J Ultrasound (2016) 19:211–215
DOI 10.1007/s40477-014-0151-0

CASE REPORT

Intraoperative cerebral ultrasound for third ventricle colloid cyst removal: case report

Assunta Filippini · Francesco Prada · Massimiliano Del Bene · Francesco DiMeco

Received: 3 October 2014 / Accepted: 21 November 2014 / Published online: 10 December 2014

Abstract
Purpose To assess the usefulness of intraoperative Ultrasound (ioUS) and Echo-Color-Doppler (ECD) for the surgical removal of a specific deep-sited lesion.
Methods Case report of a woman underwent surgery of a third ventricle colloid cystremoval.
Results The ioUS technique depicted the deep intraventricular lesion and all theanatomical structures surrounding the lesion; helping us defining the best trajectory forthe safest surgical removal.
Conclusion In our experience ioUS and ECD have demonstrated to be a reliable anduseful intraoperative tool in neurosurgery, not only for superficial tumors but for deepintraventicular lesions as well.

Keywords Colloid cyst · Ultrasound · Eco-color-doppler · Hydrocephalus · Drop attack

Riassunto
Obiettivi Lo scopo di questo articolo è quello di mostrare l'utilizzo dell'ecografia intra operatoria, in B-mode ed Eco-Color-Doppler, durante un intervento di asportazione di lesione situata profondamente nelle strutture endocraniche cerebrali.
Materiali e Metodi Descrizione di un caso clinico di asportazione chirurgica di una cisti colloide del terzo ventricolo per via trans-ventricolare frontale destra.
Risultati L'imaging ecografico intraoperatorio ha permesso di evidenziare e riconoscere precisamente la lesione endoventricolare e tutte le strutture circostanti, seppur situate profondamente, permettendo in tal modo durante l'intervento di assicurare la definizione del miglior approccio chirurgico per una asportazione completa e anatomicamente sicura.
Conclusioni In base alla nostra esperienza la tecnica ecografica si è dimostrate affidabile e sicura, durante le procedure neurochirurgiche di asportazione lesionale, non solo per le patologie superficiali (corticali/sottocorticali), ma anche nei casi di lesioni profonde e nel riconoscimento di strutture vitali.

A. Filippini (✉) · F. Prada · M. Del Bene · F. DiMeco
Department of Neurosurgery, Fondazione IRCCS Istituto Neurologico "C. Besta", Via Celoria 11, 20133 Milan, Italy
e-mail: assunta_filippini@virgilio.it

F. Prada
e-mail: francesco.prada@istituto-besta.it

M. Del Bene
e-mail: macs.delbene@gmail.com

F. DiMeco
e-mail: fdimeco@istituto-besta.it

Abbreviations

CC	Colloid cyst
IOUS	Intraoperative ultrasound
ECD	Eco-color doppler
NN	Neuronavigation
CT	Computed tomography
MRI	Magnetic resonance imaging

Introduction

Colloid Cysts (CC) are uncommon brain lesions, accounting for 0.2–2 % of all brain tumors. This benign neoplasm is generally located in the anterior portion of the third ventricle and account for 7–10 % of all intraventricular lesions [1]. Major clinical features include symptoms related to increased intracranial pressure and hydrocephalus, due to

foramina of Monroe obstruction. Other common signs are sudden drop attacks caused by transient cerebrospinal fluid pathway occlusion, and amnesia related to forniceal compression [2, 3].

Pediatric cases have been associated to a more aggressive clinical and radiological pattern compared to their adult counterparts [4, 5].

The first surgical excision was successfully performed by Dandy in 1921 [9]. Microsurgical resection has become the "gold standard" in CC treatment. Many surgical approaches are to be considered; the main routes are the transcortical/transventricular (either microsurgical or endoscopic) [6, 8] or interhemispheric with all possible variants (transcallosal, interforniceal, transchoroidal) [6, 7, 9]. The surgical approach is usually chosen on the basis of radiological and clinical features [10]. In particular, when there is concomitant hydrocephalus a transventricular microsurgical approach is preferred [11].

