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CT and MR Appearance of Otolaryngologic Packing Materials

C. Hartley, K. L. Ng, and A. Jackson

PURPOSE: To examine the CT and MR appearances of four packing materials commonly used in otolaryngologic surgery. **METHODS:** The CT and MR appearances of bismuth and iodoform paraffin paste, aqueous betadine gauze, calcium sodium alginate, and triadocortyl cream were examined. CT attenuation values were measured using phantoms containing packing materials. MR characteristics were examined by packing the external auditory meati of volunteers. Two illustrative case reports also are presented. **RESULTS:** Bismuth and iodoform paraffin paste has a high CT attenuation (>3000 Hounsfield units) resulting in severe image degradation attributable to streak artifact. Aqueous betadine gauze was of high attenuation (258 Hounsfield units; SD, 16.5) but did not cause image degradation. The attenuation values of calcium sodium alginate and triadocortyl creme coincided with those of muscle and fat, respectively. On MR, calcium sodium alginate and bismuth and iodoform paraffin paste had imaging characteristics similar to muscle and aqueous betadine gauze had appearances similar to bone marrow. Triadocortyl cream had a high signal equal to that of fat on T1-weighted images but a lower signal similar to bone marrow on T2-weighted images. **CONCLUSIONS:** The presence of bismuth and iodoform paraffin paste can give rise to clinically important image degradation on CT. More seriously, residual packing material may be misinterpreted as infection or tissue necrosis.

Index terms: Computed tomography, postoperative; Foreign bodies; Magnetic resonance, postoperative; Temporal bone, surgery

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Artificial surgical packing materials are commonly used in otolaryngology and may be left in place for a considerable period. A range of these materials is commercially available; the choice depends on their hemostatic properties and their ability to resist infection. This study documents the computed tomography (CT) and magnetic resonance (MR) appearances of four commonly used packing materials and discusses the implications of these observations in clinical practice via two illustrative case reports.

Materials and Method

The four packing materials selected for analysis were: (*a*) bismuth and iodoform paraffin paste (BIPP; Evans Medical Ltd, Langhurst, Norsham, Sussex, United Kingdom); (*b*) aqueous betadine gauze (Napp Lab Ltd, Cambridge, United Kingdom); (*c*) calcium sodium alginate fiber (Kaltostat; Britcair, Aldershot, Hants, United Kingdom); and (*d*) triadocortyl cream (TAC; Squibb & Sons Ltd, Hounslow, Middlesex, United Kingdom).

Samples of all four materials were tightly packed into separate plastic vials, which were each individually attached to a water phantom and scanned with a GE 8800 CT scanner. A series of 10-mm sections through each phantom was done and attenuation values were measured on the region of interest with a standard 0.5-cm circular cursor. For each phantom, a series of five scans was done and attenuation values of the packing material were measured on a central image to avoid inadvertent inclusion of adjacent air-containing portions of the phantom. The attenuation values of a range of normal tissues were measured from a series of five clinical head scans with the same scanner.

For MR imaging, the external auditory canals of volunteers were packed in turn with each of the packing materials. Both T1- (spin-echo 500/25/2[repetition time/echo time/excitations]) and T2- (fast spin-echo 6000/1021) weighted coronal images were obtained with a 0.5-T General Electric Vectra unit. A total of three examinations was performed with each packing material. Multiple region of

