tube drained bile freely, but the volume gradually diminished and after the tube was removed on the 7th day there was no further leakage. The baby's recovery was rapid and uninterrupted and he was taking full feeds by the 12th postoperative day. Qualitative biochemical analysis of the stones showed them to be composed of cholesterol, calcium, and bilirubin.

At no stage was the baby jaundiced or anaemic, and blood cultures were repeatedly sterile. There was no history of gallbladder or haemolytic disease in the family. The mother was slightly obese and had been taking oral contraceptives before conceiving this child. During pregnancy she took routine oral iron supplements. A baby born 2 years previously was normal.

Since discharge from hospital the child has made normal progress and has never been jaundiced. There has never been a palpable gallbladder on examination. An intravenous cholangiogram done at the age of 9 months showed good filling of the gallbladder but attempts to show the bile duct failed. Examination will be repeated at the age of 2 years unless there is prior indication.

Discussion

Cholelithiasis occurring in a neonate has been reported on several occasions in the past, as far back as 1838, but not in an otherwise normal child.

Potter, reviewing published reports in 1928, quoted several cases of neonatal and indeed fetal cholelithiasis, but all these cases were associated, as far as one can tell, with either haemolytic disease or abnormality of the biliary tree. The youngest child reported by Walker, in a series from The Hospital for Sick Children, Great Ormond Street, of children presenting with symptoms of cholelithiasis, was 4 months (Walker, 1957).

In the absence of a predisposing cause the diagnosis is probably impossible to make in the neonatal period without proceeding to laparotomy. The usual radiographic and biochemical tests that may help in the older age group are impracticable or confusing at this time.

Having made the diagnosis at laparotomy one is faced with the problem of whether to perform a simple cholecystostomy or proceed to cholecystectomy. Cholecystostomy leaves the child liable to form further stones, but at this age cholecystectomy would be a difficult and possibly hazardous manoeuvre.

Probably the best approach is that described by Carswell and Willis (1969) who initially performed cholecystostomy on a child of four months with gallstones, but later had to do a cholecystectomy in the light of recurrent obstructive jaundice from more stones. Possibly early analysis of the composition of the bile secreted would allow the decision to be taken earlier if its make-up is shown to be lithogenic (Bouchier, 1973).

In the case presented no specific aetiology has yet been found. Prolonged follow-up is obviously essential since there may be a recurrence and further operative intervention prove necessary.

Summary

Cholelithiasis occurring in a 4-day-old child is reported. This is believed to be the youngest normal child with the disease. The diagnosis and treatment are discussed.

REFERENCES

- Bouchier, I. A. D. (1973). The biochemistry of gallstone formation. *Clinics in Gastroenterology*, **2**, 49.
- Carswell, W. R., and Willis, J. D. (1969). Cholecystitis with gallstones in infancy and childhood. *British Journal of Surgery*, **56**, 547.
- Potter, A. H. (1928). Gall-bladder disease in young subjects. *Surgery, Gynecology and Obstetrics*, **46**, 795.
- Walker, C. H. M. (1957). Aetiology of cholelithiasis in childhood. *Archives of Disease in Childhood*, **32**, 293.

R. G. HUGHES and MARGARET J. MAYELL
Department of General Surgery, Frenchay Hospital,
Bristol BS16 1LE.

Hydrocephalus treated by compressive head wrapping

Compressive cranial wrapping has been used in America as an alternative to shunt procedures for the treatment of mild to moderate hydrocephalus (Epstein, Hochwald, and Ransohoff, 1973). Shunts carry a considerable morbidity and mortality (Clark, 1969), making alternatives worthy of consideration. A technique similar in principle was described in Britain over 150 years ago (Barnard, 1823-24). The purpose of this paper is to remind paediatricians that compressive cranial wrapping is a viable alternative to shunt dependency, to describe a simple method of applying it in order to give a controlled, reproducible pressure, and to present a case in which it proved successful.