Image guidance is nowadays mandatory in cerebral surgery, and neuronavigation (NN) is a routine tool to plan and control the different steps of surgery. Nevertheless, being based on pre-operative images that are not updated, it does not account for intraoperative changes [12, 13].

In this paper, we describe a case of a third ventricle colloid cyst resected with intraoperative ultrasound (IOUS) guidance along with neuronavigation. We discuss the ability of IOUS to highlight even deep-seated brain lesions, along with their relationships with surrounding neural and vascular structures; providing a real time, dynamic imaging that, coupled with neuronavigation, facilitates the surgical approach and enhance the surgical strategy.

Case description

A 58-year old woman presented at our institution with 1-year history of drop-attack-like symptoms, followed by a generalized seizure 1 month before admission in our hospital.

She performed a brain computed tomography (CT), which showed a rounded-shape hyperintense lesion, located in the anterior portion of the third ventricle, with concomitant lateral ventricles dilatation.

The patient underwent further evaluation with cerebral magnetic resonance imaging (MRI), which confirmed the lesion in the third ventricle. The lesion appeared iso-hyperintense in T1-weighted sequences, without contrast enhancement after Gadolinium injection. The radiological pattern was highly suggestive for colloid cyst of third ventricle with obstructive hydrocephalus.

The patient underwent microsurgical excision of the lesion via right frontal transcortical-transventricular approach through the enlarged right lateral ventricle, with neuronavigation guidance and IOUS.

Surgical planning was performed using a standard NN system (Stealth Station, Medtronic, USA). A coronal para-sagittal frontal right craniotomy was performed (Fig. 1).

After bone flap removal, US evaluation is performed, using a last generation US device (MyLab, Esaote, Genoa, Italy). A 3–11 MHz linear US probe (LA 332 –Esaote, Italy) is placed in a surgical sterile transparent plastic sheath (Civco, USA), along with 5 ml of US transducing gel. The probe is placed over the dura to acquire standard B-mode imaging scans. The lesion is identified on the two axes and measured. The lesion is also localized with standard NN. We also assessed the surgical trajectory through the lateral and third ventricle and evaluated the location of the lesion, as well as its relationship with the surrounding structures and its total surgical removal using US.

The lesion was scanned in both coronal and sagittal axis (Fig. 3, 4) and the relationship with the surrounding structures such as foramen of Monroe, choroidal plexuses fornices, thalamic veins, and the anterior part of the third ventricle, has been assessed.

The surgical trajectory is confirmed after proper US evaluation of the right lateral ventricle and position of the foramen of Monroe, planning the correct point of entrance and the correct angle for the transcortical-transventricular surgical corridor (Fig. 1).

The Echo-Color-Doppler (ECD) modality allows also the identification of vascular structure along the surgical corridor and nearby the lesion. In this specific case, it was possible to identify the pericallosal and callosomarginal arteries (Fig. 4) and the thalamic veins during the surgical approach.

The anterior part of the third ventricle was precisely depicted identifying its anatomical structures; supraoptical recess, the infundibulum, and the choroidal plexus were identified (Fig. 2).

Direct US visualization of all anatomical landmarks helped to define the trajectory to reach the lesion and proceed to excision in microscopic view, sparing and preserving all the fundamental structures of this anatomical region.

The post-operative CT scan demonstrated complete removal of the mass, associated to initial reduction of ventricular dilatation, with no surgical-related complications.

Histopathology confirmed the lesion was a colloid cyst.

The patient fully recovered in few days and was discharged in 4 days without any radiological deficit.

At 6 months follow-up, she was seizure-free and returned to her daily duties.

Discussion

Colloid cysts are rare benign lesions, with surgical indication in most of cases, especially if hydrocephalus is present.

