Barium granuloma of the transverse colon

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Summary

A case of barium sulphate granuloma of the transverse colon following gunshot wounds to the abdomen has been described. Scanning electron microscopy with electron probe microanalysis was used to confirm the presence of barium sulphate and the absence of lead or other elements related to the gunshot wounds.

Introduction

Barium sulphate granuloma is a very rare complication of barium enemata. It was first described by Beddoe, Kay and Kaye (1954). Since then, a variety of reports have been published (Levine and Simpson, 1960; Caney and Stephens, 1973; Lewis, Keistein and Koss, 1975). It has been reported as occurring in the appendix (Chant, 1970) and as a complication of bronchography (Mital *et al.*, 1975). The purpose of this paper is to describe a case of barium sulphate granuloma of the transverse colon, occurring as a complication of a gunshot wound to the abdomen.

Clinical summary

The patient was a 56-year-old male who was admitted to the Royal Victoria Hospital following a gunshot wound to the chest and abdomen. The chest injuries were repaired and, at laparotomy, perforation of the jejunum and laceration of the colon were identified. The perforation and lacerations were sutured and a proximal colostomy performed. The patient made a rapid recovery from his extensive injuries.

However, a barium enema performed 2 months later revealed a stricture of the transverse colon from the distal end of which was a small fistulous tract. Consequent upon this, the area of narrowed colon was removed and the colostomy closed. Since then the patient's condition has been uneventful.

Material and methods

The specimen of transverse colon taken at laparotomy was fixed in 10% formaldehyde. Following macroscopic description, blocks were selected and fixed in Bouin's fluid for routine processing. Sections cut from the paraffin wax-embedded blocks were stained with haematoxylin and eosin and examined.

Serial material was obtained from the paraffin wax blocks and processed for routine X-ray microanalysis in the scanning electron microscope (Cameron and McKee, 1978).

The specimens were examined in a Cambridge Instrument S-600 Stereoscan Electron Microscope equipped with a link X-ray microprobe analysis system utilizing a Kevex Si (Li) detector. Operational voltage was 20 kV. Photographic records were obtained using Polaroid 3³/₄ × 4³/₄ land pack type 105 and Ilford Fp. 4 35 mm film.

Results

The gross specimen consisted of 12 cm of large intestine. Approximately 5 cm from one limit was an area of stricture formation. Arising from this was a 1.0 cm-long fistulous tract. Histological examination of sections taken from this area revealed normal mucosa and muscle coat. However, there was quite marked submucosal and serosal fibrosis. In addition, in the serosa numerous macrophages were seen containing greenish crystalloid material (Figs 1 and 2).

When viewed in the scanning electron microscope the tissue structure was easily recognized and comparable to that observed in histological section (Fig. 3). An area of high electron activity was observed. This area showed little detail when examined at up to × 1000 magnification (Fig. 4). Microprobe analysis of this and similar areas revealed counts as shown in Table 1. The count time used was 100 seconds.

TABLE 1. Teletype print-out of typical energy spectrum

Energy (eV)	Integral	Element
1.48	1041	Al
1.72	335	Si
2.26	53224	S
2.62	3311	Cl
4.44	36845	Ba
4.84	13399	Ba (B ₁)
5.16	1632	Ba (B ₂)
5.52	964	Ba (γ ₁)

FIG. 1. Low power view of serosal aspect of colon showing the barium granuloma. HE, $\times 32$.

FIG. 2. Higher power to show the macrophages containing granular material. HE, $\times 80$.

FIG. 3. Consecutive section to Fig. 1 viewed in the scanning electron microscope, $\times 40$.

FIG. 4. Higher power of Fig. 3, $\times 800$.

Discussion

Barium granuloma of the rectum is an exceedingly rare condition. At present, twenty cases have been described in past publications (McDonald and Rowe, 1976).

It has been suggested that previous rectal biopsy, excessive intraluminal pressure, pre-existing disease such as ulcerative colitis, diverticulitis or carcinoma may be predisposing factors in the development of barium granuloma following an enema. Obviously improper or an excessively forceful technique would also be important.

The presence of barium granuloma should not cause any serious clinical problems but if there was excessive fibrosis it might cause some diagnostic difficulties.

As far as the authors are aware, barium granuloma has not been previously described from the transverse colon. This case was of particular interest in that it demonstrated an unusual method of development of such a lesion. It would seem most likely that some barium leaked along the fistulous tract at the site of previous surgery and this became lodged in the serosa of the bowel. Some accompanying fibrosis was seen but as this was located at the site of a fistula this is hardly surprising. In agreement with other workers (Gaston, 1969) the present authors were surprised to see so little reaction.

It is peculiar that this condition should be so rare, considering the numerous occasions when circumstances could predispose to its development. Review of past records in the Department of Pathology, Queen's University, Belfast, reveals only one other case which was associated with diverticulitis of the sigmoid colon. The rarity may be real, or apparent due to failure to recognize the lesion or disinclination to report it.

It was obviously of great importance to identify exactly the nature of the material present in the granuloma. It was considered likely that it did represent barium sulphate from the enema but it was also necessary to exclude any possibility of its being related to any parts of the ammunition that caused the initial wounds. It was for this reason that the tissue was subjected to electronprobe microanalysis.

