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X-RAY EXAMINATION OF ADULT INTUSSUSCEPTION, WITH PARTICULAR REFERENCE TO ANGIOGRAPHIC FINDINGS

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成人腸重積症の X 線検査

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筆者は4例の成人腸重積症(回腸結腸型2例, 結腸結腸型1例, 小腸小腸型1例)に対して, 各種の消化管造影検査ならびに選択的血管造影検査を施行し次の如き結論を得た。

本症は小児の場合とは異なり, 慢性に経過することが多く, 便秘に傾きやすい。そのため注腸造影検査時の前処置が不十分となり, 本法によつてその詳細を把握することは困難な場合が多い。これに反して, 経口的大腸造影検査は自然な重積状態を観察でき, その詳細は圧迫法によつてよく観察し得た。更に, 経肛門的に空気を送入れた二重造影法の併用は注腸造影検査に優るとも劣らない

造影能を示し, その重積状態をよく表現し得た。

血管造影検査を行なえば, 大腸型の腸重積症に対して, 病変の部位診断は無論, その重積型まで容易に診断可能であり, 同時に先進部の性状や転移巣も診断し得た。本症に特徴的な血管造影所見は外筒を構成する腸壁内動脈と, それに直交して上行する嵌入腸管の支配動脈である。しかし, 小腸型の腸重積症では小腸動脈が複雑にからみ合うため上記の如き特有な造影所見をとらえ難く本法によつて腸重積症と診断することはできなかつた。

Introduction

Adult intussusception, accounting only for 5-16% of all cases of intussusception, even inclusive of infantile cases, is regarded as a relatively rare disease¹⁾²⁾. Moreover, this disease, unlike its infantile version, is liable to be induced by organic pathological changes in the intestinal lumen, and its treatment requires laparotomy. For this reason, it needs adequate preoperative diagnosis, but the conventional roentgenographic technique have not necessarily been capable of unraveling the causal diseases and of demonstrating the state of infolding in detail.

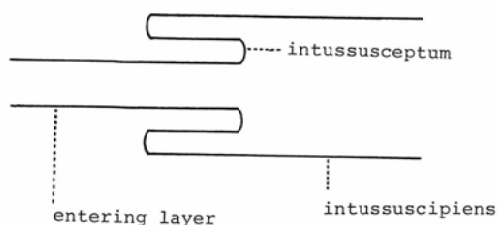
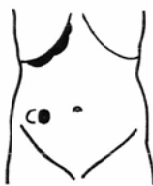
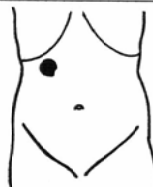
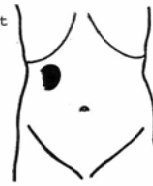


Fig. 1. Schema of an intussusception.

Table 1. Adult intussusception

Case	Chief complaints and presenting manifestations	Abdominal findings	Fecal occult blood	Interval between onset and operation	Type	Cause	Surgical technique	
1. A.U., 32, male	Pain in the right lower abdominal region; anemia; black stool		Tumor of hens' egg size without mobility but with tenderness	++	7 months	Ileo-colic	Iliac carcinoma	Resection of the ileum
2. E.T., 55, female	Pain in the upper abdominal region		Tumor of fist size with mobility and tenderness	-	20 days	Colo-colic	Colic lipoma, 5.5 x 5 x 5 cm	Resection of the right colon
3. H.S., 61, male	Pain in the right upper abdominal region; melena		Tumor of fist size with mobility and tenderness	++	3 months	Ileo-colic	Iliac lipoma, 2.5 x 2.5 x 2 cm	Resection of the ileum
4. M.H., 41, female	Pain in the lower abdominal region and fullness of the abdomen 6 days after operation	No palpable tumor; pain in the lower abdominal region	-	2 days	Jejunojejunal	Alimentary tube	Restoration	

In four cases of adult intussusception lately encountered, the author performed angiography and could precisely diagnose not only the nature of causal diseases but the state of infolding in three of the four. Aeration through the rectal tube was concomitantly performed at the examination of the colon after a barium meal, which demonstrated the state of infolding of the intestine in detail. The cases are presented herein, with emphasis on the usefulness of these technique.

