricle hemorrhage	Ventriculomegaly and an active 3rd ventricle hemorrhage.	NO	YES
72	**61**	**F**	Hakim-Adams triad, progressive headache	Three-ventricle hydrocephalus, occluded aqueduct.	Ventriculomegaly	YES	NO
73	**40**	**M**	RICP, headache, confusion, fever, meningeal signs, ataxia. HIV +	Hydrocephalus, thalamic tumour with 3rd ventricle involvement.	Ventriculomegaly, pale granular ependyma, no tumour in 3rd ventricle.	NO	YES
74	**41**	**F**	RICP, previous posterior fossa operation	Three-ventricle hydrocephalus.	Ventriculomegaly, adhesive arachnoiditis in premesencephalic and prepontine cistern.	NO	YES
75	**31**	**M**	RICP	Three-ventricule hydrocephalus	Ventriculomegaly, cisternal cysticercosis	NO	NO
76	**67**	**M**	Headache, tremor, confusion, incoherent language	Hydrocephalus, ventricular cysticerci	Ventriculomegal, aracnoid cyst	NO	YES
77	**65**	**M**	Headache, aggressive behavior, somnolence	Cystic lesions in Sylvian sulcus	Epidermoid in Sylvian sulcus.	NO	YES
78	**72**	**M**	Hakim-Adams triad, progressive headache	Three-ventricle asymmetric hydrocephalus, occluded aqueduct.	Ventriculomegaly, ependymitis with opaque epithelia.	NO	YES

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
79	**81**	**M**	Right hemi-paresis, memory dysfun-ction, visual and auditive hallucinations.	Hydrocephalus, diencephalic lesion affecting 3rd ventricle.	Ventriculomegaly, thinning and protruding cyst in 3rd ventricle wall.	NO	YES
80	**40**	**F**	Seizures, RICP.	Three-ventricle hydrocephalus, increased prepontine cistern, brain calcifications.	Ventriculomegaly, cysticerci in prepontine and premesencephalic cistern.	YES	NO
81	**27**	**M**	RICP, ataxia, dystonia.	Brain stem tumour with 3rd and 4rd ventricle involvement.	Ventriculomegaly, tumour invading 3rd ventricle.	YES	NO
82	**54**	**M**	RICP.	Three-ventricle hydrocephalus, cisternal cysticerci. Post ETV and cysticercal removal. Hydrocephalus.	Ventriculomegaly, cisternal cysticercosis.	YES	NO
83	**54**	**M**	RICP	Post ETV and cysticercal removal. Hydrocephalus.	Ventriculomegaly, severe ventriculitis-arachnoiditis. Ventriculomegaly, severe ventriculitis-arachnoiditis	NO/ YES	NO/ NO
84	**39**	**F**	RICP	Hydrocephalus, 3rd ventricle tumour.	Ventriculomegaly, tumour in 3rd ventricle.	YES	NO
85	**62**	**F**	Headache, memory loss.	Three-ventricle hydrocephalus.	Ventriculomegaly.	YES	NO
86	**33**	**M**	RICP, myalgia.	Hydrocephalus, ependymitis.	Ventriculomegaly, granular ventriculitis and arachnoiditis	YES	YES
87	**59**	**M**	RICP.	Three-ventricle hydrocephalus.	Ventriculomegaly, cisternal cysticercosis	YES	NO

