Child's Nerv Syst (1987) 3:371–374

Child's Nervous System CNS

© Springer-Verlag 1987

Ultrasound-guided brain abscess aspiration in neonates

Francisco Theophilo[1,2,3], Antonio Burnett[2], Geraldo Jucá Filho[2], Alexandre Adler[2], Silvia Miranda[2], Lais Theophilo[1,2], Manoel Carvalho[2,3], and José Lopes[2,3]

[1] Neurosurgical Clinic, NeuroRio Clínicas Integradas, Rio de Janeiro, Brazil
[2] Newborn Intensiv Care Unit. Centro Pediátrico Lagoa, Rio de Janeiro, Brazil
[3] Fernades Figueira Institute, Oswaldo Cruz Foundation, Rio de Janeiro, Brazil

Abstract. Four cases of brain abscess in neonates are described, diagnosed by ultrasonography and CT. All abscesses were confirmed surgically. One patient was operated on 5 weeks after diagnosis because of initial parental refusal. The etiology in all cases was meningitis superimposed on an hypoxic-ischemic insult. Two cases had a single abscess while the other two had multiple lesions. All cases were operated on with intraoperative ultrasound examination through the fontanelle. The case with delayed aspiration showed complete evolution from localized cerebritis to complete capsule formation with mass effect. One abscess was sterile, and in the others grew *Klebsiella pneumoniae* and *Enterobacter aerogenes.* The microorganism initially isolated from the lumbar CSF was also found in the abscess. Even after sterilization of the lumbar CSF, all abscesses were still present. Ultrasound examination and CT are compared.

Key words: Ultrasound – Brain – Abscess.

Brain abscess is a well-known disorder [1, 3, 14, 40] with a higher incidence in adults than in children [11, 15, 40, 41]. In the last 12 years one of the authors (F.T.) has diagnosed and treated more than 20 cases of brain abscess in patients 1 to 18 years of age [41]; however, only recently have we diagnosed brain abscess in neonates. In spite of the several mechanisms described in childhood (direct spread, hematogenic, cardiogenic, etc. [41]), we believe that in all cases described in this paper there was a common pathway for the development of brain abscesses, namely, the association of meningitis and cerebral tissue injury secondary to ischemic lesions [2]. Ischemia leading to brain necrosis is, we believe, a major predisposing factor for bacterial implantation and localized cerebritis, which is the first stage of the development of brain abscess.

Offprint requests to: F. Theophilo, NeuroRio Clínicas Integradas, Rua Voluntários da Pátria, 445 sale 204-Botafogo, 22270 Rio de Janeiro, Brazil

The routine use of cerebral ultrasonografy in our newborn intensive care unit has enabled us to make a definitive diagnosis of brain abscess. All diagnoses were also confirmed by CT, and in our experience brain abscess imaging was more clearly and earlier defined by ultrasound than by CT.

Patients and methods

Case 1

This patient was a premature male infant, one of twins whose mother had a premature rupture and subsequent infection of the membranes. After admission, the baby developed progressive respiratory distress and meningitis. On the 4th day of life the clinical course suddenly deteriorated and cerebral ultrasonography showed a subependymal and intraventricular bleeding, which was treated with repeated lumbar punctures and, later, external ventricle drainage. Treatment with antibiotics was started according to the CSF antibiotic sensitivity test. Weekly cerebral ultrasonography was carried out, and eventually showed a right parietal brain abscess 3 cm in diameter. A CT scan (second generation) did not detect the abscess. The infant was operated on under local anesthesia and light sedation. A burr-hole was made over the abscess, which was drained via a cannula inserted under ultrasound guidance through the anterior fontanelle. The purulent material in this case was sterile. The baby developed hydrocephalus after infection had been overcome and was treated with V-P shunt. He showed good clinical recovery and, in a follow-up after 6 months he showed normal neurological development. Ultrasonography showed slight assymetry of the lateral ventricles and normal parenchyma.