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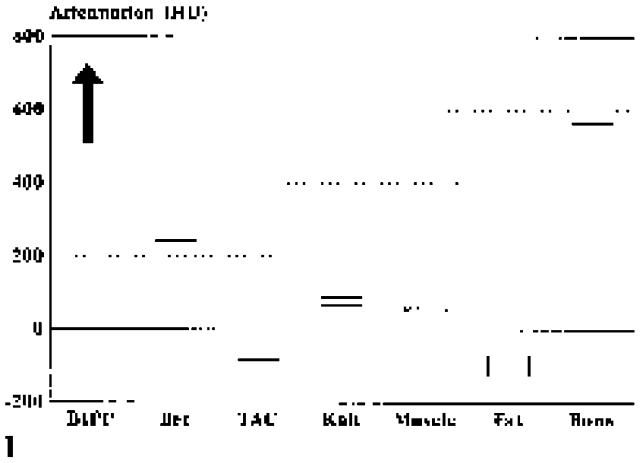
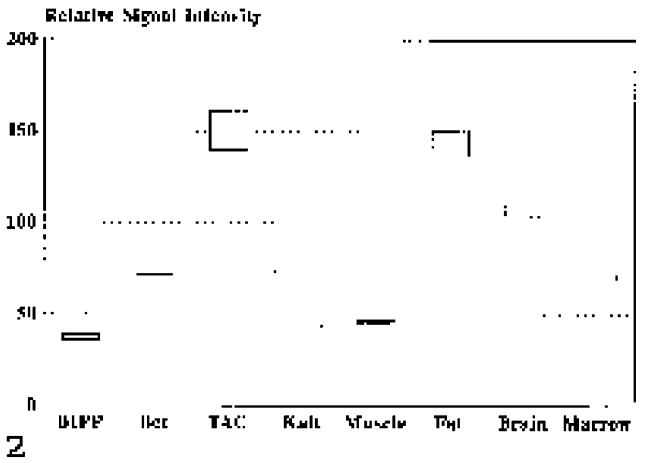




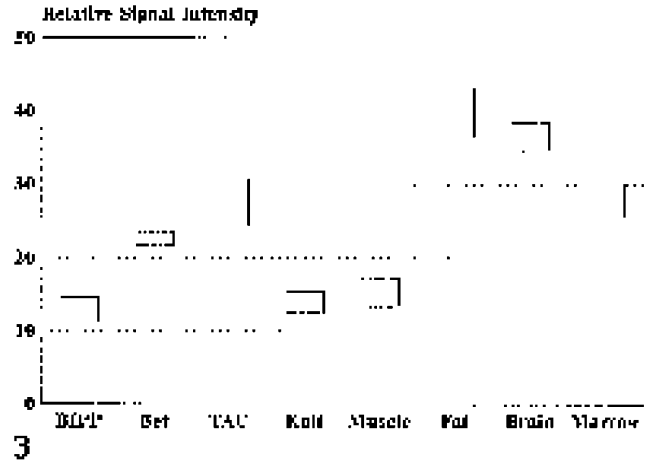


Fig 1. CT attenuation values of packing materials and normal tissues. Measurements represent corrected mean values based on five measurements. The demonstrated range is 2 SD for single pixel values. The attenuation of bismuth and iodoform paraffin paste was above the range of measurement available (>3000 HU).

Fig 2. Relative signal intensity of packing materials on T1-weighted MR (spin-echo 500/25). Measurements represent corrected mean values based on three measurements. The demonstrated range is 2 SD for single pixel values.

Fig 3. Relative signal intensity of packing materials on T2-weighted MR (fast spin-echo 6000/102). Measurements represent corrected mean values based on three measurements. The demonstrated range is 2 SD for single pixel values.

BIPP indicates bismuth and iodoform paraffin paste; *Bet*, aqueous betadine gauze; *TAC*, triadocortyl cream; and *Kalt*, calcium sodium agminate.

interest measurements were taken from the packing materials as well as a selection of the adjacent tissues, namely muscle (masseter), bone marrow (body of C-2), fat (subcutaneous), and brain (temporal lobe white matter). All region of interest measurements used a standard 0.5-cm circular cursor.

Region of interest measurements were used to calculate corrected population means for each intensity value (1). Because the variance of mean region of interest measurements is dependent on sample size, the distribution of pixel intensity values was recorded as the corrected standard deviation of single pixel values based on sample values for each tissue.

Results

On CT images, bismuth and iodoform paraffin paste showed high attenuation that was above the region of interest measurement abilities of the scanner (>3000 Hounsfield units [HU]) and produced significant streak artifact on phantom images. Aqueous betadine gauze also was of high attenuation (mean, 258 HU; SD, 16.5) but did not give rise to any reduction in image quality. The attenuation value of calcium sodium alginate (mean, 78.5 HU; SD, 10.5) and triadocortyl cream (mean, −72.5 HU; SD, 8.5 HU) coincided with the normal ranges for muscle and fat, respectively (Table, Fig 1).