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
88	**64**	**M**	Dysartria, ataxia, dementia, headache	Three-ventricle hydrocephalus, cisternal cysticercosis	Ventriculomegaly, cisternal cysticercosis	YES	NO
89	**69**	**F**	Headache, seizures, aphasia, weakness	Three-ventricle hydrocephalus.	Ventriculomegaly, mild arachnoiditis	NO	NO
90	**32**	**F**	RICP	Hydrocephalus	Ventriculomegaly	YES	NO
91	**37**	**F**	RICP, ataxia, vertigo	Three-ventricle hydrocephalus, cystic cerebellar tumour	Endoscopy-assisted resection of haemangioblastoma	YES	NO
92	**26**	**M**	RICP, ophtalmo-plegia, somnolence	Three-ventricle hydrocephalus, thalamic tumour.	Ventriculomegaly, 3rd ventricle compression, sponge-like tumour.	YES	NO
93	**37**	**M**	RICP	Isolated cyst from shunted ventricles.	Ventriculomegaly, intracystic cysticerci, isolated from shunt tip	NO	YES
94	**42**	**F**	RICP, seizures	Communicating hydrocephalus	Ventriculomegaly, cisternal fibrosis unable to pass the endoscope	NO	YES
95	**48**	**M**	RICP	Three-ventricle hydrocephalus	Ventriculomegaly	YES	NO
96	**40**	**F**	RICP, colloid cyst in the 3rd ventricle	Three-ventricle hydrocephalus, colloid cyst in 3rd ventricle roof	Ventriculomegally, colloid cyst. Partial resection in second endoscopy	YES/ YES	NO/ NO
97	**33**	**M**	RICP	Hydrocephalus	Ventriculomegaly	YES	NO
98	**37**	**F**	RICP	Three-ventricle hydrocephalus, colloid cyst in 3rd ventricle	Ventriculomegaly, colloid cyst. Total resection through vellum interpositum	YES	NO
99	**16**	**F**	Epilepsy	Arachnoid cyst in left sylvian fissure	Thick and stiff onion-skin cystic walls. Cystic communication to basal cisterns	YES	NO
100	**53**	**M**	RICP, dementia	Three-ventricle hydrocephalus, third ventricle tumour	Ventriculomegaly, third ventricle craniopharyngioma	YES/ YES	NO/ YES

Case	Age	Sex	Clinical Diagnosis	Image Diagnosis	Endoscopic Diagnosis	Ct/Endo Correl	Tx Modif
101	**70**	**M**	RICP, dementia	Communicating hydrocephalus	Ventriculomegaly	YES	NO
102	**82**	**M**	RICP, dementia	Three ventricle hydrocephalus	Ventriculomegally. Cysticercal resection in basal cistern. Widespread ependymitis on a second operation.	NO/ NO	YES/ NO
103	**24**	**F**	RICP	Right lateral ventricle hydrocephalus	Right lateral ventriculomegally due to Monroe foramen blocking by ependymal lining	NO	YES
104	**46**	**F**	CSF fistula	Right frontal floor defect with encephalocele	The same	YES	NO
105	**28**	**M**	RICP	Universal hydrocephalus due to intraventricular firm tumour	Soft bloody intraventricular tumour	YES	YES

*Diagnosis and findings of second endoscopy.
RICP: Raised Intracranial Pressure. **SD**: Shunt dysfunction. **CSF**: Cerebrospinal Fluid. **M**: Male. **F**: Female.

Table 1. Endoscopy Cases Characteristics.

Among our cases, 72% have been admitted with raised intracranial pressure. Most of these consisted of hypertensive hydrocephalus, although some were diagnosed as intracranial haematomas, cystic tumours with no hydrocephalus, arachnoid and cysticercal cysts, and other diagnosis. All of them but a few were resolved with endoscopic procedures, including drainage, resection and fenestration.

Focal neurological dysfunction was the second syndromic diagnosis which was associated with brain infarcts, visual or other cranial nerve impairment. Some of these cases shared other syndromes such as raised intracranial pressure, meningismus, etc., since these diagnoses were not exclusive.

Dementia was associated with 14% of the cases explored with endoscopy. Not attributed to raised intracranial pressure, necessarily, although shared by this syndrome was a constant feature. Many of these patients were diagnosed as Hakim syndromes and had some improvement of the dementia component after endoscopic exploration and subsequent shunting.

Seizures as an epileptic entity or an isolated event was present in 13% of the cases studied. In some patients epileptic fits were an integral part of the disease, especially in those which were operated on for seizure control under endoscopical supervision. Such cases have been subject to other publications (2) nevertheless it is worth stressing that endoscope-assisted procedures in open neurosurgeries for patients with pharmacological deficient control, have made substantial contributions to the success in the treatment of those patients.

Central nervous system infection (4%), cerebrospinal-fluid fistula (2%), chiasmal compression syndrome (2%), and endocrine syndrome (2%) were other pathological entities encountered in the series.