Case 2

This patient was a full-term newborn, who had a normal delivery but perinatal asphyxia requiring resuscitation. He was admited with respiratory distress and later developed meningitis. He was treated with antibiotics for *Klebsiella pneumoniae* and was developing well when low tension of the anterior fontanelle was noticed. At that time the only neurological finding was absence of the suction reflex. CT showed multiple large brain abscesses localized in the bilateral frontal and left parieto-occipital areas. He was operated on several times with serial ultrasound-guided tapping of all abscesses; a total of 170 ml pus was obtained (Fig. 1). The infant then began to suck and showed rapid clinical

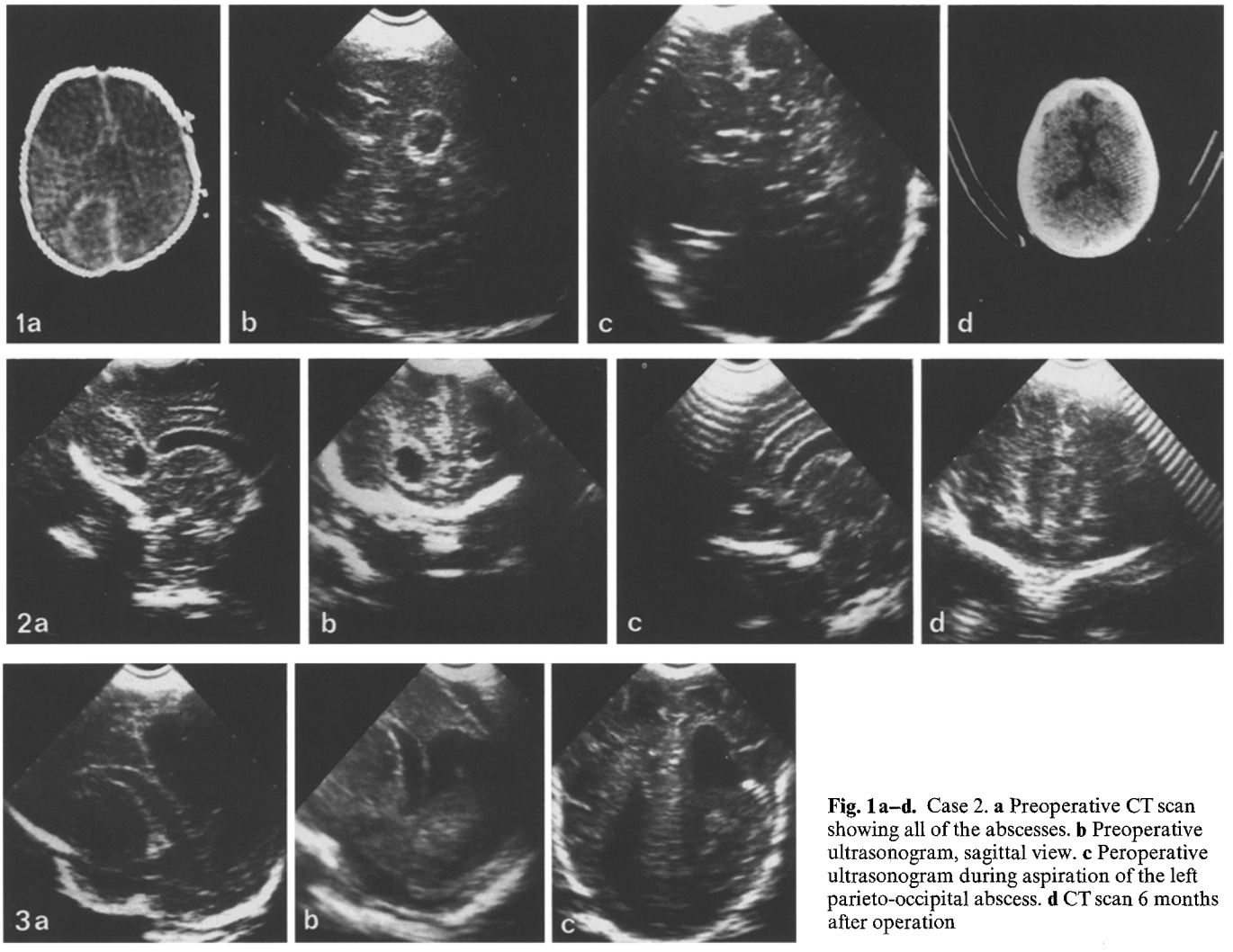

Fig. 1a–d. Case 2. **a** Preoperative CT scan showing all of the abscesses. **b** Preoperative ultrasonogram, sagittal view. **c** Peroperative ultrasonogram during aspiration of the left parieto-occipital abscess. **d** CT scan 6 months after operation

Fig. 2a–d. Case 3. **a** Preoperative ultrasonogram, sagittal view. **b** Preoperative ultrasonogram, coronal view. **c** Peroperative ultrasonogram, sagittal view. **d** Postoperative ultrasonogram, coronal view

Fig. 3a–c. Case 4. Ultrasonograms: **a** preoperative at time of diagnosis, sagittal view; **b** preoperative, 5 weeks later; **c** peroperative, coronal posterior view

improvement. He was discharged without apparent abnormality. Ultrasonography and CT after 7 months are both normal. The child shows no neurological abnormality.