Under optimum conditions, tissues for elemental analysis would be frozen and unfixed or fixed in either purified glutaraldehyde or para-formaldehyde. The use of such fixatives as Bouin's fluid, which contains approximately 0.015% sulphur, should be avoided as they introduce contaminants into the tissue. It must be underlined that the choice of Bouin's fluid in this instance was made as a routine histological procedure before any thought was given to microanalysis. However, the addition of such a small percentage of sulphur could not account for

the extremely high counts obtained in the tissue.

A round of ammunition consists of a bullet, the cartridge case, the powder and the primer.

Older ammunition contained primers based on mercury fulminate ($\text{Hg}(\text{CNO})_2$). Nowadays, however, the more modern primer is composed of lead styphnate ($\text{C}_6\text{H}(\text{NO}_2)_3\text{O}_2\text{Pb}$) and barium nitrate ($\text{Ba}(\text{NO}_3)_2$) with the addition of two or more of the following compounds: tetrazene $\text{C}_{18}\text{H}_{12}$; lead dioxide PbO_2 ; lead hypophosphite ($\text{Pb}(\text{H}_2\text{PO}_2)_2$); antimony sulphide Sb_2S_3 ; calcium silicide CaSi_2 ; aluminium powder Al.

The powder of a round of ammunition nowadays is composed of organic nitro compounds (smokeless powders).

The powder usually consists of a lead core covered with a gilded metal jacket (copper alloyed with 5–10% of zinc). This jacket may be bare or plated with tin or, rarely, nickel.

Spectrographic analysis of lead bullets shows the presence of other elements in traces: copper, bismuth, silver and occasionally thallium.

The cartridge case is made in most instances of brass. Within recent years the primer cap at the base of the cartridge has been nickel-plated. Occasionally one also finds that the brass case is nickel-plated.

Firearms discharge-residues consist of powder, primer, lubricants, and metals. Analysis of such residues have shown that the most frequently occurring elements are lead, antimony, barium and copper. If one includes older ammunition, then mercury must be added to the list.

Thus, when a bullet is fired from a gun, it will have residues, from the primer, etc., on its surface. When the bullet penetrates the clothing, skin, etc. of the victim, some of the residues from its surface will be transferred to the perimeter of the bullet hole owing to the wiping action of the clothes, wound margin, etc. Nevertheless it is still possible that on coming to its final rest the bullet still may have a percentage of these substances (residues) on its outer surface.

In the present case, the victim was apparently shot by a rifle and none of the bullets remained within him. It was felt, however, that it was just possible that the 'residues' or even minute fragments of the bullet itself might have at least contributed to the development of the granuloma.

It was for this reason, therefore, that electron probe microanalysis was undertaken.

As can be seen from the results, barium and sulphur were present in very large amounts with much lesser quantities of aluminium and chlorine. Lead, antimony, calcium, copper, tin, nickel, bismuth, silver and thallium were not identified.

Thus, although the presence of barium could be linked with firearms residues, the fact that the other

commonly found elements, lead, antimony, and copper, were not identified would tend to exclude the possibility of the granuloma being due to residues. Similarly, the absence of lead, copper, zinc, tin, and nickel would exclude the possibility of the granuloma being due to fragments of the bullet.

The presence of aluminium is not as easily explained and it was most likely due to contamination. It may have come from the metallic top of the fixative container or from the specimen stub, although a thick carbon planchet separated the specimen from the surface of the mounting stub.

It was therefore considered that the elements identified could only be attributed to the barium sulphate of the enema.

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References

- BEDDOE, H.L., KAY, S. & KAYE, S. (1954) Barium granuloma of the rectum: a report of a case. *Journal of the American Medical Association*, **154**, 747.
- CAMERON, C.H.S. & MCKEE, P.H. (1978) A rapid method for use in the routine histopathological laboratory for the identification of deposits in tissue sections. *Irish Medical Laboratory Technology*, (in press).
- CANEY, J.A. & STEPHENS, D.H. (1973) Intramural barium (barium granuloma) of colon and rectum. *Gastroenterology*, **65**, 316.
- CHANT, Q.W. (1970) Barium appendicitis. *Journal of the Oklahoma State Medical Association*, **63**, 570.
- GASTON, E.A. (1969) Barium granuloma of the rectum. *Diseases of Colon and Rectum*, **12**, 241.
- LEVINE, S. & SIMPSON, D.B. (1960) Barium sulphate granuloma of the rectum. *American Journal of Proctology*, **11**, 485.
- LEWIS, J.W., KEISTEIN, M.D. & KOSS, N. (1975) Barium granuloma of the rectum. An uncommon complication of barium enema. *Annals of Surgery*, **181**, 418.
- MCDONALD, C.C. & ROWE, J.R. (1976) Retrorectal fistula secondary to barium-abscess granuloma. *Diseases of Colon and Rectum*, **19**, 71.
- MITAL, O.P., NARANG, R.K., MISRA, U.S., SACHAN, A.S. & SAXENA, H. (1975) Barium granuloma following bronchography: A case report. *Indian Journal of Chest Diseases*, **17**, 55.