On MR imaging, calcium sodium aginate and bismuth and iodoform paraffin paste showed signal characteristics similar to muscle, whereas the T1 and T2 signal intensities of aqueous betadine gauze coincided with those of bone marrow. Triadocortyl cream had a signal intensity similar to fat on T1-weighted images but a lower signal intensity similar to that of bone marrow with T2-weighting (Table, Figs 2–4).

Case Histories

Case 1

A 54-year-old non–insulin-dependent diabetic man was admitted with a short history of

Attenuation values and relative signal intensities of surgical packing materials and a selection of normal tissues*

	CT	T1-weighted MR	T2-weighted MR
Bismuth and iodoform cream	>3000 (. . .)	37.5 (1.5)	13 (1.7)
Betadine gauze	258 (16.5)	75 (2.9)	22.7 (1.0)
Triodocortyl cream	−72.5 (8.5)	150 (10)	27.2 (2.8)
Calcium sodium alginate	78.5 (10.5)	46 (3.0)	13.9 (1.5)
Muscle	54.5 (3.5)	46 (1.0)	15.4 (1.9)
Fat	−97.5 (27.5)	143 (6.5)	37.9 (2.4)
Bone	613 (47.5)	. . .	. . .
Brain	. . .	107 (3.0)	36.5 (1.9)
Marrow	. .	70 (1.4)	27.8 (2.4)

*Values represent corrected population means (SD) calculated from repeated measurements.

drowsiness and confusion and was found to have a right sixth nerve palsy, nystagmus, and trunkal ataxia. CT showed a 2-cm right-sided ring-enhancing lesion in the posterior fossa and opacification of the mastoid air cells (Fig 5A). An ear, nose, and throat review disclosed a 30-year history of intermittent discharge from the right ear, and examination demonstrated a retraction pocket containing squamous debris. Posterior fossa craniectomy confirmed a cerebellar abscess, which was drained and subtotally resected. Three weeks after initial surgery,