Neurocysticercosis is a parasitic disease that has been diagnosed not only in some developing countries, where it is considered endemic, but also in developed countries, where it is experiencing a continuous increase. The cause of this increase is an ever growing migrant population towards many countries of **N**orthamerica, Europe, etc. Many series of cases of neurocysticercosis highlight the role for endoscopy in order to achieve two main purposes: to diagnose with precision in cases of intracranial and intraspinal cysts where no scolex has been observed with image studies, and to establish a treatment protocol for different pathological entities related to the parasite, such as hidrocephalus, associated with different degrees of ventricular/cisternal inflammatory lesions, as well as its appropriate timing. According to our observations, individual therapeutic measures may be indicated for different time spans in regard to cysticercal disease. The removal of the cyst may be only a limited part of the treatment when dealing with a complex case, in which other anti-cystciercal measures have failed. In such cases, different treatment modalities may be included simultaneously, given the extensive clinico-pathological polymorphism of this disease.

Cysticercosis cases have presented in our hospitals with many clinical manifestations, such as raised intracranial pressure due to mass effect and/or hypertensive hydrocephalus, meningitis, stroke, dementia, epilepsy, etc. It is not uncommon to include in the treatment protocol several drugs, such as one or more antiepileptics, analgesics, immune depressors, gastric protectors, antibiotics, anticysticercals, etc. Moreover, the treatment modalities include one or more surgical operations which may commonly include endoscopic procedures that the neurosurgeon must be ready to perform.

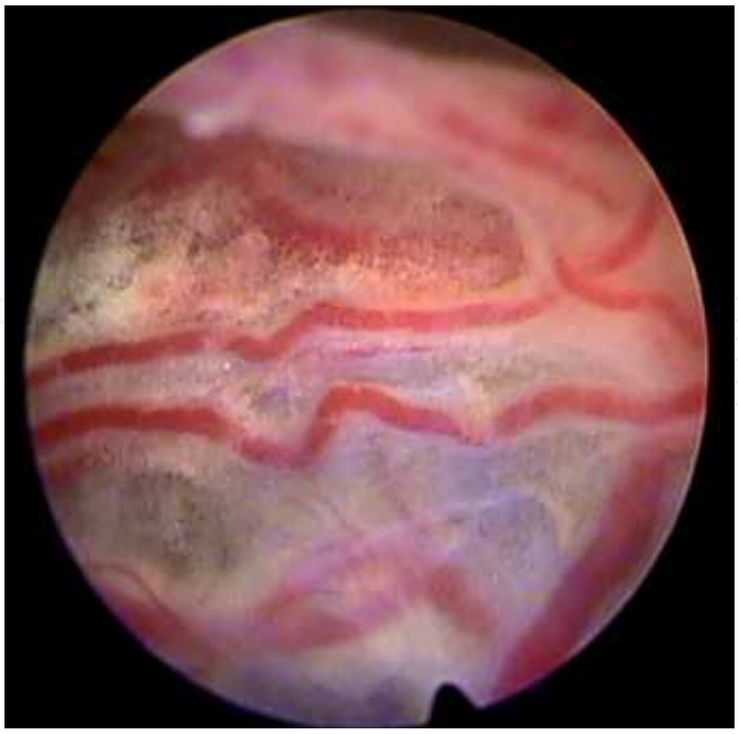

Fig. 1. Vascularised capsule from cyst containing live cysticerci.

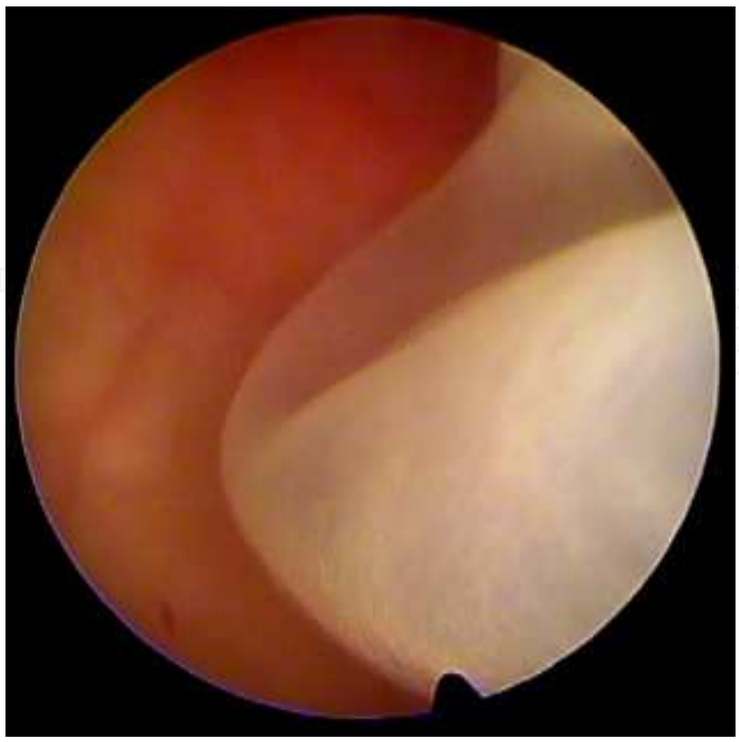

Fig. 2. Intracapsular view of the viable cysticerci and the characteristics of the highy vascularised capsule wall.

