Clinical Use of Transillumination*†

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Transillumination of fluid-filled intracranial pathology in infants and small children has been discussed in recent reports (Calliauw, 1961; Dodge and Porter, 1961; Shurtleff, 1964). The threefold purpose of this communication is (1) to describe a method for both quantitation and easy recording of observed transillumination, (2) to emphasize the detection of potentially curable intracranial lesions, and (3) to stress the usefulness of transillumination in detecting and evaluating fluid-filled lesions in body areas, other than the skull.

Method

Others have described methods for transillumination photography that are both time consuming and somewhat variable in results (Dodge and Porter, 1961; Cambern and Shurtleff, 1961; Taylor, Dent, Lynch, and Alexander, 1956). For the past few years we have been recording cases on High Speed Ektachrome, Daylight ASA 160, using a single lens reflex camera.

The transillumination light is an 800 watt second Ascor Spotlight (Fig. 1) projected through a Cooke 2 in. f/18 lens in place of the usual fresnel lens (Fig. 1). In this manner the light can be 'coned down' with no escape and the beam condensed with little loss.

The fill light is a 200-watt second strobe (Fig. 1) with blue filter bounced from ceiling or wall and triggered by a photocell (Fig. 1) within the transilluminating spotlight head (Fig. 1). The cool blue tones resulting from the blue filtered light record the reddish areas of transillumination much more realistically than would be the case if normally balanced light were used.

Exposure is one flash at f/5.6 or f/8, depending on the amount of transillumination observed. Since the speed of the strobe obviates the effect of any movement, it is possible to hand-hold the camera and struggling child without loss of clarity. Room lights may be left on.

Results

A standardized light source, time of exposure, and recording device obviate the variables inherent in

the use of a 2 cell flashlight and human eye (Dodge and Porter, 1961; Shurtleff, 1964). We still use the flashlight for routine screening on the wards and in our clinics.

A number of variables still makes interpretation an art based on experience. The variables include the amount of blood and thickness of skull (Calliauw, 1961); the thickness and colour of scalp (Dodge and Porter, 1961); the child's age—up to 9½ years (Shurtleff, 1964); the thickness of overlying tissue—0.4–2.1 cm. (Shurtleff, 1964); and the clarity of the transmitting fluid—up to 3,700 cells/c.mm. and 2.6% of protein (Shurtleff, 1964).

We are now studying the limits of transillumination of the subarachnoid fluid in prematures, as described by Lanman, Partanen, Ullberg, and Lind (1958), using a grid and photographic recordings for standardization.

Case Reports

Case 1: Hydrocephalus. A 49-day-old baby was admitted with an abnormally enlarging cranium. The mother's gestation had been interrupted at 30 weeks by a bloody vaginal discharge, which subsequently led to caesarean section delivery of a 3 lb. 10 oz. (1,643 g.) baby and a placenta praevia. During the next 5 days there were frequent bouts of apnoea, requiring resuscitation by positive pressure.

Grand mal seizures were noted also. Cyanosis, despite 40% O₂, persisted up till the 10th day. The head circumference enlarged more rapidly than normal, from 28.5 cm. to 35 cm. by the age of 48 days. On admission, the head transilluminated (Fig. 2a); the fontanelle was full and tense; the frontal cerebral mantle measured 1.2 cm. (Fig. 2b), and the intraventricular pressure was 200 mm. CSF. The ventricular fluid contained 292 mg./100 ml. protein, 1960 RBC, and 23 WBC/c.mm. At the age of 64 days a right ventriculo-auriculostomy was performed, and 6 weeks later the frontal cerebral mantle measured 2.7 cm. (Fig. 2c). At 11 months of age the shunt obstructed, causing lethargy, irritability, apnoeic spells, and enuresis. The shunt was re-established. Intraventricular pressure was 300 mm. CSF. The patient has been asymptomatic since with normal intellectual assessments at 18 months and 26

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FIG. 1.—Diagram of transillumination photography equipment: 800 watt second Ascor spotlight; Cooke 2-in. 5/18 lens in place of fresnel lens; fill light 200 watt second strobe; photocell within transilluminating spotlight.

months. Head size and neurological examination are now normal.