Case 3

This patient was a premature female infant with severe hyalin membrane disease who developed meningitis (*Enterobacter aerogenes*). The infant showed good development, but had a daily mild fever. Ultrasonography, however, showed bilateral frontal abscesses. Under local anesthesia, bilateral frontal burr-holes and ultrasound-guided tapping was done (Fig. 2). The child was discharged 1.5 weeks later and hydrocephalus was demonstrated by sonography 3 weeks later. A V-P shunt procedure was carried out. She was doing well but after 4 weeks ultrasound revealed an isolated left lateral ventricle. A biventricular peritoneal shunt with Y-connection was inserted using a proximal Holter-Hausner low-pressure valve.

A 6 months of age, follow-up examination revealed normal neurological status and development, with normal ultrasound findings.

Case 4

This patient was a premature male infant who developed respiratory distress and meningitis (*Enterobacter aerogenes*) and was treated with respiratory assistance and antibiotics. As the lumbar CSF became sterile, ultrasonography revealed a right parieto-occipital brain abscess. Because of initial parental refusal to allow surgical treatment, the infant was treated conservatively. After 5 weeks he became somnolent, ceased to suck, had fever, an elevated erythrocyte sedimentation rate, and leukocytosis. Successive ultrasonograms showed evolution from a large area of parenchymal bleeding to abscess formation, producing a mass effect on the atrium of the adjacent lateral ventricle (Fig. 3). Finally, he was operated on in the same way as the other babies. He was later discharged in good condition. We do not have any follow-up data on this child.

Discussion

In 12 years, experience with brain abscesses [40, 41] we have been able to diagnose this pathology in newborns only in the last 12 months after the introduction of routine cerebral ultrasound examinations through the anterior fontanelle with real-time equipment using high-frequency transducers. We perform routine ultrasound examination, not because of the possibility of brain abscess, but because other more common abnormalities may be revealed, such as subependymal and intraventricular bleeding, meningitis, encephalitis, ventriculitis, periventricular leukomalacia, congenital malformations, hydrocephalus and others [2, 5, 6, 8, 17, 18, 25, 33, 34, 36, 37]. But, among all these patients we diagnosed four brain abscesses in newborns who had no signs indicating the diagnosis. Because of early diagnosis we could treat those infants before a (complete capsulated) space occupying brain abscess had developed.

We think that among all newborns with meningitis and hypoxic-ischemic cerebral insult, those who develop abscesses are those immunologically able to circumscribe the infection and develop a capsule. Because of this natural selection prior to operative treatment, they seem clearly to have a better prognosis than the others with generalized infection.

Since the mid-1970s, CT has been the principal aid to diagnosis. This has been the most important development in the diagnosis of brain abscess in recent times [9, 11, 19, 21, 24, 27–31, 38, 39, 42–46]. Most authors found a higher mortality in brain abscesses before CT [4, 9, 10, 15, 20, 22, 26, 27]. The CT appearance can be clearly seen, with the use of contrast, as a ring structure with a central hypodense area. The evolution of a brain abscess capsule on CT scans has been studied [7, 12–14], and the presence of a ring structure does not mean that there is a mature capsule [12]. To obtain a qualitative assessment, CT scans should be repeated at intervals [13, 14]. Cerebral examination by ultrasound requires a gap in the cranial vault to be effective. In children with open fontanelles and with modern dynamic real-time ultrasonographic examination, the images obtained are more than sufficient for diagnosis.

Advantages in comparison to CT are that there is no need for contrast, and dynamic examination with recording of the whole examination in videotape is possible. The examination can be made at the bed side, using it in a routine way without difficulty in the nursery. There is no need for general anesthesia and it is less expensive. A disadvantage is that complete subdural examination is not possible because of the viewing angle.

Therefore, we think that ultrasonography in neonates, in relation to CNS infection, is now more helpful than CT, because of all those advantages and the excellent quality of the images.

Therapy

In our previous series [41] of brain abscesses in childhood, the objective of therapy was the extirpation of the abscess, whenever possible. We did abscess tapping and aspiration when the capsule was not yet hard enough to be operated on safely. Primary total extirpation was performed in special cases [41].