I. Case Report

Case 1. A 32-year-old man visited the hospital with chief complaint of pain in the right lower quadrant of the abdomen and anemia. As shown in Table 1, palpation of the abdominal region revealed that the lower margin of the liver was palpable two-finger breadth; and a hard mass with a smooth surface and with little mobility was palpable in the right lower quadrant of the abdomen, accompanied by two kinds of obscurely demarkated and soft masses lateral to the former.

Roentgenography of the digestive tract: Barium enema showed a mass-like shadow measuring 5×11 cm in the ascending colon, with the end of the mass depressed in the center (Fig. 2). Double contrast roentgenography by means of concurrent aeration through the anal tube at the examination of the

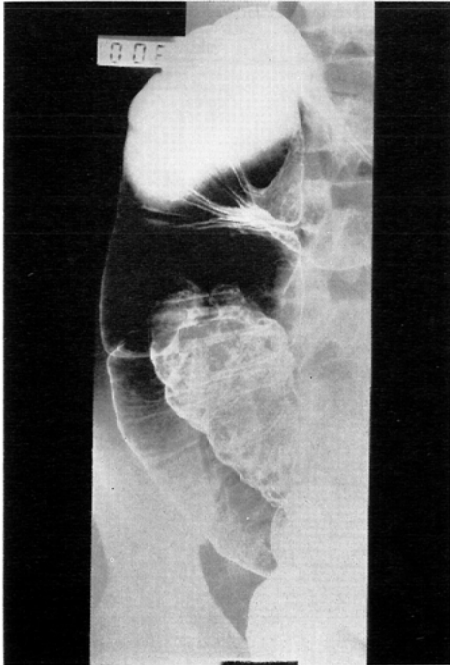


Fig. 2. Case 1. Roentgenogram after a barium enema. A large tumor-like shadow (5×11 cm) protruding into the lumen of the ascending colon is seen. Its leading edge is depressed in the center.

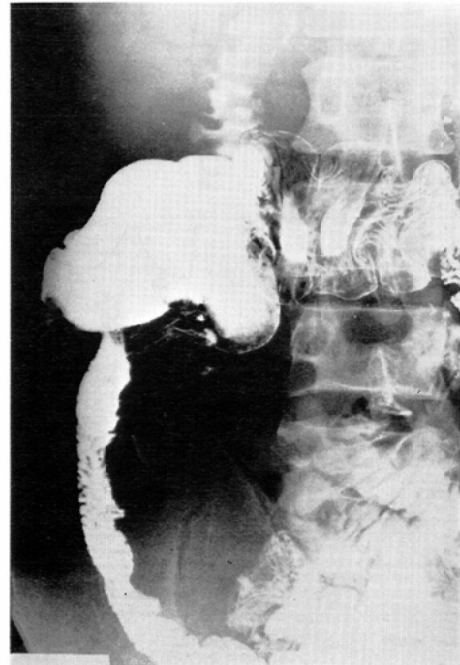


Fig. 3. Case 1. Double contrast roentgenogram by aeration through the anal tube at the examination of the small and large intestines after a barium meal. The terminal ileum is thin, and intussuscepted into the ascending colon, with the coiled spring-like shadow in part of the intussusciptions.

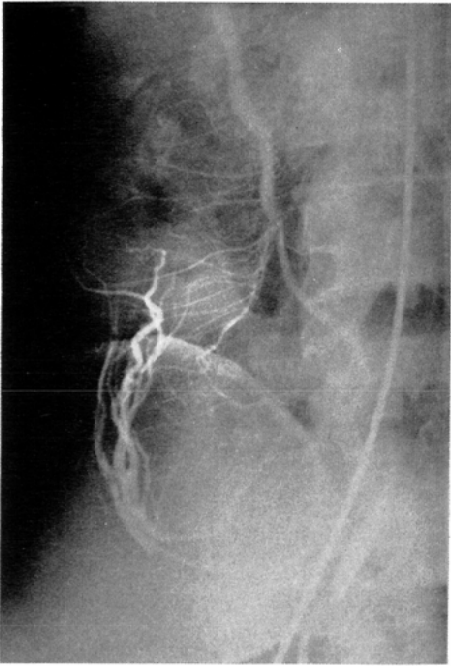


Fig. 4. Case 1. Superior mesenteric arteriogram. The ileocolic artery is thickened as the vessel supplying the malignant tumor, and ascends while crossing the vasa recta of the ascending colon at right angle. Features of malignancy are seen at the top of the intussuscepted arteries, associated with interruption of the marginal arteries.