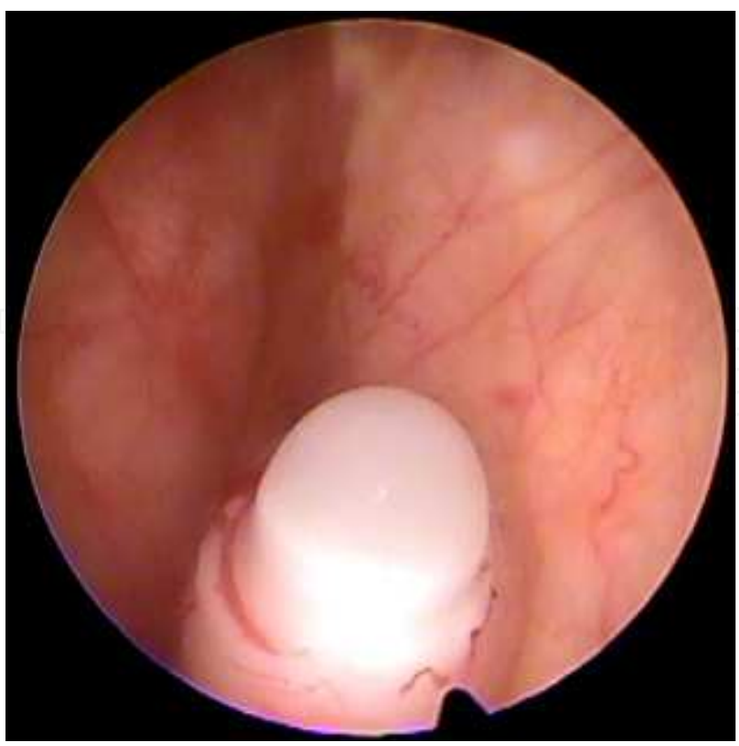

Fig. 3. Intracapsular communication with the ventricular catheter from the shunt system.

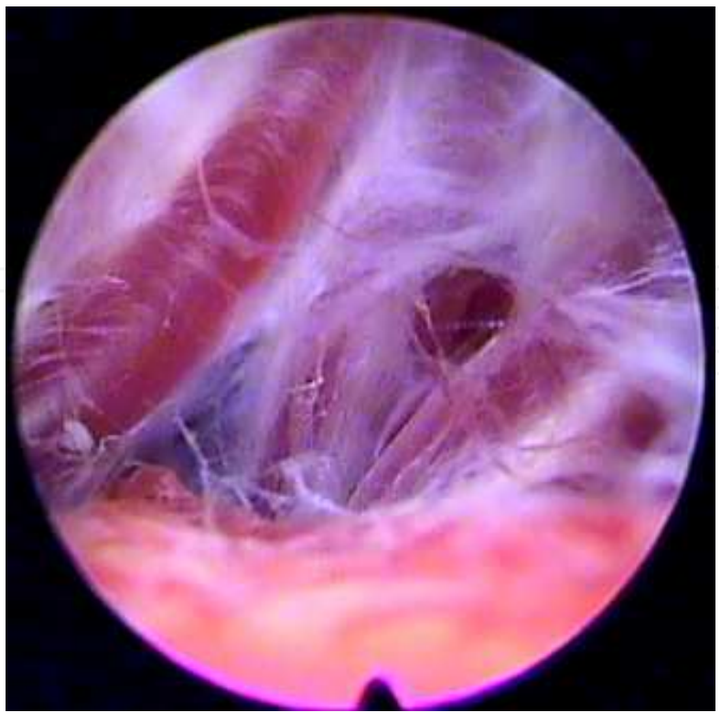

Fig. 4. Firmly adhered capsule to pericystic blood vessels in a case of an arachnoid cyst in the left Sylvian fissure.