In these four cases of brain abscesses in neonates, we performed aspiration even in the cases of multiple abscesses. The literature describes ample experience using intraoperative ultrasound for different surgical goals such as brain tumors, cysts, hematomas, arteriovenous malformations, inflammatory masses or abscesses, and even for intracranial shunt tube placement in infants [16, 23, 32, 35].

In a series of 191 lesions published by Rubin and Dohrmann [32], ultrasound was deemed to have played a useful role in operations on 101 (53%) of the lesions and showed only 3 brain abscesses, none in the neonatal age. Based on the technical experience of ultrasound-guided biopsy of brain tumors, we treated our cases of suspected brain abscesses in newborns with this technique. The procedure is very easy and requires only local anesthesia. Even when multiple, the abscesses can be reached and the pus of all of them be drained. If necessary, serial tappings can be done in the same way.

Our impression is that if the newborn shows brain abscess as a complication of meningitis and hypoxic-ischemic insult, there has been a strong immunological reaction to a generalized infection, enabling a capsule to develop. The technique of ultrasound guided brain-abscess tapping can help the baby during this period, giving a better chance of survival and perhaps a more acceptable neurological outcome.

References

1. Alonso-Treceno JL, Martinez-Vidal J (1977) Complicaciones endocraneales de las otitis medias. Ann Otorinolaringol Ibero-Am 4:451–467
2. Babcock DS, Han BK (1985) Sonographic recognition of gyral infarction in meningitis. AJR 144:833–836
3. Ballance CA (1922) A glimpse into the history of the surgery of the brain. (The Thomas Vicary Lecture) MacMillan, London
4. Bhatia R, Tandon PN, Banervi AK (1973) Brain abscess – an analysis of 55 cases. Int Surg 58:565–568
5. Bowerman RA, Donn SM, Dipietro MA, D'Amato CJ, Hicks SP (1984) Periventricular leukomalacia in the pre-term newborn infant. Sonographic and clinical features. Radiology 151:383–388
6. Bowerman RA, Donn SM, Silver TM, Jaff MH (1984) Natural history of neonatal periventricular/intraventricular hemorrhage and its complications: sonographic observation. ARJ 143:1041–1052
7. Britt RH, Enzmann DR (1983) Clinical stages of human brain abscesses in serial CT scans after contrast infusion. Computerized tomography, neuropathological and clinical correlations. J Neurosurg 59:972–989
8. Chow PP, Horgan JG, Taylor KJ (1985) Neonatal periventricular leukomalacia: real time sonographic diagnosis with CT correlation. AJR 145:155–160
9. Claveria LE, Du Boulay GH, Moseley IF (1976) Intracranial infections: investigation by computerized axial tomography. Neuroradiology 12:59–71