Case report

A girl was born by spontaneous vertex delivery on 21 March 1973. A large thoracolumbar meningo-myelocoele was present, which was closed surgically. Hydrocephalus developed almost immediately and was confirmed by ventriculography. At the age of 5 weeks a Spitz-Holter valve was inserted. At the age of 24 weeks the valve became infected with *Staphylococcus aureus* and had to be removed. Her head circumference was then below the 10th centile but steadily increased. At the age of 50 weeks when it was 48.2 cm (2.5 cm above the 90th centile), compressive cranial wrapping

was begun as a possible alternative to a second shunt procedure. Before wrapping, the ventricular CSF pressure was 185 mm of CSF, and brow-up ventriculograms showed a cerebral mantle thickness, measured anteriorly, of 26 mm on one side and 30 mm on the other. At the occipital pole it was 15 mm and 6 mm, respectively. Allowing for a projection magnification factor of 1.14, the true values would probably be 23, 26, 13, and 5 mm.

Method

A piece of Netelast size F tubular elastic net bandage* was invaginated into itself to form a two-layered cap. After 2 weeks the number of layers was increased to 6 using about 1.5 m length of Netelast F and repeatedly invaginating it upon itself until the required number of layers was obtained. The cap was worn continuously (Fig. 1) except for its removal for 30 minutes four times daily to reduce impedance to scalp blood flow. It was well tolerated. Because of gradual loss of tension a new cap was required every 4 weeks. After initial observation in hospital, the child was seen for outpatient review every 2 weeks. The pressure between the scalp and the cap was measured with a water-filled balloon

and manometer. For an eight-layered cap it was 250 mm of water.

Results

During the next 8 months her head circumference remained constant (Fig. 2) until it returned to the 90th centile at age 1 year 7 months. The anterior

FIG. 2.—Head circumference chart showing the effect of the cap.

fontanelle had almost closed. There was no papilloedema and she appeared to see normally. In view of the risks of infection inherent in ventriculography the cerebral mantle was measured by ultrasound and found to be 23 mm on the right and 24 mm on the left anteriorly, a barely significant decrease. In the occipital region it had apparently increased to 27 mm (right) and 15 mm (left). The skin over her thoracolumbar defect was not bulging.

At 1 year 9½ months of age she was tested with the Griffiths Mental Development Scale by a skilled Child Health Medical Officer. Scale A (Locomotor) was not used as her physical handicap would have given a misleading score. She obtained a quotient of 94 for each of scales B (personal-social), C (hearing and speech), and E (performance), and 91 for scale D (eye and hand co-ordination). These results placed her intelligence within the average range (90–110).

The cap was discontinued at age 2 years 1½ months and the excessive rate of head growth has not recurred.

Discussion

Shunting procedures for neonatal hydrocephalus produce several complications, notably septicaemia with persistent bacterial growth in the valve, with

FIG. 1.—Netelast cap in use.

*Manufactured by Roussel Laboratories Ltd., London.

subacute ventriculitis in some cases, and multiple pulmonary thromboses leading to hypertension and eventually to heart failure (Clark, 1969). In addition, 40% of such shunts require revision operations (Clark, 1969). Most of the deaths in treated cases are due to shunt complications (Guthkelch, 1967). Compressive cranial wrapping can stop hydrocephalus within 6 months if applied from an early stage, without the risks mentioned above (Epstein *et al.*, 1973).

Animal experiments suggest that in neonatal hydrocephalus the skull expands because the sutures are lax and unable to resist the slightly raised intracranial pressure (Hochwald *et al.*, 1972a; Epstein *et al.*, 1973). If the bones of the cranial vault are supported by an external pressure the ventricular CSF pressure rises slightly to the point at which it may open a stenosed aqueduct or increase transventricular absorption of CSF (Epstein *et al.*, 1973). Such absorption occurs by passage of CSF through the ventricular wall, whence it is absorbed within 600 μ m of the ventricular surface (Lux *et al.*, 1970) into the blood vessels of the brain parenchyma which drain to the straight sinuses (Sahar, Hochwald, and Ransohoff, 1970). It has been suggested that the fluid crosses the cerebral cortex to reach the subarachnoid space in babies (Davson, 1972), but this does not occur in the experimental animal (Sahar *et al.*, 1970). In addition, the increased pressure may reduce production of CSF by the choroid plexuses (Hochwald *et al.*, 1972b).