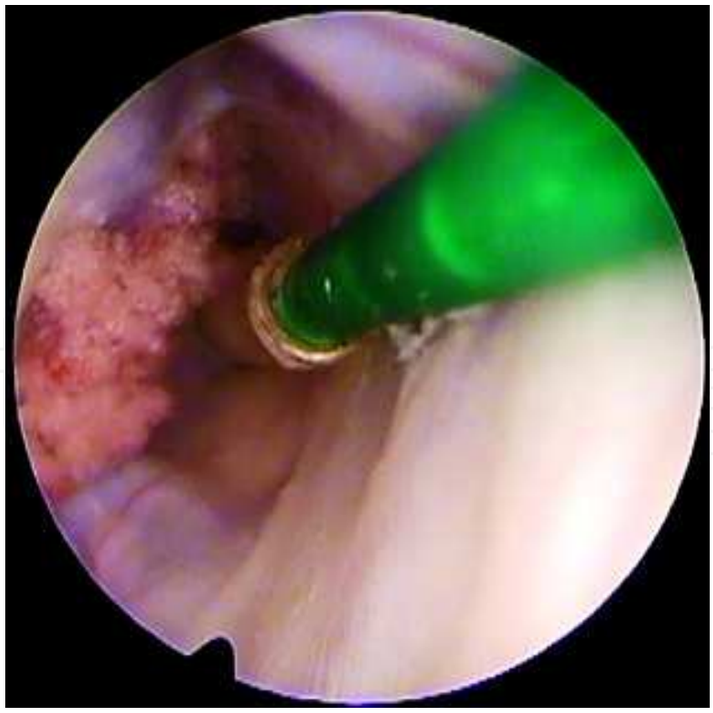

Fig. 5. Colloid cyst capsule involvement of the choroid plexus and foramen of Monroe. Wall characteristics resemble closely those of an aracnoid cyst in vascularity, firm consistency and piercing resistance.

As opposed with some centers in which complicated patients are sent home to meet their fate, all the patients in our hospitals receive some kind of treatment, regardless of their condition. Cases of so called malignant cysticercosis are treated with all the therapeutic resources at hand, with an aggressive treatment that matches the malignancy of the disease.

Some unusual cases of neurocysticercosis have been described previously (7). Although some cases may be considered as coincidences, others may be pathological enigmas. One of these latter cases is a patient who was initially diagnosed as having an interhemispheric arachnoid cyst. During endoscopic exploration, a cyst with a highly vascularised hard capsule was encountered. After several perforations were made, a transparent yellow fluid escaped from the interior of the cyst and several viable cysticerci were also found. The parasites and several blood clots adhered to de walls of the cyst were then removed and finally the cyst was communicated with the ventricluar system where a functional shunt system was previously installed (figures 1-3). After a thorough search in the literature, cyst formations in the subarachnoid space that surrounded live cysticerci have not been previously described. The capsule was similar in resistance, vascularity, and rigidity to those found in other cystic lesions, like arachnoid and colloid cysts (figures 4-5). This could mean that cystcerci may also colonize arachnoid cysts or, on the other hand, they may form a capsule quite similar to that of a congenital condition.

Although few endoscopically accessible tumours can be resected completely, biopsies of larger and more vascularised lesions can be taken with precision from selected areas, considering the amount vascular proliferation, its location and associated phenomena. Because of blurring of the entire field, which may be time-consuming to clear and sometimes difficult to achieve, a bloody fluid-filled space is a major drawback during the tumour resection. Among the tumour type that have been reported to complete or almost complete resection, colloid cysts, some astrocytomas, subependymomas, third ventricle craniopharingiomas, etc, may be mentioned. Hydrocephalus, if present, can be treated during the same exploratory procedure.

Our experience with endoscopy in tumour cases has included 19 cases. Biopsies have been performed in 11 cases while resections have been accomplished in 8. Some of the tumour types include meningiomas and craniopharingiomas within the third ventricle, exophytic gliomas, cystic astrocytomas and carcinomas. Although some intracranial lesions don't have a neoplastic nature strictly speaking, colloid, porencephalic, and arachnoid cysts may also be included in this section because of its commonly associated mass effect.

