An Evaluation of Micropaque Barium Sulphate as a Radiographic Marker for Cerebral Abscess

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In 1962 Clarke et al. introduced micropaque barium sulphate, a sterile suspension of barium sulphate, the particles varying in size between 0.5 μ to below 0.1 μ, as a substitute for thorium dioxide in the radiographic marking of cerebral abscesses. They used this material in 8 patients with cerebral abscesses and reported that micropaque was superior to thorium dioxide. They believed that because micropaque was inert chemically it would be a safe material in brain tissue as well as in the ventricular system or subarachnoidal spaces.

The purpose of the present investigation was to determine the reactivity of micropaque barium sulphate in brain tissue, the cerebral ventricles, the subarachnoidal spaces, and in artificially induced cerebral abscesses.

Method

Microbarium was evaluated for reactivity of tissue by introducing it into the parenchyma of the brain in animals intraventricularly and in the subarachnoidal spaces and into artificially made abscesses. These experiments are summarized in Table 1.

**Table 1**

<table>
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<th>Number of animals used in each experiment</th>
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<td>Parenchymatous</td>
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<td>Intraventricular and subarachnoidal</td>
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<td>Abscess cavity</td>
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Died at 18-24 hrs. The third dog received 3 separate injections of the material, 0.75 cc. each at 4-day intervals, and was sacrificed 11 days after the initial injection.

Cavity of Cerebral Abscess. Sterile abscesses were created in 4 cats (approximate weight 3 kg.) and 1 monkey (cynomolgus, 4.3 kg. in weight) by the method of Sperl and associates by placing psyllium seeds subcortically. After a 3-week interval the area was re-explored and the cavity was aspirated. An amount of micropaque sulphate just sufficient to fill the cavity (approximately 0.5 cc.) was then introduced.

In the group of cerebral abscesses radiographs of the area were made immediately after the instillation of the barium and at 7 to 10 days later. All animals were then sacrificed and the brains were examined histologically.

Results

Direct Intraparenchymatous Injection. By 3 weeks after the introduction of micropaque sulphate into the brain tissue a prominent zone of macrophages had developed around the foreign material (Fig. 1). Many of the macrophages had ingested the barium and a sharp line of separation was established from the minimally reactive brain. The brain tissue adjacent to the zone of macrophages showed a definite glial reaction (Fig. 2). There was no evidence of migration of the barium-laden macrophages.

Intraventricular and Subarachnoidal Injection. After the introduction of the micro-
FIG. 1. Intraparenchymatous microbarium. (A) Free microbarium. (B) Zone of microbarium-laden macrophages. (C) Minimally reactive brain tissue. (Hematoxylin and eosin, ×148)

FIG. 2. Intraparenchymatous microbarium. Higher power view of area marked in Fig. 1. The glial reaction is entrapping the microbarium-laden macrophages. (Phosphotungstic acid hematoxylin, ×210)
barium into the ventricular system there was an outpouring of polymorphonuclear leukocytes and macrophages within 24 to 72 hrs. Many of the macrophages contained ingested microbarium. After 48–72 hrs. the ependymal lining in many areas was lost and the subependymal glial plate was visibly edematous (Fig. 3). Perivascular cuffing of inflammatory cells could be seen around the blood vessels of the adjacent brain tissue.

Within the cortical subarachnoidal space and in the cisterna magna the microbarium caused a marked response of polymorphonuclear leukocytes and macrophages. Many of the macrophages contained ingested microbarium. The pia arachnoid was visibly swollen but the adjacent brain tissue showed minimal reaction (Fig. 4). Blood vessels of the pia arachnoid were dilated and the endothelium was swollen (Fig. 5), but the vessels of the surrounding brain tissue were normal.

Regardless of whether the microbarium was introduced into the ventricle or cisterna magna, the major portion of the material was found concentrated in the basilar cisterns and along the spinal subarachnoidal spaces. Response of polymorphonuclear leukocytes and macrophages was evident over the spinal pia arachnoid and about the cauda equina. Many macrophages contained ingested microbarium.