Fig. 6. Case 1. A resected specimen. An adenocarcinoma originating in the terminal ileum.

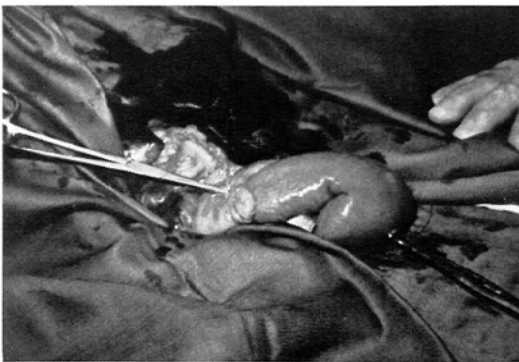


Fig. 5. Case 1. Operative photograph. Ileocolic intussusception.

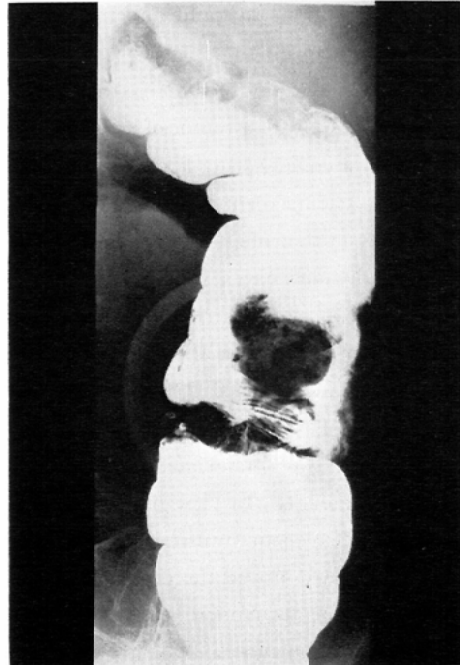


Fig. 7. Case 2. Roentgenogram of the colon after a barium meal (prone position). Compression reveals tumor shadow with a smooth margin and a coiled spring-like shadow in the colic wall medial to it.

colon after a barium meal disclosed that the ileum was invaginated deep into the ascending colon, with a coiled spring-like shadow in part of the wall of the ascending colon (Fig. 3).

These pathological changes led to the diagnosis of ileocecal intussusception. However, presence or absence of a tumor in the forepart of the intussusception and its properties were unknown, more the relation of this diagnosis to the two masses found by palpation was disclosed.

Angiography: On the superior mesenteric arteriogram, the ileocolic artery was thickened to feed the tumor, which coursed inside the colon, crossing the vasa recta of the ascending colon at right angle, with features of malignancy at its end. Disruptions and clear demonstration of tumor were observed in the marginal artery close to the ileocecal region. This case was diagnosed as ileocolic intussusception due to a malignant tumor occurring at the terminal ileum, with the medial hard mass palpable at the initial examination corresponding to disruption of the marginal artery, with metastases to the ileocecal lymph node. Celiac arteriography also indicated multiple metastases to the liver (Fig. 4).

The findings from laparotomy were well consistent with the angiograms, and the tumor at the forepart of the intussusceptum was histologically diagnosed as an adenocarcinoma (Figs. 5 and 6).

Case 2. A housewife aged 55 visited the hospital with a chief complaint of intermittent upper abdominal pain persisting for two days. Neither nausea nor vomiting was complained of, and the patient rather complained of a tendency to constipation.

Palpation of the abdominal region, as shown in Table 1, disclosed that a mobile mass of the size of a fist was palpable in the right upper quadrant of the abdomen, which was accompanied by a mild tenderness on compression.

Roentgenography of the digestive tract: On the roentgenogram of the colon after a barium meal was seen a shadow of a tumor of hen's egg size with a smooth margin in the middle part of the ascending colon, with a coiled spring-like shadow in part of the colic wall, oral to the tumor shadow (Fig. 7). On the barium enema roentgenogram, the tumor was greatly moved to the oral side, with a coiled spring-like shadow in the colic wall. From these findings, this case was diagnosed as intussusception but, as in *Case 1*, its detailed nature was unknown.