Comment. The medical curiosity, hydranencephaly or absence of the brain, can be suspected by transillumination (Alexander, Davis, and Kitahata, 1956). However, we have observed 4 children with transillumination patterns suggestive of hydranencephaly, but with normal or near normal development for 2 to 4 years, following successful CSF decompression. Light transmits through tissue up to 2.1 cm. thick (Shurtleff, 1964). Children with

as little as 1 cm. frontal cerebral mantle can develop normally (Shurtleff, Foltz, and Sella, 1963; Foltz and Shurtleff, 1963). Hence, transillumination of the skull can be used as a clinical screening method for detecting hydrocephalic children who are potentially treatable.

Secondly, the rapid re-expansion of the cerebral mantle (Fig. 2b and c) can be followed by the disappearance of light transmission. Recurrence of clinical symptoms associated with reappearance of transillumination in a child heralds shunt obstruction.

FIG. 2.—Case 1. (a) Transillumination; (b) air contrast radiograph, showing hydrocephalus; and (c) repeat air study 2 months after operation.

FIG. 3.—Case 2. (a) Transillumination; and (b) air contrast radiograph, showing large brain cyst.

Case 2: Congenital Brain Cysts. At 4 months of age this baby was noted by a private physician to have abnormal transillumination (Fig. 3a). At the age of 6 weeks cranial circumference had been large, but subsequent growth was consistent with chest circumference growth. By the age of 4 months she could not hold up her head, and there was left parieto-occipital prominence (over the area of transillumination). Air studies (Fig. 3b) revealed a non-communication cystic space filled with clear fluid under a pressure of 250 mm. CSF. Shift of the ventricles toward a more normal position, softening of the fontanelle, and a lowered cyst pressure resulted from a cysto-ventriculostomy via a ventriculoscope. Six months later she was readmitted because of persistence of abnormal transillumination and an enlarging cranium. Open craniotomy revealed multiple cysts which were interconnected by partial removal of the cyst walls. Wide connexion with ventricular system was also established. Biopsy revealed tufts and choroid plexus cells in the lining of the cyst. 2 months later air contrast studies revealed good communication between a much larger cystic left hemisphere and the ventricles. A cysto-atrial shunt using a Pudenz-Heyer valve was complicated by *Staphylococcus albus* sepsis. The shunt was removed and the infection eradicated. One month later a successful cysto-atrial shunt was re-established. One subsequent shunt obstruction was easily revised two months later. Three months after this revision similar symptoms, lethargy, irritability, and fever were associated with good shunt dynamics and culture of α -haemolytic streptococci from the ventricular CSF. Antibiotic therapy eradicated the organism without removal of the shunt. One month later she experienced an isolated *grand mal* seizure. Now age 34 months, she has a normal head size, no cranial transillumination, and a normal intellectual assessment.

Comment. This second treatable and translucent intracranial lesion has been reported in detail by Rand, Foltz, and Alvord (1964). Isolated choroid

plexus-like tissue, sporadically lining the wall of multiple cysts lying partially within substance, has now been observed in 5 children followed for 1 to 5 years. All but one child, who also had prolonged severe antibiotic-resistant cysto-ventriculitis, are functioning at a normal or near-normal level.

These readily diagnosed lesions have had a sharply demarcated, bright, and asymmetric pattern of transillumination in each of our patients. The apparent good prognosis, despite brain distortion by space-occupying lesions, is encouraging. This preventable cause of mental deterioration can now be recognized and treated.

Case 3: Subdural Hydroma. A 3-month-old infant entered the hospital because of cephalomegaly since birth and vomiting for 2 weeks before admission. Gestation, delivery, and previous history were otherwise normal. Physical examination revealed only a symmetrically enlarged cranium (43.5 cm.) which transilluminated (Fig. 4a). He was bright and alert and was apparently developing normally. An air contrast radiograph revealed a large subdural space (Fig. 4b). Exploratory craniotomy revealed transparent filmy membranes enclosing a clear, colourless fluid. Microscopical examination revealed no haematin pigment in tissue that was identical with subarachnoid membranes. Following removal of the membranes, the patient has done well. Now 7 years after operation, his physical examination is normal. His school function and intellectual assessment are superior (IQ 136).

Comment. These thin, non-haematin pigmented, clear membranes in the subarachnoid space represent duplication of subarachnoid membranes (subdural hydroma), rather than a chronic subdural haematoma (subdural hydroma) (Ingraham and Matson, 1944; Kinley, Riley, and Beck, 1951).

FIG. 4.—Case 3. (a) Transillumination; and (b) air contrast radiograph, showing large subdural space in a baby considered to have a subdural hydroma (see text).