Endoscopic views from the tumour capsule and surface may have a characteristic appearance when its fluid is clear or has been washed with physiologic solution. There is usually a vascular mesh composed of layers of nets imposed one on top of the other, as onion skins. The vascular proliferation as observed with endoscopy vary according to the tumour type, and it is most abundant as more malignant the tumour is (figs 6-7).

Endoscopic assistance in open cranial neurosurgery has been described for several years, according to the articles written by Perneczky and coworkers, among others (4). Indications of endoscopy related to this modality have also increased, and ongoing publications of new indications are constantly appearing in the words neurosurgical literature. It is frequently used to reach spaces that are normally difficult to observe with the microscope, making the surgical procedure safer. Aneurysm clipping, cranial nerve dissection, are some among many the operations that may normally be assisted with endoscopes.

New indications for endoscopy imaging have been appearing continuously, not only to obtain a precise diagnosis, but also to assist in open surgical procedures. It is now possible to measure the extent of callosal section with endoscopy assistance, as well as ventricular

exploration before electrode implantation during epilepsy surgery (3). Among our cases, an endoscopical exploration of the temporal horn of the lateral ventricle was explored previous to electrode placement for resective epilepsy surgery in three patients. In another 2 patients, the endoscope was used to assess the extent of the callosal section. There were no complications derived from these procedures which take only several additional minutes in the operating period. Other authors have inserted electrodes within the ventricles for the same purpose, and their conclusions are similar to ours (5).

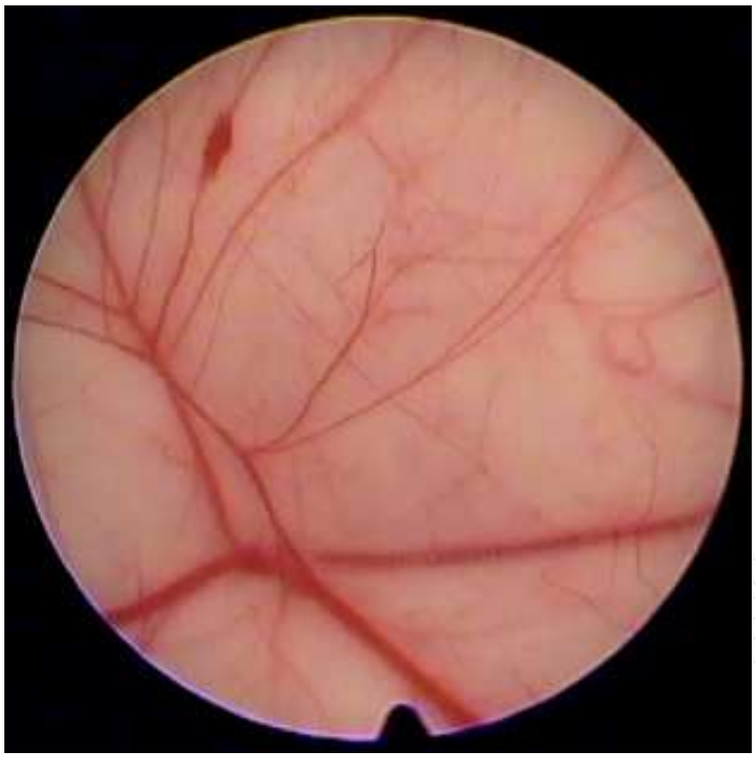

Fig. 6. Visceral cyst wall in a case of cystic astrocytoma. Large vessels organized in several leyers with different depths, occasionally with varicous formations.

HIV-associated hydrocephalus has been explored endoscopically in three patients. Clinically, they have been diagnosed following a continuously deteriorating and waisting condition that suddenly involved the central nervous system. Other common clinical data, like diarrhea, weight loss, cutaneous lesions, etc. were present at the time of hydrocephalus diagnosis. CT scans demonstrated obstructive hydrocephalus with a variable degree of inflammatory ependymal reaction which was confirmed with endoscopical observations. Grayish-white exudates in the ependymal lining, pseudo-membrane formation, inflammatory bands, etc. and other lesions that blocked the cerebro-spinal fluid drainage systems, like the foramen of Monroe and the cerebral aqueduct, were constant findings. Similar to the tuberculous leptomeningitis, the clinical course in these patients was a progressive deterioration regardless of the pharmacological and surgical treatments.