Angiography: Superior mesenteric arteriography showed that the ascending branch of the ileocolic artery began to infold at about the part where it anastomosed with the descending branch of the right colic artery, and reached the hepatic flexure, while crossing the vasa recta of the ascending colon at right angle. The descending branch of the ileocolic artery remained fixed at the normal position, and its iliac branch was not deviated. The infolded artery was of normal thickness, with no malignant changes at its leading edge. In view of the appearance of the shadows in the soft part, however, the case was diagnosed as colocolic intussusception due to a polyp or benign tumor, e.g., lipoma (Fig. 8).

Laparotomy proved the case to be colocolic intussusception with the anterior wall of the ascending colon intussuscepted and, because of severe adhesion, ileocolectomy was performed. The forepart of the intussusceptum was a lipoma protruding from the colic wall into the colic lumen (Fig. 9).

Case 3. A 61-year-old man had a history of occasionally excreting a large amount of black stool after about one week of constipation for the preceding six months. He had noticed the presence of a mass of the size of a child's head in the right hypochondriac region two months before, but this mass had disappeared on excretion of a large amount of black stool in about one month. As he had been attacked

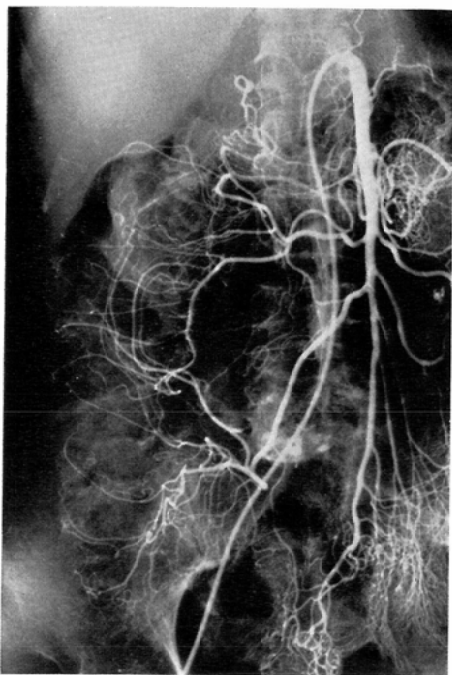


Fig. 8. Case 2. Superior mesenteric arteriogram. The ascending branch of the ileocolic artery begins to be intussuscepted at about the part where it anastomoses with the descending branch of the right colic artery, and ascends while crossing the vasa recta of the ascending colon before it reaches the hepatic flexure. A case of colocolic intussusception.

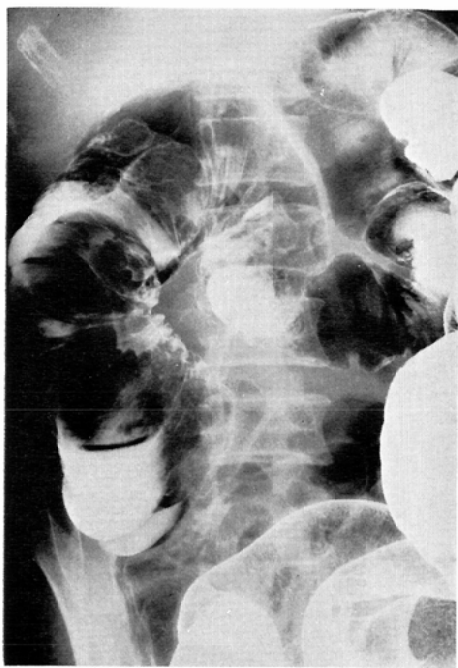


Fig. 10. Case 3. Roentgenogram after barium enema. The coiled spring-like shadow is seen in part of the superior wall of the small intestine infolded into the ascending colon. Its details are unknown because of insufficient pre-treatment.

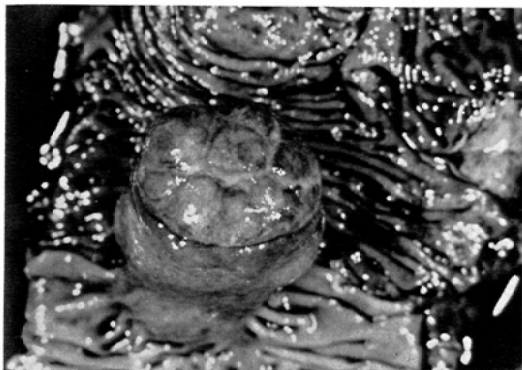


Fig. 9. Case 2. Resected specimen. A lipoma measuring $5 \times 5 \times 5.5$ cm.