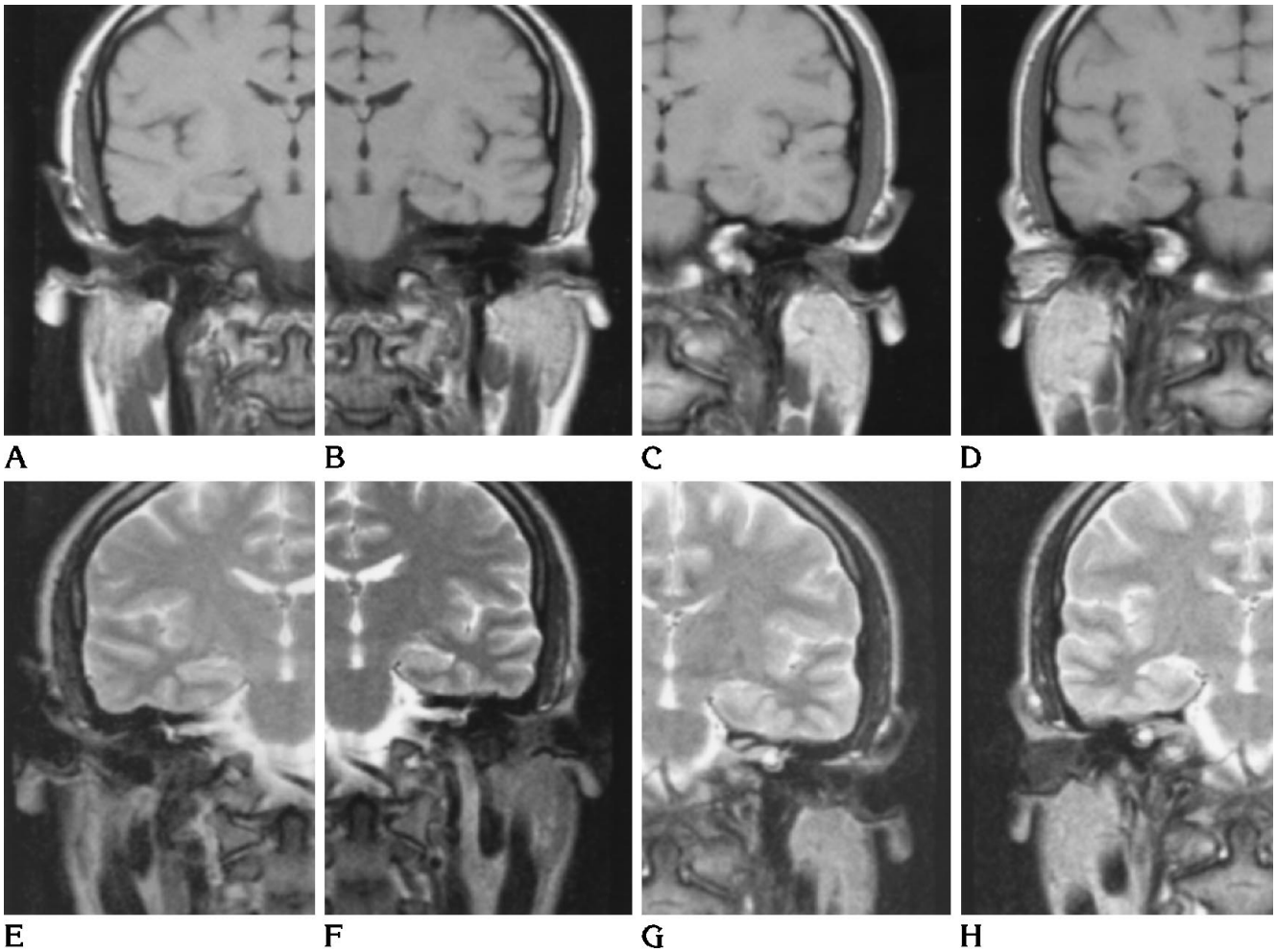


Fig 4. T1- and T2-weighted images of packing materials in the external auditory meatus in volunteers. The T1-weighted images are of bismuth and iodoform paraffin paste (*A*), aqueous betadine gauze (*B*), calcium sodium alginate (*C*), and triadocortyl cream (*D*). *E* through *H* show corresponding T2-weighted images.

A B C

Fig 5. *A*, Case 1. Axial postcontrast CT shows a ring-enhancing mass lesion in the right cerebellar hemisphere and enhancement extending from it to the petrous surface of the hemisphere.

B, Axial postcontrast CT after surgery shows marked degradation of image quality attributable to streak artifact from bismuth and iodoform paraffin paste packing in the surgical cavity.

C, Axial postcontrast T1-weighted MR (gradient echo 540/14; flip angle 90°) after surgery shows a large residual abscess cavity.

after improvement of his general condition, a right radical mastoidectomy was done. The mastoid cavity was packed with bismuth and iodoform paraffin paste which remained in place for 4 weeks. CT done a week later to determine the size of the abscess remnant was nondiagnostic because of the presence of marked streak artifacts (Fig 5B). MR subsequently demonstrated a small remnant with no evidence of image degradation (Fig 5C). After eventual removal of bismuth and iodoform paraffin paste, further follow-up CT was of high quality and showed no evidence of residual packing material.

