Thermography in the management of carotid-cavernous fistulas

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The authors report their experiences with thermography as a new tool to assess the diagnosis and postoperative control of patients with carotid-cavernous fistulas (CCF). A zone of increased temperature on the homolateral orbital region is described in cases of CCF. A supraorbital “cool” area, as seen in patients with carotid stenosis or occlusion, is observed when surgery with the Jaeger-Hamby technique has been successful. Thermograms obtained in five patients are presented and the pathophysiology of these findings is discussed.

KEY WORDS • thermography • carotid-cavernous fistula • diagnosis

SINCE 1969, we have been working in the field of thermography and its applications to the study of neurological and neurosurgical patients, especially in relation to cerebrovascular insufficiency due to extracranial vascular occlusion. However, we could find no similar studies in the literature relating to the diagnosis and management of carotid-cavernous fistulas (CCF).

We are presenting five patients with CCF studied by thermography. A group of 117 cases of cerebrovascular disease similarly studied by Wood included two patients with CCF, but his findings did not coincide with ours.

Material and Method

Thermographic studies were performed with the Swedish 665 AGA Thermovision unit. This is a very sensitive (resolution capacity 0.2°C) and fast-operating apparatus in which the infrared radiation is detected by an indium-antimony crystal cooled by liquid nitrogen (-196°C). The thermal radiation is converted by the crystal into video signals which after amplification are transferred to the display unit and processed in the same manner as the image in a television receiver. The result is a picture of different degrees of brightness, corresponding to varying intensities of infrared radiation. The amount of infrared radiation is directly proportional to the intensity of temperature. The picture on the screen is photographed with a Polaroid camera, and appears as a continuous range of gray tones where cooler areas are darker, and hotter areas lighter. The intensity of tone is proportional to the temperature. The thermovision unit permits the simultaneous illumination of points of equal temperature (isotherms) superimposed on the normal pic-

*Thermovision unit made by AGA Infrared systems AB, 181 81 LIDNGO, Sweden.

†Camera made by Polaroid Corporation, Waltham, Massachusetts.
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TABLE 1
Summary of clinical findings in five patients with carotid-cavernous fistulas

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Bruit</th>
<th>Chemosis</th>
<th>Exophthalmos</th>
<th>Extraocular Muscular Paresis</th>
<th>Impaired Vision</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>M</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<td>yes</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>M</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
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<td>no</td>
</tr>
<tr>
<td>3*</td>
<td>35</td>
<td>F</td>
<td>no</td>
<td>slight</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>4</td>
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<td>M</td>
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<td>yes</td>
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<td>no</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>M</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

* The patient in Case 3 developed a characteristic clinical picture 1 week after thermography had been performed.

Thermography

There is a wide range of technical possibilities with this system, not described in this paper.

This series consists of five consecutive patients with CCF admitted to our department between 1969 and 1973. These patients were all operated on according to the technique described by Jaeger and advocated by Hamby. All the patients had been victims of traffic accidents 1 to 16 days before admission. The important clinical features are presented in Table 1.

Previous to examination, the patient was placed for 15 to 20 minutes in a draft-free room at a constant temperature of 20°C and a humidity of approximately 50%. Once the skin had acquired a uniform cooling and drying, thermograms were taken in frontal and lateral projections with a Polaroid camera. The thermograms were evaluated by pictorial comparison of similar points in the contralateral side of the face. The use of isotherms and temperature difference measurements was very helpful in doubtful cases. Postoperative studies were performed as controls, first three days after surgery, then every 3 to 5 days, and finally every month for 3 months.

Results

Diagnosis

Figure 1 is typical of the thermographic findings in the CCF cases studied in this investigation. The thermogram reveals a zone of increased temperature which extends over the homolateral orbital and supraorbital regions, as compared to the opposite side. The hottest spot is located on its medial aspect (angular region); thermograms in all of our other cases were similar, with slight variations.

Postoperative Control

After the trapping and embolization technique was carried out, a cool area (dark) over the homolateral half of the face could be observed during the first days, darkest over the supraorbital region. Repeated control thermography showed that only the supraorbital dark area persisted as described in cases of internal carotid occlusion (Fig. 2).

Recurrence

In one case, Case 4, thermographic signs were the first indication of recurrence of the CCF. In that case the postoperative thermographic changes described above disappeared and the warm pattern over the orbit returned (Fig. 3), as shown in the preoperative thermogram. Recurrence was confirmed by angiography. For this reason repeated control thermography at 3- to 5-day intervals is recommended following the surgical procedure.

Discussion

Since 1809, when Benjamin Travers published the classic description of "pulsating exophthalmos," many publications have been made on this relatively uncommon intracranial vascular lesion. The clinical picture depends basically on the venous drainage of the cavernous sinus. In CCF, the direction of flow changes to the main tributaries of the cavernous sinus, with the superior and inferior ophthalmic veins usually the most
affected. As a result of those hemodynamic changes, congestion in the orbital region causes a temperature increase in this area, which explains our thermographic findings. One should remember that, in normal conditions, skin temperature is basically determined by the cutaneous blood supply.

We have not seen a supraorbital area of coolness, as observed in one of the two cases reported by Wood, although this possibility exists due to stealing from the ophthalmic artery flow. In very few cases, the orbital veins are not congested because occasionally the arterial blood flow is diverted to the cerebral veins and not to the orbital veins. This phenomenon has been reported in cases where the flow is diverted to contralateral orbital veins by way of the circular sinus and
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Fig. 3. Case 4. Left: Thermogram 7 days after trapping and embolization of a right CCF. Right side of the face is darker (cooler) than the left. Compare especially both orbital and supraorbital areas. Right: Thermogram 2 months after operation reveals that the right supraorbital region is no longer cooler than the left and that the right angular plus the whole orbit are warmer (lighter). These changes suggested recurrence of the CCF, which was confirmed by angiography.

opposite cavernous sinus. In such a case the thermographic changes may be found in the "wrong" side.

We think that in patients with CCF, the venous congestion is the most important factor determining the temperature changes in the orbital and supraorbital region. This could mask the circulatory deficit in the ophthalmic artery that may exist because of stealing. The postoperative thermograms are similar to the ones described in cases of carotid stenosis or occlusion, since the pathophysiological basis is the same, namely, blood flow reduction through the ophthalmic arterial branches. This finding has been a reliable indication of surgical success. Likewise, thermography was shown in one case to be a useful indication of recurrence of the fistula, when previous thermographic studies are available for comparison.

References

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