Fig. 11. Case 3. Double contrast roentgenogram by aeration through the anal tube at the examination of the colon after a barium meal. The state of intussusception is clearly observable.

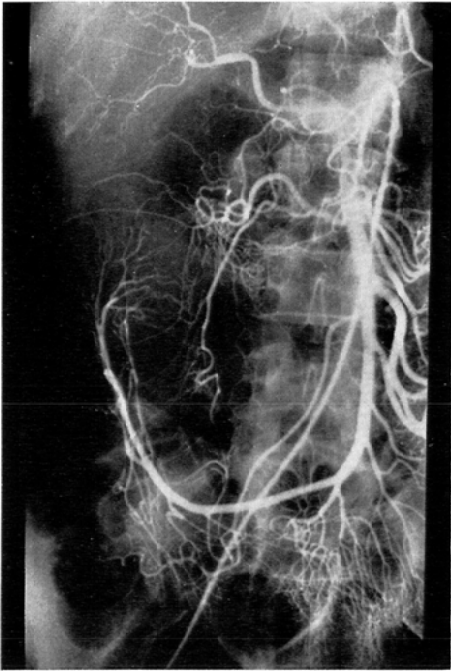


Fig. 12. Case 3. Superior mesenteric arteriogram. The ileal artery of the intussuscepted part makes a hairpin curve to cross the vasa recta of the ascending colon at right angle.

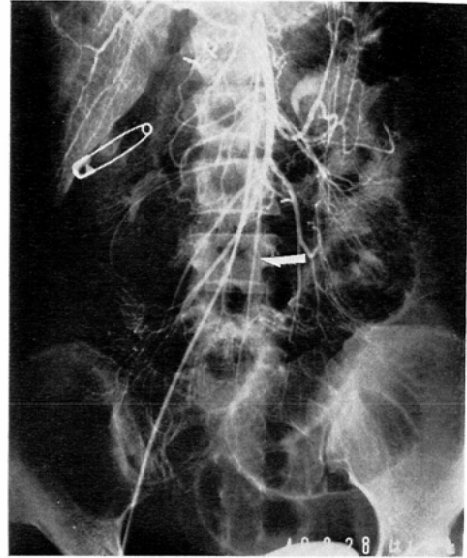


Fig. 14. Case 4. Superior mesenteric arteriogram. The superior jejunal branches are extended and deviated by the distended intestine. The jejunal branch marked with an arrow is linearly stretched, but it cannot be defined as an abnormal shadow.

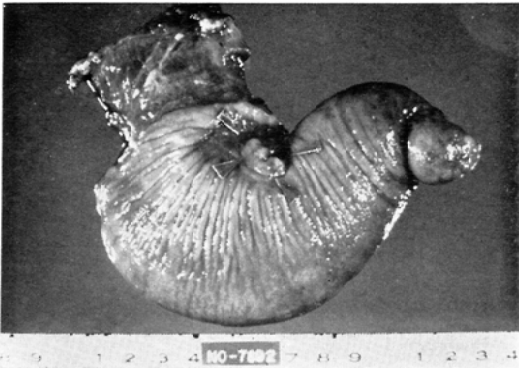


Fig. 13. Case 3. Resected specimen. An internal fistula is formed at the arrow-marked part. The forepart of the intussuscepted portion is a lipoma measuring 2.5×2.5×2 cm.

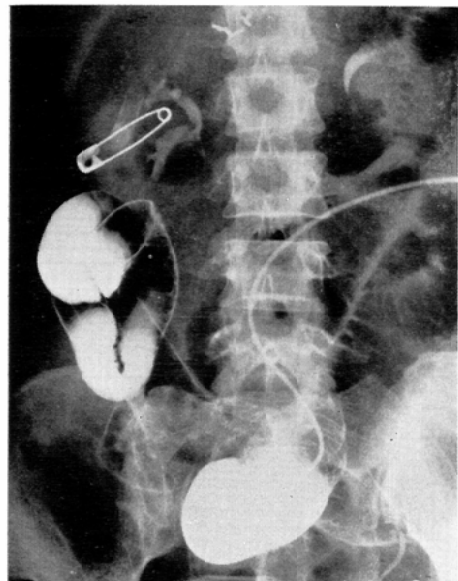


Fig. 15. Case 4. Roentgenography with a barium meal applied through feeding fistula. The obstructed site is consistent with the area supplied by the extended intestinal branches.

by abdominal pain after meals, he had gradually come to refuse to eat, and became emaciated and, as an attack of abdominal pain had occurred a few days before, he visited the hospital for examination in detail. He had again noticed the presence of a mass in the right upper quadrant of the abdomen by himself.

