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Jugular Vein Obstruction Caused by Turning of the Head

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In vivo and cadaver studies demonstrated that turning the head to one side results in torsion and compression of the ipsilateral internal jugular vein. This can obstruct venous drainage from the head and cause increased intracranial pressure in patients who have had ligation or resection of the contralateral jugular vein or who have maldevelopment of the contralateral dural sinuses.

The routine use of jugular venous catheterization during the past 10 years [1] has revolutionized treatment of seriously ill patients by enabling continuous monitoring of central venous pressure, rapid infusion of blood products and fluid, convenient venous sampling, and parenteral alimentation. Jugular vein catheters can be left in place for extended periods (weeks to months), allowing long-term therapy in patients whose management would previously have been limited by venous access. Jugular vein catheterization is not without problems; the complications are many and often serious [2]. The causes and effects of nearly all of these complications are obvious; however, no previous investigators have adequately elucidated the conditions under which jugular vein catheterization could lead to the complication of increased intracranial pressure.

We recently evaluated two premature infants who had episodes of increased intracranial pressure after jugular vein catheters had been placed. The short course of these episodes led us to consider whether such a transient event as turning the head might contribute to the compromise of venous return from the head. To study the effect of head position on the patency of the internal jugular veins, we conducted two simple experiments, one in an infant monkey and the other in an infant human cadaver.

Materials and Methods

In the first experiment, an infant monkey was anesthetized intravenously with barbiturate, and small polyethylene catheters were placed in each internal jugular vein and tied in place. The catheters were connected to a Y adapter in order to make simultaneous bilateral jugular vein injections. Venograms were obtained using the frontal projection with the monkey supine during each of three hand injections of contrast material administered with the monkey's head: (1) in brow-up neutral positions, (2) turned to the right, and (3) turned to the left.

In the second experiment, right jugular venograms were obtained of an infant cadaver using an indwelling venous catheter, the tip of which was in the superior vena cava near the junction of the right brachiocephalic vein and the right internal jugular vein. The venograms were obtained using the frontal projection with the head of the supine infant in a neutral brow-up position and at various degrees of rotation to the right and left.

Results

When the monkey's head was placed in a neutral position, both internal jugular

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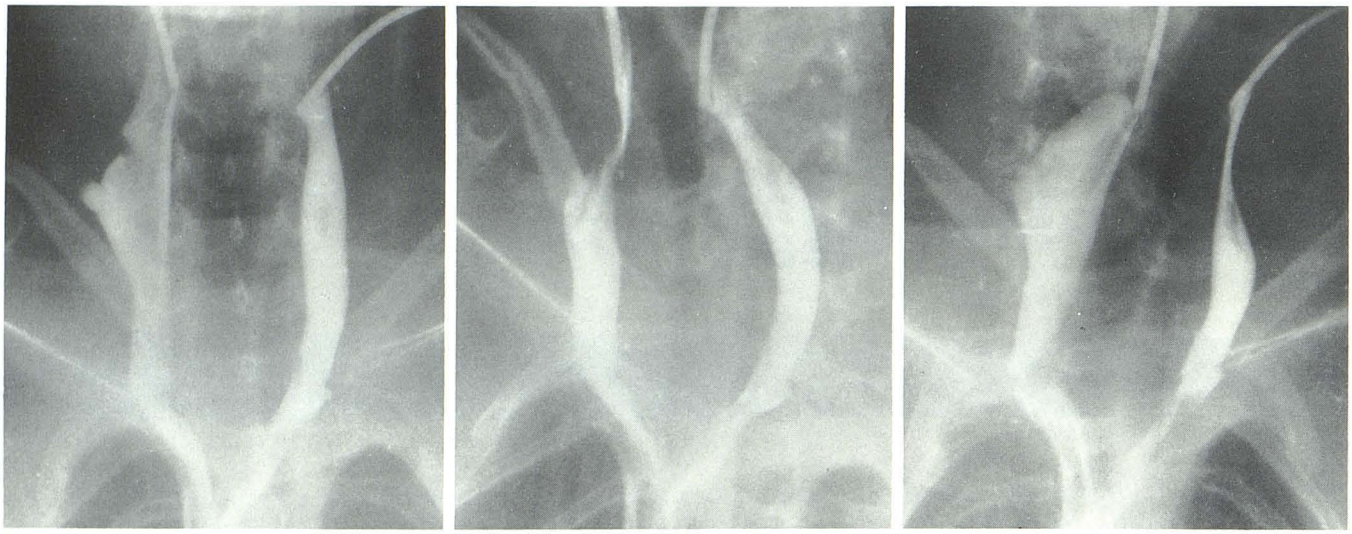