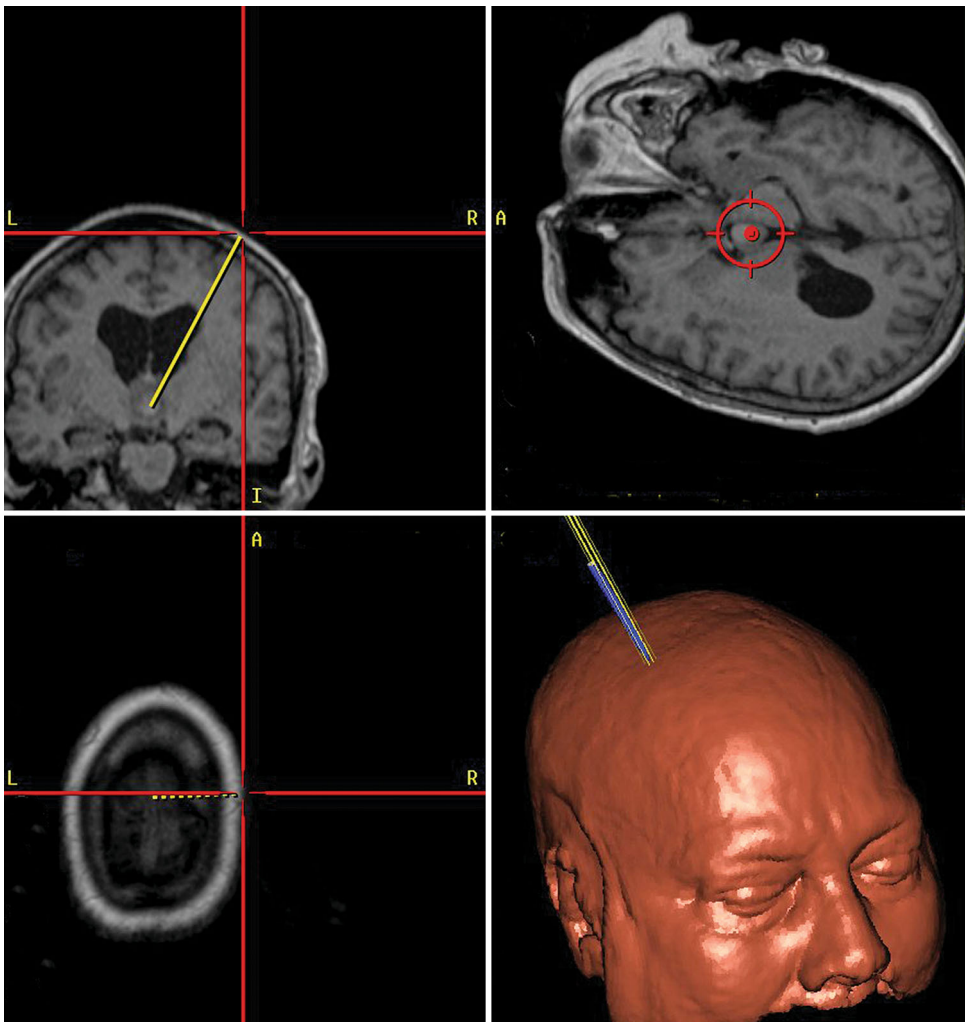

Fig. 1 Neuronavigation trajectory planning. From *left* to *right* from *up* to *down*: coronal view; axial view; 3D view

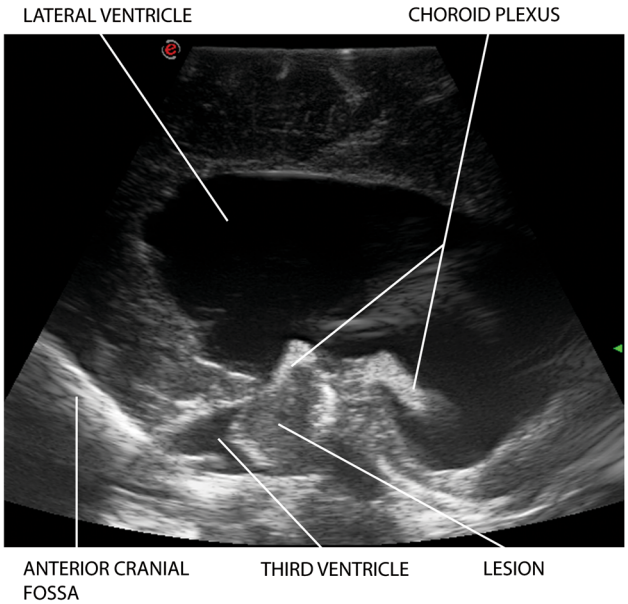

Fig. 2 Coronal-oblique view B-mode scan

This case has been one of the hundreds of cases in which we adopt intraoperative US.