The objective findings are shown in Fig. 1; an elastic, soft mass with a smooth surface was palpable in the right hypochondriac region, accompanied by respiratory mobility.

Roentgenography of the digestive tract: Barium enema failed to demonstrate details of abnormalities because of insufficient preparations (Fig. 10).

In gastrointestinal series then performed, an attempt was made for double contrast study by means of aeration through the anal tube at the time when barium meal filled the proximal portion of the colon after passing through the thin ileum. This technique revealed that the terminal ileum was intussuscepted into as deep as the middle portion of the transverse colon, with a tumor shadow at its leading edge (Fig. 11).

Angiography: The ileocolic artery was found fixed to the normal position, but the trunk of the superior mesenteric artery feeding the terminal ileum coursed inside the ascending colon, while it drew a hairpin curve, and ascended, while it crossed the vasa recta of the ascending colon that constituted the intussusciens at right angle. For these findings, this case was diagnosed as ileocolic intussusception with the terminal ileum as the intussusceptum and, because no malignant features were found in the invaginated portion, it was diagnosed as an idiopathic case or a case due to benign tumor (Fig. 12).

The findings in laparotomy well conformed with the angiogram. The intussusception was an ileocolic one, and the forepart of the intussusceptum consisted of a lipoma. There was an internal fistulation between the external wall of the intussusceptum and the internal wall of the intussusciens (Fig. 13).

Case 4. A 41-year-old woman was operated for cancer of the stomach by P-shape esophagojejunostomy following total gastrectomy, with a jejunal alimentary fistula provided by the use of a silicone tube.

Attack of abdominal pain began to occur about the sixth postoperative day, with a fluid level noted on the plain X-ray film of the abdomen.

Angiography: Superior mesenteric arteriogram showed the greatly deviated jejunal branch of the artery, accompanied by the extended vasa recta due to distended intestine. One of the intestinal arteries (marked with an arrow in Fig. 14) was extended, attracted towards the anal side. However, these angiographic findings were not diagnostic of intussusception (Fig. 14).

Roentgenography of the digestive tract: Roentgenography of the digestive tract with barium meal applied through the feeding tube disclosed that the obstructed site was consistent with the intestinal arterial branch that was straightened on the angiogram. However, its cause could not be discovered (Fig. 15).

Laparotomy revealed that this was a case of enteroenteric intussusception with the tube for the jejunal alimentary fistula as the intussusceptum.

II. Discussion

Adult intussusception is a relatively rare disease¹⁾²⁾ and apparently differs from the infantile version in that because it runs a chronic course and that a variety of causal diseases are found in 80–85% of the

cases⁵⁾. Therefore, roentgenography after a barium enema, which is combinedly aimed at a therapeutic means as in infantile intussusception, cannot be a good roentgenographic diagnostic means for adult intussusception, but for further detail the X-ray examination is always necessary.

Not only plain roentgenography of the abdomen but barium enema and examination of the colon after a barium meal have been chiefly employed for the roentgenographic diagnosis of this disease, and have actually been a very useful diagnostic means. Especially, roentgenography of the digestive tract revealed the coiled spring-like shadow characteristic of this disease, and this pathological change has been used as the decisive finding for definitive diagnosis of intussusception.

As described above, however, this disease runs a chronic course and is liable to cause constipation, which results in the retention of a large amount of fecal mass in the intestinal lumen, making the necessary preparations for barium enema insufficient, and, in fact, making it difficult to thoroughly get hold of abnormalities in the colon. Roentgenography of the digestive tract after a barium meal, on the other hand, has the merit of allowing the natural state of intussusception to be observed, while, because the large bowel is filled with barium enema, it is difficult to take the roentgenogram of the infolded portion of the intestine unless by the compression method; thus, it has the demerit that it cannot get hold of the whole view on one film. For this reason, in order to overcome the demerits of the above-mentioned two X-ray techniques, the author made an attempt at double contrast roentgenography of the large bowel by means of making the patient ingest barium meal through the oral route and then aerating through the anus.