10. Coulam CM, Seshul M, Donaldson J (1980) Intracranial ring lesions: can we differentiate by computed tomography? Invest Radiol 15:103–112
11. Danziger A, Price H, Schechter MM (1980) An analysis of 113 intracranial infections. Neuroradiology 19:31–34
12. Dobkin JF, Healton EB, Dickenson T, Brust JCM (1984) Nonspecificity of ring enhancement in "medically cured" brain abscess. Neurology 34:139–144
13. Enzmann DR, Britt RH, Placone RC, Obana W, Lyons B, Yeager AS (1982) The effect of short-term corticosteroid treatment on the CT appearance of experimental brain abscesses. Radiology 145:79–84
14. Enzmann DR, Britt RH, Placone R (1983) Staging of human brain abscess by computed tomography. Radiology 146: 703–708
15. Garfield J (1969) Management of supratentorial abscess – a review of 200 cases. Br Med J 2:7–11
16. Gooding GAW, Edwards MSB, Rabkin AE, Powers SK (1983) Intraoperative real-time ultrasound in the localization of intracranial neoplasma. Radiology 146:459–462
17. Han BK, Babcock DS, McAdams L (1985) Bacterial meningitis in infants. Sonographic findings. Radiology 154:645–650
18. Hecht ST, Filly RA, Callen PW, Wilson-Davis SL (1983) Intracranial hemorrhage: late onset in the preterm neonate. Radiology 149:697–699
19. Joubert MJ, Stephanov S (1977) Computerized tomography and surgical treatment in intracranial suppuration. Report of 30 consecutive unselected cases of brain abscess and subdural empyema. J Neurosurg 47:73–78
20. Karandanis D, Schulman JA (1975) Factors associated with mortality in brain abscess. Arch Int Med 125:1145–1150
21. Kaufman DM, Leeds NE (1977) Computed tomography (CT) in the diagnosis of intracranial abscesses. Brain abscess, subdural empyema and epidural empyema. Neurology 27: 1069–1073
22. Kiser JL, Kending JH (1963) Intracranial suppuration: a review of 139 consecutive cases with electron-microscopic observation on three. J Neurosurg 20:494–511
23. Knake JE, Chandler WF, Gabrielsen TO, Latacil JT, Gebarski SS (1984) Intraoperative sonographic delineation of low-grade brain neoplasma defined poorly by computed tomography. Radiology 151:735–739
24. Lott T, El-Gammal T, Da Silva R (1977) Evaluation of brain and epidural abscesses by computed tomography. Radiology 122:371–376
25. Machado HR, Machado JC, Contrera JD, Assirati JA, Martelli N, Colli BO (1985) Ultrasonographic evaluation of infantile hydrocephalus before and after shunting. Child's Nerv Syst 1:341–345
26. Morgan H, Wood MW, Murphy F (1973) Experience with 88 consecutive cases of brain abscess. J Neurosurg 38:698–704
27. Moussa AH, Dawson BH (1978) Computed tomography and the mortality rate in brain abscess. Surg Neurol 10:301–304
28. New PFJ, Davis KR, Ballantine H Jr (1976) Computed tomography in cerebral abscess. Radiology 121:641–646
29. Nielsen H, Gyldensted C (1977) Computed tomography in the diagnosis of cerebral abscess. Neuroradiology 12:207–217
30. Phillips JP, Briggs M (1978) Brain abscess. Lancet II:1374
31. Reinhard B (1979) CT-Befunde bei Hirnabszessen. RöFo 131:644–648
32. Rubin JM, Dohrmann GJ (1985) Efficacy of intraoperative use in evaluating intracranial masses. Radiology 157:509–511
33. Rumack CM, Manco-Johnson ML, Manco-Johnson MJ, Koops BL, Hathaway WE, Appareti K (1985) Timing and course of neonatal intracranial hemorrhage using real-time ultrasound. Radiology 154:101–105
34. Shackel Ford GD, Fulling KH, Glasier CM (1983) Cysts of the subependymal germinal matrix: sonographic demonstration with pathologic correlation. Radiology 149:117–121
35. Shkolnik A, McLone DG (1982) Intraoperative real-time ultrasonic guidance of in the cranial shunt tube placement in infants. Radiology 144:573–576
36. Siegel MJ, Shackel Ford GD, Perlman JM, Fulling KH (1984) Hypoxic-ischemic encephalopathy in term infants: diagnosis and prognosis evoluated by ultrasound. Radiology 152: 395–399
37. Slovis TL, Shankaran S, Bedard MP, Poland RL (1984) Intracranial hemorrhage in the hypoxic-ischemic infant: ultrasound demonstration of unusual complications. Radiology 151:163–169
38. Stephanov S (1978) Experience with multiloculated brain abscesses. J Neurosurg 49:199–203
39. Stevens EA, Norman D, Kramer RA (1978) Computer tomographic brain scanning in intraparenchymal pyogenic abscesses. AJR 130:111–114
40. Theophilo F (1982) Klinik und Therapie beim Hirnabszess. Thesis, University of Hannover
41. Theophilo F, Markakis E, Theophilo L, Dietz H (1985) Brain abscess in childhood. Child's Nerv Syst 1:324–328
42. Weichert HC, Nau HE, Bongartz EB (1979) Computertomographische Untersuchungen in der Verlaufskontrolle von SHT. Indikationen und Ergebnisse. Chir Prax 26:209–216
43. Whelan MA, Hilal SK (1980) Computer tomography as a guide in the diagnosis and follow-up of brain abscess. Radiology 135:663–671
44. Wise BL, Gleason CA (1979) CT-directed stereotactic surgery in the management of brain abscess. Ann Neurol 6:457–459
45. Wood MW, Cardenas R, Moore C (1980) Influence of CAT scanning on the diagnosis and mortality rate of brain abscess. J Tenn Med Assoc 73:325–327
46. Zimmermann RA, Patel S, Bilaniuk LT (1976) Demonstration of purulent bacterial intracranial infections by computed tomography. ARJ 127:155–165