CERVICAL VENOUS REFLUX IN DYNAMIC BRAIN SCINTIGRAPHY

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Cervical venous reflux, shown by dynamic brain scintigraphy, was investigated through three avenues of approach: (A) ***by reviewing 371 randomly chosen routine dynamic intracerebral bloodflow studies to estimate its incidence;*** (B) ***by correlative positive-contrast superior venacavography in patients with characteristic cervical venous reflux; and*** (C) ***by performing dynamic brain scintigraphy while utilizing various positional and physiologic maneuvers to attempt to produce cervical venous reflux in patients who did not exhibit this phenomenon on earlier examination. Although any obstruction of the superior vena cava or a properly timed Valsalva maneuver in selected patients can produce the scintigraphic picture of cervical venous reflux, in most cases it is a normal phenomenon due to incompetent or absent cervical venous valves.***

Unusually high levels of radioactivity in the cervical area during the early phase of dynamic encephaloscintigraphy are sometimes seen in nuclear medicine laboratories. Speculation that this finding always indicates a significant pathologic state within the neck or in the downstream venous system led to its subsequent investigation.

MATERIALS AND METHODS

Dynamic brain scintigraphy was performed as follows: A small bolus (average 2.5 cc) of 10–15 mCi of ^{99m}Tc-pertechnetate was injected into an antecubital vein, using Oldendorf's technique (*1–3*). A left-sided injection was used because of the space limitations of our camera room. A Searle Radiographics Pho/Gamma III HP camera recorded the images at 2-sec intervals, beginning immediately after injection, on 35-mm film. Either posterior or anterior projections were used, depending on the clinical situation. Although there were varying degrees of observed activity in the cervical region, only those cases in which activity was extremely intense and well defined were studied further. Two patients with cervical venous reflux underwent positive-contrast superior venacavography. This was done by first performing a left-sided injection into the antecubital vein, followed by a second study with bilateral antecubital vein injections using a deliberately slow (3-sec) hand injection. Renografin-76 (30 cc) was introduced into each antecubital vein through a catheter. Bilateral venous pressures and Decholin arm-to-tongue circulation times were also obtained. Dynamic scintiphotos were then compared with positive-contrast superior venacavograms.

A number of additional patients underwent dynamic brain imaging for a second time (Table 1), using various positional and physiologic maneuvers. The first study did not exhibit cervical venous reflux:

1. Three patients in a left-side-down lateral decubitus position, left arm injected, anterior and posterior dynamic scintiphotos.

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TABLE 1. RESULTS OF POSITIONAL AND PHYSIOLOGIC MANEUVERS

Maneuver	Number positive	Number of cases
Decubitus projection, left side down, left-sided injection	0	3
Sitting up, left-sided injection	0	5
Standing, left-sided injection	0	2
Supine, head dependent, posterior projection, left-sided injection	0	2
Supine, Valsalva maneuver, anterior projection, left arm injection	2	12
Supine, anterior projection, right arm injection	0	6

2. Five patients in sitting position, left arm injected, anterior dynamic scintiphotos.
3. Two patients in a standing position, left arm injected, anterior dynamic scintiphotos.
4. Two patients supine, head dependent, left arm injected, posterior dynamic scintiphotos.
5. Twelve patients supine performing a Valsalva maneuver, prior to and during left arm injection, anterior scintiphotos.
6. Six patients supine, right arm injected, anterior scintiphotos.

RESULTS

Of the 371 randomly chosen cases, 14 were positive for early intense well-defined radioactivity within the neck, an incidence of 3.5%. Of these, ten showed only left-sided cervical activity. Analysis of the current diagnosis, sex, anatomic position during the study, and cardiovascular status of the 14 positive cases showed no common pattern that would aid in explaining the phenomenon. The median age was 70 years (excluding a 1-year-old infant).

Of the two patients who showed dynamic scintigraphic cervical venous reflux and who also had positive-contrast superior venacavography, both correlated well with respect to the presence of reflux and its laterality. These patients did not have superior venacaval obstruction. One patient had absent valves in the external jugular system; the other had valves present, but incompetent to retrograde flow. An example of this latter type is shown in Fig. 1, 2, and 3. Figure 1 shows a striking example of bilateral early cervical activity in a dynamic scintigram. Figure 2 is the positive-contrast superior venacavogram, showing bilateral filling of the posterior cervical veins, the thyrocervical veins, transverse cervical veins, suprascapular veins, anterior jugular veins, external jugular veins, and internal jugular veins (*4–6*). Figure 3 shows a clearly patent superior vena cava (bilateral arm injections). To exclude the possibility of subclinical cardiac decompensation, the patient was carefully examined. Both external jugular veins filled from above. Decholin arm-to-tongue circulation time on the right was 12 sec, and on the left, 10 sec. Venous pressure on the right was 120 mm. This represents normal circulation time and normal venous pressure.

The results of injections made during positional and physiologic maneuvers are presented in Table 1. These results do not appear to be statistically significant, but it is of interest that the only two positive instances of cervical venous reflux were produced during Valsalva maneuvers.

DISCUSSION

The phenomenon of intense cervical radioactivity in the early phase of dynamic encephaloscintigraphy represents reflux filling of the cervical venous system (*7*). The phenomenon can be assessed in four categories: technical, anatomic, physiologic, and pathologic.