From our experience IOUS has demonstrated to be a precise and reliable intrasurgical technique, to identify all anatomical landmarks, achieving an intraoperative real-time visualization of the lesion itself, all its surrounding structures, both neural and vascular, as well as ventricular system. This tool is also useful in defining surgical route and supporting evaluation of the extent of resection.

NN system, although valuable for bone flap positioning and to calculate the surgical trajectory, has a decreased precision after dural opening due to brain shift [12, 13], in particular after entering the lateral ventricle and after cerebrospinal fluid escapes in cases with concomitant hydrocephalus, and tissue manipulation.

With the dramatic improvement of US imaging definition and resolution, this has become a useful tool for many neurosurgical intervention [15, 16].

In this particular case, we choose a transcortical-transventricular route taking account of the hydrocephalus. With

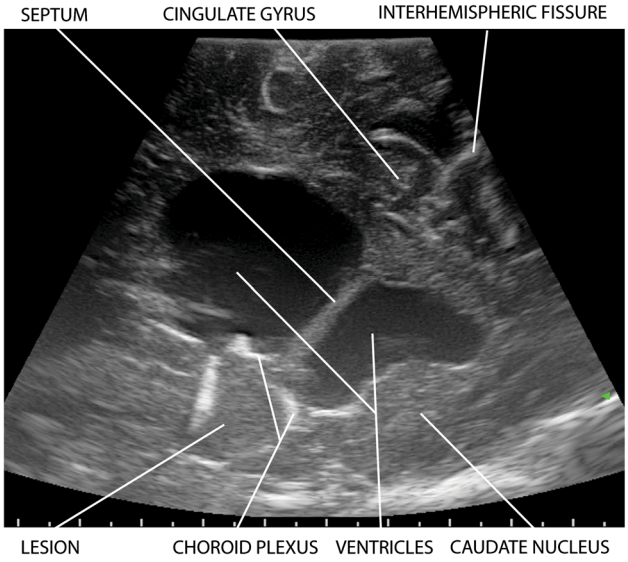

Fig. 3 Right frontal coronal-oblique view B-mode scan

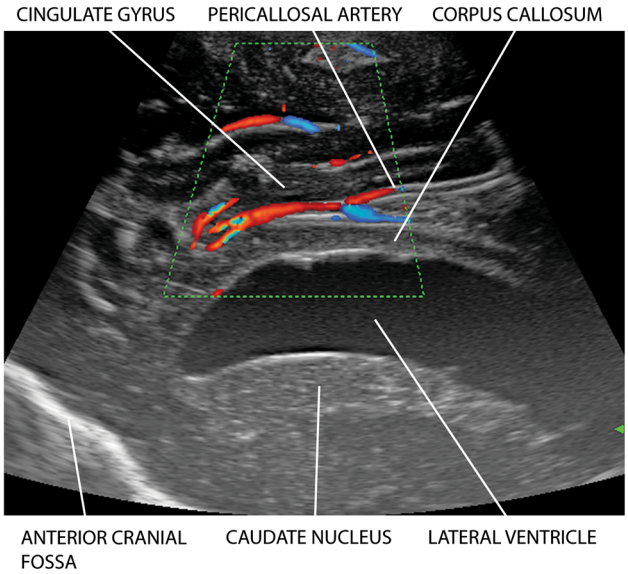

Fig. 4 Right frontal parasagittal B-mode with Eco-color-doppler scan

the assistance of IOUS, we were able to precisely define all the structures around third ventricle anatomical region (supraoptic recess, infundibulum, choroidal plexus, basilar artery) and design the precise way through these structures to excise the lesion without damage. The ventricular system was easily depicted, along with the falx, the tentorium, and the venous sinus (Fig. 2, 3).

With its highly defined feature of all these structures IOUS amount to guide intervention for intraventricular lesions and masses near by this deep anatomical region, where the presence of all these structures of primary importance dictate the need to characterize and protect them before and during excision.

Direct US visualization of all anatomical structures helped us define the safest trajectory to reach the lesion and proceed to complete excision in microscopic view.