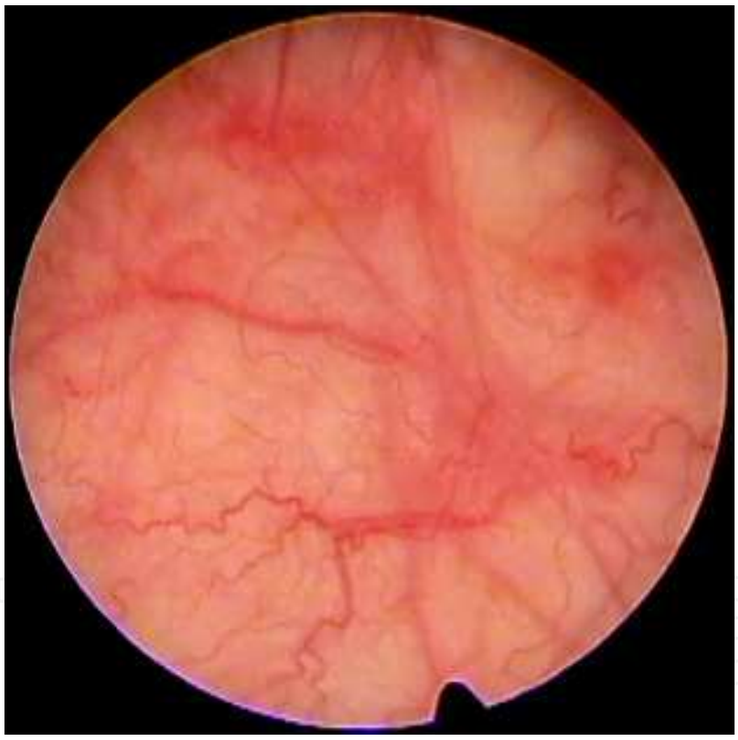

Fig. 7. Dense proliferation resembling a multi-leyer vascular mesh in a case of cystic carcinoma. Opaque yellow fluid has been removed and substituted with saline solution.

Postoperative complications after the use of endoscopical equipments are very rare, owing to the minimally-invasive nature of the procedure and the relative ease which the equipment may be handled. Some of these complications reported in the literature have been cases of infections, haemorrhages, or additional cerebral lesions caused by the surgeon; raised intracranial pressure during the procedure caused by defective fluid drainage-related at the time of endoscopy, which may account for neurological deterioration and death, has become a recent concern that was largely ignored in the past.

Among our cases, the complications that have been observed were accidental punctures to the ventricle walls and lacerations to the borders of the foramen of Monroe. These lesions have apparently been clinically silent. Unsuccessful endoscopical procedures may sometimes be considered as surgical complications, considering the cerebral laceration that is necessary to have access to the ventricles. Taking into account those cases, we would have a higher rate of complications, especially in early procedures when the endoscopic equipments were more modest.

Although not described by other authors, and even denied by some (6), the endoscopic findings encountered during a second procedure in patients with persistent hydrocephalus following cyticercal resection, have consisted of different types of inflammatory lesions. Because the release of the cyst content has been the probable cause for such inflammatory lesions, these findings that appear in the postoperative period, may be considered by some as complications. Four patients diagnosed as persistent cysticercal hydrocephalus, in which we have performed a second endoscopical observation, could then have increased our complication rate.

Technological progress has included endoscopy as well as other similar procedures that may be yield similar images, like virtual endoscopy. Until now the special lenses-based Hopkins system images may be superior compared to those obtained through a pixel-based computer reconstruction, although digital technology may be superior to optic technology at some point.

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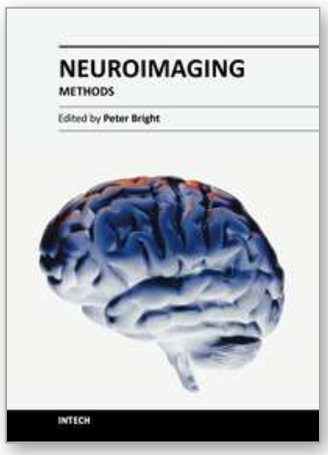

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Neuroimaging methodologies continue to develop at a remarkable rate, providing ever more sophisticated techniques for investigating brain structure and function. The scope of this book is not to provide a comprehensive overview of methods and applications but to provide a 'snapshot' of current approaches using well established and newly emerging techniques. Taken together, these chapters provide a broad sense of how the limits of what is achievable with neuroimaging methods are being stretched.

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