Fig. 1.—Monkey. Bilateral jugular venogram in frontal projection. **A**, With head in neutral position, both veins are widely patent. **B**, With head turned to right, right vein is markedly narrowed. **C**, With head turned to left, left vein is markedly narrowed.

veins were widely patent (fig. 1A). When the monkey's head was turned to the right, the right internal jugular vein narrowed markedly (fig. 1B). When the monkey's head was turned to the left, the left internal jugular vein narrowed (fig. 1C). In each instance of turning, the contralateral jugular vein remained patent.

When the head of the infant cadaver was placed in a brow-up neutral position or very slightly turned to the right, the right internal jugular vein demonstrated normal caliber (fig. 2A). As the head was turned further to the right, the right internal jugular vein progressively narrowed (figs. 2B–2D). When the head was turned to the left, the right internal jugular vein again became fully patent (fig. 2E).

Discussion

Both of our studies indicate that when the head is turned to one side, the ipsilateral internal jugular vein can become functionally obstructed. These results confirm those of others [3–5], but they have not been published in the radiologic literature. The mechanism causing this obstruction is the twisting of the vessel on its axis in the midpart of its course through the neck (figs. 1 and 2). If the contralateral internal jugular vein is already occluded for any reason (such as thrombus formation around the catheter or ligation of the vein when the catheter is inserted), turning the head can further compromise venous return. As a result of these two conditions, intracranial venous pressure can increase considerably and subsequently cause hydrocephalus. The two premature infants we evaluated quite likely manifested this combination of events.

The venous drainage of the head is complex and varies from person to person. Venous obstruction of the superficial venous system of the head often leads to edema and can become unmanageable, but such obstruction is usually not so critical as obstruction of cerebral veins.

The cerebral venous drainage depends on a network of dural sinuses and on the jugular-vertebral venous system. Obstruction at either of these sites can have serious consequences, depending on the availability of collateral channels. In a study of the normal variations of the dural sinuses at the torcular Herophili [4], only 57% of 215 specimens had free communication along the superior sagittal, straight, occipital, and transverse sinuses. Clearly, jugular vein occlusion on the side of the dominant venous drainage could result in severely limited cerebral venous drainage. In addition to the drainage through the jugular system, there are other individually small but very numerous channels arising from the skull base and orbits that communicate with the lower jugular system and with the vertebral venous system [6, 7]. The fact that patients survive bilateral jugular vein ligation or resection is clear evidence that, in some patients, this system can compensate for an obstructed jugular venous system. Nevertheless, numerous reports have attested to the fact that obstruction of the jugular venous system can lead to the development of hydrocephalus [8–13].

The cause of jugular obstruction that we report, that is, torsion-compression, has not been emphasized in the radiologic literature and represents a potentially serious, but avoidable, problem in any critically ill patient, especially one with obstruction of the contralateral jugular vein. Our study demonstrated that when the head is turned to the side, torsion-compression of the ipsilateral jugular vein occurs. That mechanical compression or torsion of the jugular vein not only obstructs venous drainage but also increases cerebrospinal fluid pressure has been stressed in the literature by several investigators [14–16], who showed that cerebrospinal fluid pressure can increase with external compression

