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PICTORIAL REVIEW

Imaging appearance of topical haemostatic agents: pictorial review

HOWARD T HELLER, MD, BRETT S WALKER, MD, CHERYL A SADOW, MD and MARY C FRATES, MD

Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA

Address correspondence to: Dr Howard T. Heller

E-mail: HHeller@partners.org

ABSTRACT

Topical haemostatic agents have become an essential tool to assist with the control of bleeding during surgery as well as to facilitate wound closure. The imaging appearance of these agents can overlap that of abscess or tumour. Knowledge of the appearance of these various agents on ultrasound and CT is crucial to avoid misdiagnosing pathology, potentially resulting in unnecessary interventional procedures.

INTRODUCTION

Haemostatic agents fall into several broad categories including absorbable agents and biologic agents.¹ Absorbable agents include gelatin foams (e.g. Gelfoam®; Pharmacia & Upjohn, Kalamazoo, MI) and oxidized cellulose (e.g. Surgicel®; Johnson & Johnson, New Brunswick, NJ). These are widely used in both visceral surgery and neurosurgery. Biological agents include topical thrombin and fibrin sealants such as Floseal® (Baxter, Deerfield, IL) and Surgiflo® (Johnson & Johnson). Depending upon the particular agent, these substances can be applied intraoperatively as sheets, sponges, films or pastes. The purpose of this essay is to demonstrate and familiarize the reader with the imaging appearance of various common topical haemostatic agents.

Biologic agents, Floseal and Surgiflo

Floseal is a bovine-derived gelatin matrix combined with a component of human thrombin. This mixture is injected *via* a syringe whereby the gelatin component swells, acting as a tamponade upon contact with blood. Similarly, Surgiflo is another widely used gelatin matrix agent (of porcine rather than bovine origin) that can be mixed with either saline or thrombin and injected, reportedly with similar efficacy to Floseal.² Because of the aerated nature by which the material is administered, echogenic dirty shadowing can be expected on ultrasound in the early post-operative period (Figure 1). Similarly, air and fluid can be seen in the operative cavity on CT (Figure 2).

Absorbable agents, Gelfoam and Surgicel

Gelfoam is made from animal-derived gelatin that is made into a sponge-like form. It can be applied over the surface

of a bleeding area, such as a sponge, film or paste, or made into small plug-like particles that can be injected *via* a syringe. Sheets or pledgets of Gelfoam can have mixed fat and fluid attenuation at CT and are relatively homogeneously isoechoic on ultrasound (Figures 3 and 4). Gelatin foam is reported to be absorbed within 4 to 6 weeks of application,¹ although in two cases in our series, calcified residual Gelfoam was seen years after surgery (Figures 5 and 6). Surgicel is a form of oxidized regenerated cellulose that originates from degenerating wood pulp rather than from animal product.¹ It is typically easier to handle than gelatin foams and can be cut to fit a specific cavity, resembling gauze in consistency. This explains the mixed air and soft-tissue appearance seen on CT and the echogenic dirty shadowing appearance on ultrasound (Figure 7). The reported average dissolution time ranges from 2 to 6 weeks, depending upon how much is used intraoperatively. However, there are reports of retained cellulose years after surgery.^{3,4}

SUMMARY

The intraoperative usage of haemostatic agents is increasingly common. The ability to recognize the imaging characteristics of various topical haemostatic agents on ultrasound and CT is crucial to avoid misdiagnosis of these materials as pathology. These agents can mimic or coexist with abnormalities such as recurrent tumour,^{5–7} post-operative haematoma or abscess.^{8–10} In the immediate post-operative time frame, characteristic appearances can be appreciated. Although some agents (particularly biological agents, such as Floseal and Surgiflo) can be expected to fully resolve, absorbable

Figure 1. Ultrasound appearance of Floseal. A 41-year-old female who presented with pelvic pain on post-operative day 16 after a left ovarian endometrioma resection. (a) Transvaginal ultrasound of the left ovary. Floseal injected into the resection cavity within the ovary is echogenic with dirty shadowing (black arrowhead), consistent with the aerated foamy nature of the injected material. In the absence of appropriate clinical history, differential diagnosis could include teratoma. (b) Follow-up ultrasound of the left ovary 58 days after surgery (white arrow) shows interval resolution of the shadowing material.

agents can occasionally create or contribute to chronic changes that persist for years. For this reason, general awareness of the imaging appearance of topical haemostatic

agents and communication with the surgeon and/or careful review of the operative notes is crucial for the radiologist before formulating a differential diagnosis.