The pattern of transillumination (Fig. 4a) suggests the irregular pattern seen in a normal, large subarachnoid space of a premature infant. The condition can be differentiated by observation over a period, during which the rate of head growth is normal, whereas abnormal collections of fluid are associated with persistently abnormal transillumination and abnormally rapid head growth.

This follow-up of a case previously reported (Shurtleff, 1964) emphasizes the value of diagnosing potentially correctable, space-occupying, and fluid-filled lesions in otherwise normal children.

Case 4: Subdural Haematoma. A 7-month-old female infant was first admitted to the hospital because of three days of vomiting. Her head circumference was 48 cm., as compared to a chest circumference of 43 cm. The tense and bulging fontanelle was associated with widely dilated pupils, sluggish light reflex, papilloedema, and flame haemorrhages in the retinae. The skull transilluminated brightly. Subdural pneumography revealed large bilateral fluid-containing spaces. Double, thick, haematin-containing membranes were removed by bilateral open craniotomy. Post-operatively, the abnormal transillumination persisted and large amounts of fluid continued to be aspirated when the skull was needled. Repeat craniotomy was performed 2 months later. Following this procedure the areas of transillumination gradually regressed until disappearance 2 months later at the age of 11 months. Head size remained stable and the fontanelle remained soft and pulsatile. Development has progressed normally and the child now has an IQ of 100.

Comment. This case report has been included to emphasize the observation of others that trans-

illumination can be a useful adjunct to the diagnosis of subacute or chronic subdural haematoma (Dodge and Porter, 1961; Horner, Webb, and Welch, 1958). Serial transillumination is a less traumatic method for post-operative evaluation of the state of clear fluid accumulation than is repeated subdural puncture.

We have observed 4 children with subacute subdural haematomas, who were transilluminated; all are doing well 3 to 5 years after operation. By contrast, those children who have had chronic subdural fluid collections that transmitted light, a history extending from 6 months to one year, and findings of cephalomegaly, and markedly thick fibrous subdural membranes, with a compressed deformed brain, are all doing very poorly or have died. Acute subdural haematomas, i.e. before lysis of the red blood cells, do not transmit light.

Serial transillumination has also been found useful in evaluating the clear fluid collections in post-shunt hydrocephalus and cystic brain disease.

Cases 1, 2, 3, and 4 illustrate four types of intracranial lesions that transmit light and that have been studied sufficiently to be recognized as treatable conditions. Other intracranial lesions that transilluminate include some subdural effusions, post-meningitis (Dodge and Porter, 1961), cerebral immaturity or prematurity (Shurtleff, 1964), and those that are associated with dehydration (Dodge and Porter, 1961). Disorders associated with a poor prognosis include advanced hydrocephalus, hydroencephaly (Alexander *et al.*, 1956), porencephaly

FIG. 5.—Case 5. Transillumination of abdomen. The dark shadow in right upper quadrant defines the liver.

(Dodge and Porter, 1961; Shurtleff, 1964), microcephaly and macrocranium (Shurtleff, 1964), and schizencephaly of Yakovlev (Shurtleff, 1964). The Dandy-Walker syndrome (congenital atresia of foramina of Luschka and Magendie: Fowler and Alexander, 1956), though potentially treatable, has led to poor results in the 5 children we have seen.

Case 5: Abdominal Transillumination. Fig. 5 illustrates transillumination applied to the diagnostic problem presented by a 4-month-old baby with an abdomen tensely distended by ascites, making it impossible to palpate the contents. Transillumination was able to demonstrate normal-sized liver and spleen, and to exclude the presence of any solid mass. (The baby was eventually found to have a congenital stenosis of the mesenteric vein.)

Comment. Single or multiple clear fluid-containing cysts of the abdomen, particularly associated with the urinary tract, transilluminate (Milner,

1964), as do renal cysts and hydronephrotic kidneys containing clear fluid. A lower abdominal mid-line mass that transilluminates has twice been demonstrated to be an obstructed urinary bladder. Transillumination has, of course, long been used to distinguish between hydroceles and solid tumours of the testis.

Summary

A rapid, simple, and quantitative method for photographic recording of translucent lesions has been presented.

Four typical cases (hydrocephalus, cystic brain disease, subdural hydroma, subdural haematoma) emphasize the use of cranial transillumination for the detection of fluid-containing lesions, often treatable, in the silent neopallium of infants.

More widespread use of transillumination is recommended to define solid organ size in the abdomen tense with clear fluid or gas, and in the differentiation of clear fluid-containing lesions from solid tumours anywhere in the body.

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