Finally, the versatility of the technique permits to verify all the anatomical references through the intervention, introducing this technique as a useful neurosurgical tool.

Conclusion

Intraoperative US, thanks to improvements in quality of imaging, has demonstrated to be a precise, reliable and complete tool, permitting to identify all the anatomical structures (neural, vascular, and ventricular), and all the lesions and masses as well, in order to define the most appropriate surgical route, solving the limits of neuronavigation, and assisting the excision of the lesion as well as evaluate the final extent of resection

Conflict of interest Assunta Filippini, Francesco Prada, Massimiliano Del Bene, Francesco DiMeco declare that they have no conflict of interest.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). All patients provided written informed consent to enrolment in the study and to the inclusion in this article of information that could potentially lead to their identification.

Human and animal studies The study was conducted in accordance with all institutional and national guidelines for the care and use of laboratory animals.

References

1. Apuzzo MLJ (1998) Surgery in and around the anterior third ventricle, 2nd edn. Williams & Wilkins, pp. 541–580
2. Aggleton JP, McMackin D, Carpenter K, Hornak J, Gaffan D et al (2000) Differential cognitive effects of colloid cysts in the third ventricle that spare or compromise the fornix. Brain 123:800–815
3. Ibrahim I, Young CA, Larner AJ (2009) Fornix damage from solitary subependymal giant cell astrocytoma causing postoperative amnesic syndrome. Br J Hosp Med 70(8):478–479
4. Kumar V, Behari S, Kumar Singh R, Jain M, Jaiswal AK, Jain VK (2010) Pediatric colloid cysts of the third ventricle: management considerations. Acta Neurochir 152(3):451–461
5. Alnaghmoosh N, Alkhani A (2006) Colloid cysts in children, a clinical and radiological study. Childs Nerv Syst 22(5):514–516
6. Sheikh AB, Mendelson ZS, Liu JK (2014) Endoscopic versus microsurgical resection of colloid cysts: A systematic review and meta-analysis of 1,278 Cases. World Neurosurg (14)
7. Azzazi A, Al Mekawi S (2010) Colloid cysts of the third ventricle: endoscopic versus microsurgical removal. Neurosurg Q 20:142–145

8. Barlas O, Karadereler S (2004) Stereotactically guided microsurgical removal of colloid cysts. Acta Neurochir (Wien) 146:1199–1204
9. Bertalanffy H, Krayenbul N,Wess C, et al. Ventricular tumors. In: Winn RH, Brem H, Sawaya R (eds). Neurological Surgery, 6th edn. Elsevier, Saunders
10. Levine NB, Miller MN, Crone KR (2007) Endoscopic resection of colloid cysts: indications, technique, and results during a 13-year period. Minim Invasive Neurosurg 6:313–317
11. Stachura K, Libionka W, Moskala M, Krupa M, Polak J (2009) Colloid cysts of the third ventricle. Endoscopic and open microsurgical management. Neurol Neurochir Pol 43:251–257
12. Hill DLG, Maurer CR, Maciunas RJ, Barwise JA, Fitzpatrick JM, Wang MY (1998) Measurement of intraoperative brain surface deformation under a craniotomy. Neurosurgery 43:514–528
13. Roberts DW, Hartov A, Kennedy FE, Miga MI, Paulsen KD (1998) Intraoperative brain shift and deformation: a quantitative analysis of cortical displacement in 28 cases. Neurosurgery 43:749–76019
14. Moiyadi AV (2010) Objective assessment of intraoperative ultrasound in brain tumors. Acta Neurochir 156(4):703–704. doi:10.1007/s00701-014-2010-3 (Epub 2014 Feb 6)
15. Mair R, Heald J, Poeata I, Ivanov M (2013) A practical grading system of ultrasonographic visibility for intracerebral lesions. Acta Neurochir 155(12):2293–2298. doi:10.1007/s00701-013-1868-9 (Epub 2013 Sep 13)
16. Prada F, Mattei L, Del Bene M, Aiani L, DiMeco F et al (2014) Intraoperative cerebral glioma characterization with contrast enhanced ultrasound. Biomed Res Int. doi:10.1155/2014/484261 (Epub 2014 Jun 12)