Figure 2. CT and ultrasound appearance of Floseal. A 36-year-old female status post laparoscopic ovarian cystectomy with Floseal placed into the ovarian resection cavity. Contrast-enhanced (a) coronal and (b) axial CT on post-operative day (POD) 12 performed for pain and fever demonstrates fluid in the pelvis and right adnexal gas (white arrowhead). (c) Transabdominal and (d) transvaginal ultrasound also on POD 12 shows echogenic material with dirty shadowing within the right ovary (white arrow), similar to the appearance of Floseal in Figure 1. No fluid collection is identified. (e) To exclude abscess, aspiration was performed on the material seen on CT and a drainage catheter placed (black arrowhead). Cultures grew no organism. TRV, transverse; UT, uterus.

Figure 3. Gelfoam sheet appearance on CT and ultrasound. A 33-year-old female status post C-section. (a) CT on post-operative day (POD) 2 demonstrates low attenuation soft-tissue material abutting the uterus (UT) anteriorly at the site of the C-section. Subtle changes within the soft tissue suggest folded material (white arrowheads). (b) Transvaginal ultrasound (coronal midline view) on POD 56 demonstrates homogeneous isoechoic folded material (white arrows) along the anterior surface of the UT, overlying the echogenic shadowing C-section site (black arrowhead) in a similar location and pattern as on the earlier CT. (c) A folded sheet of Gelfoam *ex vivo* correlates with the folded material seen at imaging.

Figure 4. Routine post-operative follow-up in an asymptomatic 79-year-old male 3 weeks after repeat carotid endarterectomy with Dacron patch angioplasty and Gelfoam placement over the graft. (a) Transverse and (b) longitudinal views of the left carotid artery. Gelfoam is seen as isoechoic material (black arrows) overlying the echogenic Dacron patch (white arrowheads) along the wall of the internal carotid artery. Differential diagnosis includes haematoma or abscess although these are both typically less well defined and less homogeneous. Careful review of the operative notes or direct communication with the surgeon and correlation with the clinical presentation is crucial in these situations. In this case, the surgeon confirmed placing a piece of Gelfoam directly over the Dacron patch. Gelfoam can also be mistaken for recurrent or residual tumour, particularly on ultrasound of the thyroid bed in patients status post thyroidectomy for cancer.⁵

Figure 5. Long-term imaging appearance of Gelfoam. A 68-year-old male status post open cholecystectomy with Gelfoam used at the surgical site, confirmed on operative notes. (a) CT 6 years after surgery demonstrates coarse branching calcifications in the gallbladder fossa (black arrow), presumed to be residual Gelfoam. (b) Transabdominal ultrasound 9 years after surgery demonstrates a corresponding irregular focus of dense echogenic shadowing in the gallbladder fossa (white arrow). We speculate that the calcification seen in this and the following case represents a form of foreign body reaction to absorbable agents as has been previously described.^{6,7}

Figure 6. Evolutionary changes of Gelfoam over time. A 60-year-old male with solitary right kidney status post partial right nephrectomy for renal cell carcinoma. (a) Ultrasound on post-operative day 1 demonstrates an echogenic shadowing mass along the capsular surface of the right kidney at the surgical site (white arrowhead). (b) Non-contrast CT 2 years post-operation demonstrates a slightly hyperdense mass (black arrowhead) with a punctate calcification at the partial nephrectomy site. (c) Non-contrast MRI performed for further characterization demonstrates a T_2 hypointense mass with mixed internal signal (white arrow). Biopsy of the mass demonstrated acellular debris consistent with residual haemostatic agent. (d) Follow-up non-contrast CT 6 years post-operation demonstrates further calcification of the mass.

Figure 7. CT and ultrasound appearance of Surgicel. A 43-year-old female status post cold knife cone biopsy for abnormal Pap test. (a) Sagittal CT on post-operative day (POD) 7 demonstrates fluid in the endocervical canal (white arrowhead) and a nodular focus of heterogeneous material inferiorly (black arrowhead). (b) Pre-drainage transabdominal ultrasound on POD 8 confirms fluid in the endocervical canal (black arrow) and a nodular echogenic shadowing focus inferiorly (white arrow) corresponding to Surgicel. (c) Transabdominal ultrasound also on POD 8 immediately after intraoperative insertion of a drainage catheter shows persistent echogenic shadowing material (black arrow), corresponding to Surgicel. The fluid collection, which was positive for *Escherichia coli* growth, is no longer visible.

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