In the dog that survived 11 days after introduction of microbarium into the cisterna magna, moderately dilated ventricles were found (Fig. 6).

Cavity of Cerebral Abscess. Radiographs made of the heads of the animals that received microbarium into sterile abscesses showed excellent delineation of the cavity both immediately after introduction of the microbarium and 10 days later (Fig. 7). Histologic examination showed the microbarium was primarily in macrophages that formed the wall of the abscess (Fig. 8). The surrounding brain tissue showed minimal reaction. No evidence of migration of the microbarium-laden macrophages was found at 2 weeks.

Discussion
The value of thorium dioxide (Thorotrast) as a radiopaque marker of cerebral abscesses has been well established\(^4\) since its introduction by Kahn\(^5\) in 1939. The marking of the abscess permits an estimation of its size and allows localization if migration of the abscess should occur. The thorium is rapidly concentrated in the wall of the abscess where it remains.

Thorium is a radioactive substance with a half-life of \(1.4 \times 10^{10}\) years. It has been implicated repeatedly in the formation of tumors at the site of injection and in hollow organs into which it was introduced, especially in the reticuloendothelial cell which engulfs the material. Dahlgren’s\(^2\) analysis would indicate that it is the radioactivity of the thorium that is responsible for its carcinogenic nature. These tumors tend to occur 10 to 35 years after the thorium was introduced. The recent report of Kyle and associates\(^6\) of a menin-
Fig. 4. Subarachnoidal microbarium. Leptomeningeal reaction in posterior fossa consisting of polymorphonuclear leukocytes and microbarium-laden macrophages. The underlying brain tissue shows no reaction. (Hematoxylin and eosin, ×175)
Microbarium for Marking Cerebral Abscess

Fig. 6. Subarachnoidal microbarium. (A) Coronal sections of normal dog brain. (B) Coronal sections at approximately the same level in the animal that survived 11 days after injection of microbarium into cisterna magna. There is generalized dilatation of the ventricular system. Microbarium is in the basilar cistern (arrow).

The original work of Thomas in 1914 and later of Lindauer and Griffith and Dixon and Heller established the danger of particulate foreign material in the subarachnoidal space. They showed that kaolin or aleuron introduced into the subarachnoidal space would cause a severe leptomeningeal reaction that led to blocking of the cerebrospinal-fluid pathways and hydrocephalus in a high percentage of experimental animals.

In 1938 Stuck and Reeves did an extensive study of the pathological effects of thorium and established that with its introduction into the subarachnoidal space, the same reaction occurred. Thus it is not the material itself but the reaction of the leptomeninges with its inflammatory exudate that is important in the eventual obstruction of the cerebrospinal-fluid pathways. The experiments reported in this paper show that microbarium causes the same inflammatory leptomeningeal response. In this regard it is in no way different from thorium. Microbarium would, therefore, be safe only when introduced into a cavity that is not in communication with the subarachnoidal space.

It is concluded from these experiments that microbarium sulphate is superior to

Fig. 7. (A) Radiograph made immediately after instillation of microbarium into the cerebral abscess in a monkey (arrow). The overlying shadow is caused by the trephined bone. (B) Radiograph made at 10 days. The abscess is still well outlined by the microbarium (arrow).
thorium for instillation in cerebral abscesses since it is not radioactive but retains the excellent concentrating and radiographic properties of thorium. These experiments do not support the contention of Clarke and associates\(^1\) that no ill effects would be caused by the presence of the microbarium in the ventricles or subarachnoidal spaces. All the precautions used to prevent thorium from contaminating the subarachnoidal space must be exercised with microbarium.

3) The lack of radioactivity of microbarium would eliminate this factor as a future cause of carcinogenesis.

4) Precautions must be exercised with microbarium, as with thorium, to prevent its entering the subarachnoidal space.

I wish to thank Dr. W. Jann Brown for reviewing the histology.

**References**

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