Technical. The average size of the injected bolus was 2.5 cc. No bolus exceeded 5 cc in volume. There-

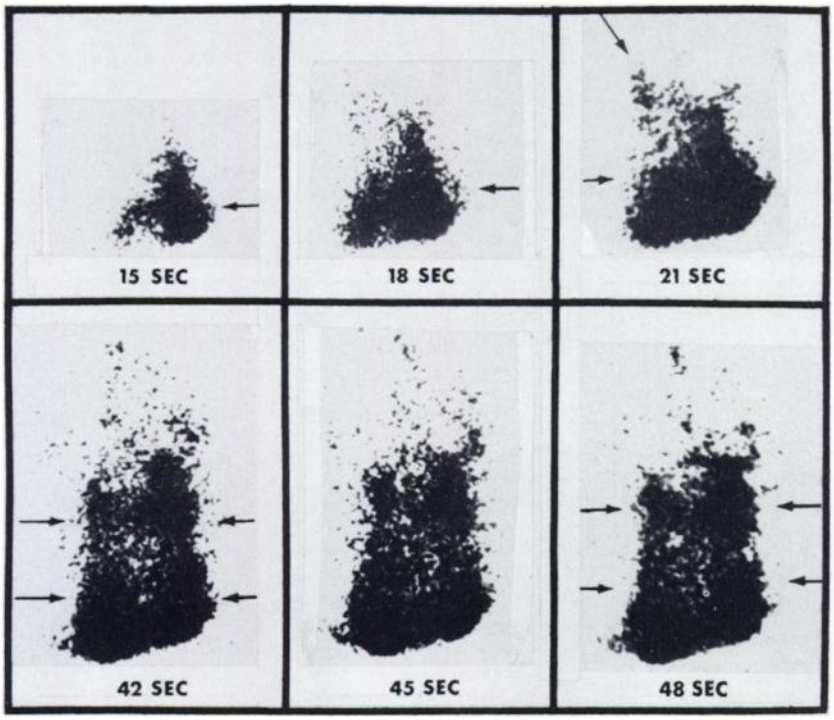

FIG. 1. Rapid-sequential brain scintigrams in 80-year-old patient. Anterior projection. Note persistence of extremely high concentration of radioactivity in cervical region (lower arrows). Middle cerebral artery (descending arrow) is best seen at 21 sec. Cervical veins (upper arrows) appear both early (15 sec) and late (42, 45, and 48 sec).

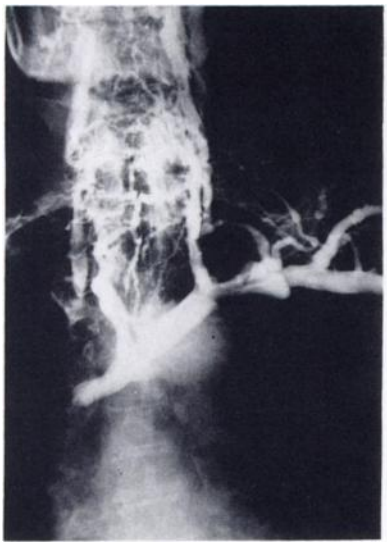

FIG. 2. Same patient, left-sided injection venogram of arm. Note filling of external and internal jugular veins, posterior cervical venous plexus, suprascapular veins, inferior thyroid vein, and other neck veins, all of which fill with left-sided injection.

FIG. 3. Same patient, bilateral venogram. Again, injection is deliberately slow (3 sec) to avoid altering normal hemodynamics. Note that superior vena cava is clear. Venous pressure and arm-to-tongue circulation times on both sides were normal.

fore, neither rapidity nor volume of injection could affect normal venous circulation. The layering phenomenon, which occurs when radiographic contrast material settles into the more dependent posterior cervical veins, is not present here.

Anatomic. The intensity and early appearance of the cervical activity rule out arterial structures. The positive-contrast venograms confirm that the structures are venous in nature. In addition, one case did have a thoracic-arch arteriogram which showed normal arterial vessels. The presence of valveless external jugular veins and other valveless cervical veins is not uncommon (*8*). Furthermore, the valves normally present in the internal jugular vein are usually incompetent to retrograde flow (*9*). Cervical veins anastomose readily and bilaterally, thus accounting for the high incidence of bilateral activity.

Physiologic. Considering that an inadvertent Valsalva maneuver by a patient may be a contributing factor, the effects of deliberate Valsalva were studied. One child had two dynamic brain scintigrams. The first study, performed while the child was mildly sedated and quiet, showed a totally normal dynamic study, whereas the second study, performed while the child was crying, showed dramatic bilateral cervical venous reflux. The effects of Valsalva maneuver are variable (*10–11*). Our findings indicate that it is a significant contributing factor in some cases—cervical venous reflux was produced in two out of twelve attempts. The Valsalva maneuver accentuates cervical venous reflux in those patients who have either absent cervical venous valves or borderline-competent valves. It is not a necessary factor, however, since one patient who showed dramatic cervical activity was comatose during the injection.

Pathologic. Superior venacaval obstruction due to tumor has been shown to cause cervical venous reflux. Tatsuya Miyame reports one case of superior venacaval syndrome in which the radionuclide superior venacavogram showed reflux filling of the external jugular vein (*12*).

Although almost all of our cases were in patients of advanced age, these patients were not in congestive heart failure at the time of examination. Severe cardiac decompensation could probably contribute to cervical venous reflux, but we have not been able to document such a case.

CONCLUSIONS

The phenomenon of cervical venous reflux shown by dynamic encephaloscintigraphy can occur in patients with valveless cervical venous systems or cervical venous incompetence. A Valsalva maneuver accentuates the phenomenon but is not necessary to produce it. Superior venacaval obstruction can be a causative factor. Conceivably, congestive heart failure could be a contributing factor but was not causative in the present series.

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