In the treatment of neonatal hydrocephalus the intraventricular pressure at the initiation of head compression is in the region of 500 mm of water. After 2–3 hours it falls to $\frac{2}{3}$ of this value, and on removing the head compression it falls to half its pretreatment level (Epstein, Wald, and Hochwald, 1974). The pressure does not cause cortical atrophy (Epstein *et al.*, 1973). When treatment is begun at the age of 1–3 weeks, the pathways of absorption have opened up and the sutures have fused sufficiently after 6 months for the skull to resist excessive expansion. Treatment can then be stopped and further head growth resumes at the normal rate.

Originally an elastic bandage was used to apply the pressure (Epstein *et al.*, 1973). 2 cases have been reported in which apnoeic attacks and incessant crying may have been caused by over-tight winding of the bandage round the head (Meyer, Price, and Reubel, 1973). In the second of Meyer's cases this view is supported by the fact that the head circumference diminished by 1.25 cm in only 5 days. A pneumatic helmet has been produced so

that accurately controlled and measured pressures can be applied (Epstein *et al.*, 1974) and the staff of the Medical Physics Department at our hospital are developing a similar device.

The use of an elastic net cap has the advantages of simplicity, ease of application, and reproducibility of pressure from one application to the next. Also, the tension can be readily varied to maintain head growth at the norm by varying the number of layers.

Summary

A simple method of applying compressive cranial wrapping for neonatal hydrocephalus is described and its beneficial use in one patient is described.

REFERENCES

- Barnard, J. F. (1823–1824). Case of hydrocephalus chronicus (chronic water of the brain) in which pressure proved most beneficial. *Lancet*, (1–2), 360.
- Clark, D. B. (1969). Hydrocephalus. *Textbook of Pediatrics*, 9th ed., p. 1292. Ed. by W. E. Nelson, V. C. Vaughan, and R. J. McKay. Saunders, Philadelphia.
- Davson, H. (1972). Dynamic aspects of cerebrospinal fluid. *Developmental Medicine and Child Neurology*, 14, Suppl. 27, 1.
- Epstein, F., Hochwald, G. M., and Ransohoff, J. (1973). Neonatal hydrocephalus treated by compressive head wrapping. *Lancet* 1, 634.
- Epstein, F., Wald, A., and Hochwald, G. M. (1974). Intracranial pressure during compressive head wrapping in treatment of neonatal hydrocephalus. *Pediatrics*, 54, 786.
- Guthkelch, A. N. (1967). The treatment of infantile hydrocephalus by the Holter valve. *British Journal of Surgery*, 54, 665.
- Hochwald, G. M., Epstein, F., Malhan, C., and Ransohoff, J. (1972a). The role of the skull and dura in experimental feline hydrocephalus. *Developmental Medicine and Child Neurology*, 14, Suppl. 27, 65.
- Hochwald, G. M., Lux, W. E., Sahar, A., and Ransohoff, J. (1972b). Experimental hydrocephalus: changes in cerebrospinal fluid dynamics as a function of time. *Archives of Neurology*, 26, 120.
- Lux, W. E., Hochwald, G. M., Sahar, A., and Ransohoff, J. (1970). Periventricular water content: effect of pressure in experimental chronic hydrocephalus. *Archives of Neurology*, 23, 475.
- Meyer, H., Price, B. E., and Reubel, C. D. (1973). Complications arising from head wrapping for the treatment of hydrocephalus. *Pediatrics*, 52, 867.
- Sahar, A., Hochwald, G. M., and Ransohoff, J. (1970). Passage of cerebrospinal fluid into cranial venous sinuses in normal and experimental hydrocephalic cats. *Experimental Neurology*, 28, 113.

F. NELSON PORTER*

Department of Paediatrics, Raigmore Hospital, Inverness, Scotland.

*Present address: Medical Paediatric Dept., Western General Hospital, Crewe Road, Edinburgh EH4 2XU.

Neonatal gastric hyperacidity Further analysis of oxytocin effect

Previous reports about gastrin levels in the neonate have shown that babies born spontaneously have higher plasma gastrin levels in the umbilical