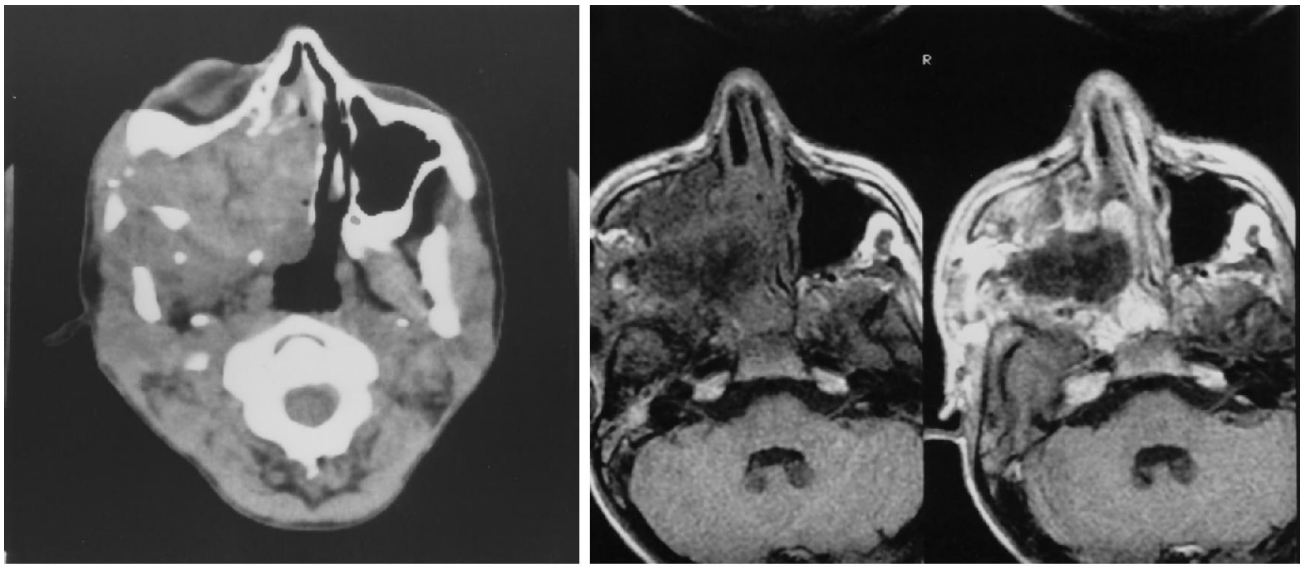
Case 2

A 13-year-old boy presented with a 4-year history of right-sided epistaxis, facial discomfort, and a few months' history of ipsilateral proptosis. After CT and MR, a diagnosis of angiofibroma was made and tumor excision was done. Because of profuse bleeding at surgery, residual tumor was thought to have been left in the region of the sphenoid and cavernous sinuses. Follow-up CT and MR (Figs 6A and B) demonstrated extensive soft-tissue abnormality throughout the maxillary sinuses extending into the nasal cavity, nasopharynx, and skull base. Postcontrast CT and MR showed no evidence of enhancement in the main body of the soft-tissue mass, which was assumed to be necrotic tumor. Carotid angiography (Fig 6C) confirmed the presence of a very vascular tumor remnant in the skull base and posterior nasopharynx with no evidence of tumor blush in the body of the maxilla. Surgery was performed again 15 months after the initial surgery, via removal of the maxilla. At surgery, large areas of presumed central tumor necrosis were found to be calcium sodium alginate hemostatic packing material from the original procedure. Residual tumor corresponded to the areas of enhancement seen on postcontrast CT and MR and to the tumor blush seen on angiography.

Discussion

Packing materials have been in common use in otolaryngology for many years. A variety of materials are available that are intended to secure hemostasis and avoid secondary infection. They also may encourage tissue granulation or stimulate new bone growth. Nasal packing is common for the control of persistent epistaxis; packing of surgical cavities after surgery to the facial skeleton, sinuses, and petrous bones is a routine part of postoperative treatment.

Ribbon gauze impregnated with bismuth and iodoform paraffin paste is a time-honored antiseptic dressing consisting of two parts iodoform and one part bismuth subnitrate in a liquid paraffin base (2). Bismuth and iodoform paraffin paste generally is acknowledged as a safe and effective packing material, and complications are rare (3–6). In the present study, the high



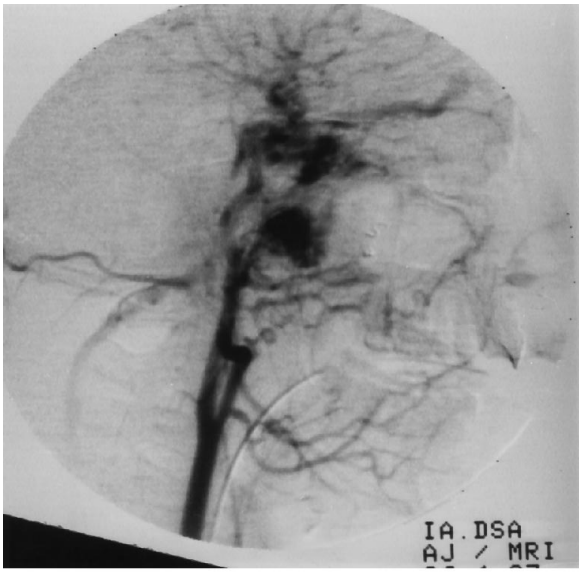


Fig 6. *A,* Postoperative CT scan shows a large soft tissue "mass" in the right maxilla.

B, Precontrast and postcontrast T1-weighted MR (gradient echo 540/14; flip angle 90°) shows a large nonenhancing central portion within the maxillary mass.