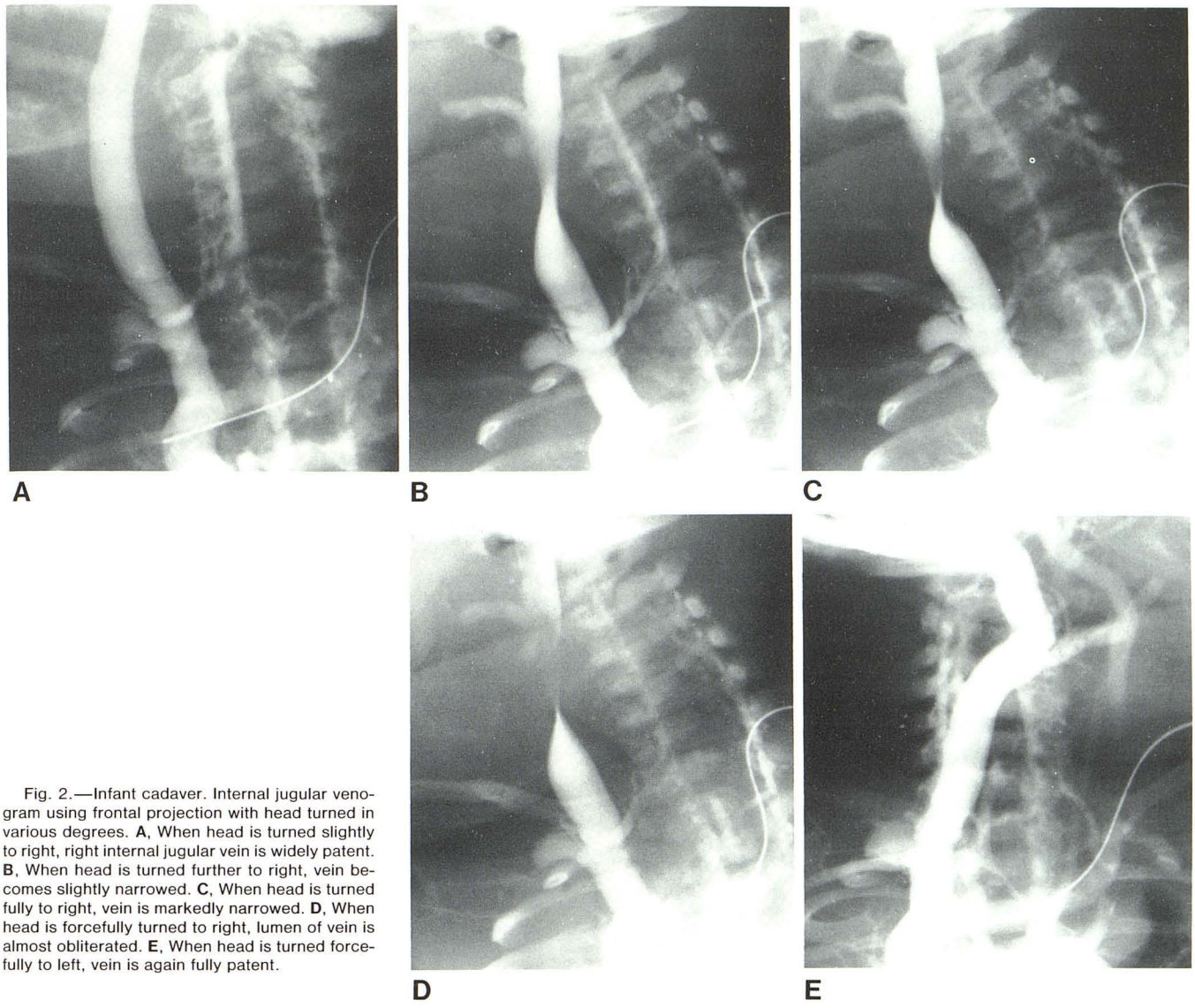

Fig. 2.—Infant cadaver. Internal jugular venogram using frontal projection with head turned in various degrees. **A**, When head is turned slightly to right, right internal jugular vein is widely patent. **B**, When head is turned further to right, vein becomes slightly narrowed. **C**, When head is turned fully to right, vein is markedly narrowed. **D**, When head is forcefully turned to right, lumen of vein is almost obliterated. **E**, When head is turned forcefully to left, vein is again fully patent.

of the jugular vein, turning the head to one side, or neck flexion/extension.

In the newborn infant, increased intracranial pressure resulting from turning the head to one side when there is concomitant contralateral obstruction in the jugular vein could have serious consequences. Embry and Peabody [17] postulated that increased intracranial venous pressure can contribute to neurologic morbidity of newborn infants either directly, by causing vascular distension leading to capillary rupture and intraventricular hemorrhage, or indirectly, by producing cerebral edema and impairment of cerebral perfusion.

Our studies clearly demonstrated that turning the head to one side results in torsion-compression of the ipsilateral internal jugular vein, which could have hemodynamically significant consequences. Though many collateral channels for venous drainage of the head are available to compensate, they may be severely compromised if resection, ligation, or catheterization of the vein, or anatomic variations in the venous channels have already obstructed the contralateral internal jugular vein.

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