C, Selective right common carotid angiogram shows tumor blush limited to the sphenoid area.

bismuth content of bismuth and iodoform paraffin paste gave rise to gross streak artifact on CT images. This has been reported previously (7) and is an important consideration when postoperative CT follow-up is likely. This is of particular importance in cases like the one here, in which intracerebral infection has spread from a focus in the petrous bone or frontal sinuses. The high bismuth concentration in bismuth and iodoform paraffin paste also will give rise to complete opacification on plain radiographs, so that removal of a nasal pack may be necessary to enable interventional angiographic treatment of persistent epistaxis.

On MR, bismuth and iodoform paraffin paste causes no image degradation, making it possible, as in case 1, to monitor postoperative infective complications. Bismuth and iodoform paraffin paste packing has a signal intensity very similar to that of muscle and soft tissue on both T1- and T2-weighted images, so that it may be possible to mistake it for an area of tissue necrosis. The presence of any packing material should be clearly ascertained before attempting to interpret images in such a case, and if bismuth and iodoform paraffin paste packing has been used, plain radiographs or CT will clarify its position if necessary.

On CT imaging, betadine-impregnated gauze had a high attenuation value, which made it easily identifiable without causing any degradation in CT image quality; however, on T1- and T2-weighted images, it showed a relatively high signal similar to that of bone marrow. Although this could give rise to confusion where betadine gauze has been placed into a surgical cavity within cancellous bone, the surgical history, together with information from CT or plain film, will easily clarify the nature and position of residual packing.

Triadocortyl cream is an aqueous paraffin cream that appears identical to body fat on CT and on T1-weighted MR images. On T2-weighted images, it shows a lower signal intensity than fat, similar to that of bone marrow but insufficient to allow clear distinction from normal fat-containing tissues. However, triadocortyl cream generally is not left within surgical cavities for any significant period and is therefore less likely than other packing materials to cause confusion with body tissues.

Calcium sodium alginate is an easily used and effective packing material that gives rise to a tight packing bundle. It is an effective hemostatic and bacteristatic agent and in addition has been shown to stimulate formation of granulation tissue and of new bone within surgical cavities (8–10). It is a stable agent that can persist for long periods, as in the case described here. The CT attenuation and MR signal intensity of calcium sodium aginate were indistinguishable from those of muscle in the present study. This gives rise to the serious possibility that retained calcium sodium alginate may be mistaken for normal or neoplastic soft tissue as in the second case described here. It is also of interest to note (Figs 4, 6A and B) that calcium sodium alginate has an irregular fibrous consistency that gives rise to a relatively heterogeneous appearance on CT and MR images. Even the absence of postcontrast enhancement does not provide accurate identification of residual calcium sodium alginate, because it may give rise to the assumption that this represents ischemic or necrotic tumor tissue. In the present case, the presence of CT and MR enhancement and of tumor blush on angiography accurately delineated the limits of the residual tumor.

In conclusion, the choice of ear, nose, and throat surgical packing materials should be based not only on their clinical properties but also on their radiographic properties if further imaging investigation is likely. In particular, bismuth and iodoform paraffin paste may be expected to cause gross degradation of CT images and to interfere with plain film and angiographic examinations. Betadine-impregnated gauze is easily identified on CT and causes no degradation of image quality, although it could be mistaken for nonenhancing soft tissue on MR examinations. Triadocortyl cream has the properties of fat on CT and on T1-weighted MR, with a slightly lower signal intensity than fat on T2-weighted MR; however, it is unlikely to be mistaken for natural tissue because it remains in place for only a short period. Calcium sodium alginate can be mistaken for nonenhancing soft tissue on both CT and MR images and furthermore may remain in surgical cavities for months or even years. Its internal fibrous structure gives rise to a heterogeneous appearance that further mimics that of normal soft tissue and that can lead to a mistaken diagnosis of infection or of residual or recurrent tumor. In all cases in which surgical packing materials are to be left in place, it is important that this is carefully documented and that these facts are available to the radiologist interpreting the films. In the case of calcium sodium alginate, it may be impossible to identify definitively the nature of retained packing materials; close cooperation between ear, nose, and throat surgeons and radiologists is essential.

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