This technique, for its aeration through the anal tube following thorough examination of filling defects as by the conventional method, can be accomplished without impairing the merits of roentgenography of the digestive tract after a barium meal, and because it is a gas that is injected through the anus, it does not cause fecal mass to move to the oral side, as does the barium enema technique. There is a paper by another author on this double contrast study⁴⁾, and the present author is of the opinion that this is the most suitable method especially for observation of the state of intussusception as in this disease.

There are few reports on angiographic examination in adult intussusception and, as far as the author is aware, there is only a paper by Chang⁶⁾, and another by Lande⁶⁾. In his paper, Chang⁶⁾, presented three cases of colic intussusception and stated that angiography was diagnostic of intussusception and its location, and the angiograms indicated that the hairpin curve of the intussusceptum-supplying blood vessels crossed the blood vessels in the intussusciens at right angle, suggesting that it would also contribute to qualitative diagnosis of the forepart of the infolded portion. The author was also able to readily diagnose the location and type of intussusception in three cases of colic intussusception out of the four cases encountered by himself. The ileocolic artery remained at the normal position, and its branch, the iliac branch, was reversed, and infolded into the ascending colon while drawing a hairpin curve together with the iliac artery continuous with it. In this instance, the deeper the infolded portion of the intestine was advanced, the more did the iliac artery with room for the mesentery to extend tend to be deviated than the iliac branch of the ileocolic artery.

In colocolic intussusception, the ascending branch of the ileocolic artery was seen infolded while crossing the vasa recta of the ascending colon at right angle.

As described above, angiography permitted a rapid diagnosis of the type of intussusception in terms

of the state of deviation of supplying blood vessels in colic intussusception, and also permitted to a certain extent qualitative diagnosis of the tumor in the infolded portion which was the inducing cause.

The present author also encountered one case of enteric intussusception. In this case, angiography disclosed deviation of the superior jejunal artery due to the distended intestine oral to the intussusception, extension of the vasa recta, and abnormally extended arteries, e.g., the arrow-marked intestinal artery in Fig. 14. The author, however, could not diagnose the case as enteric intussusception only from these findings, but diagnosed it as mere "ileus".

The following may be cited as its reasons: Because it is in the relatively thin small intestine where the pathological change in enteric intussusception is located, obstruction is liable to occur at the site where the pathological change is located; this causes the intestine, which is oral to the location of the change to be distended, making the intestinal arteries deviated and overlapping with each other in a complex manner, which makes it difficult to catch hold of changes in fine blood vessels and to identify the supplying blood vessels.

Lande⁶⁾, however, described the following as the characteristic angiograms of enteric intussusception: (a) Abrupt disappearance of mesenteric vessels at the neck of the intussusception with crowding of the vasa recta, (b) appearance of long collateral channels at the neck of intussusception, (c) angulation and retraction of major intestinal branches, (d) reversal of the course and angulation of the invaginated mesenteric vessels, (e) overlapping of the mesenteric vessels by branches of the intussusception, and (f) abrupt change in appearance of the vasa recta of distended intussusception and the distal non-distended intestine. These may be considered to include the indirect findings in this disease, and the time between onset and angiography may also be considered a factor of great significance. The present author is of the opinion that the direct finding in intussusception is the demonstration of the invaginated arteries crossing the vasa recta supplying the intussusciens even in enteric intussusception; that it is difficult to pick up the above-mentioned finding among a number of intestinal arteries which are deviated and overlapping with each other in a complex manner because of the distended intestine, as was observed in the cases encountered by himself, and that it is therefore difficult to accurately diagnose all cases of enteric intussusception by angiography alone.

Conclusion

The author performed roentgenography of the digestive tract and angiography in four adult cases of intussusception (including two cases of ileocolic intussusception, one of colocolic intussusception, and one of enteroenteric intussusception), and came to the following conclusions:

(a) Adult intussusception runs a chronic course in many cases, and it tends to be associated with constipation, preparations for barium enema become insufficient, which makes it difficult in not a few cases to get hold of detailed information by this technique.

(b) Roentgenography of the digestive tract after a barium meal permitted observation of the natural state of intussusception. Because the large intestine is filled with barium enema, this technique requires frequent compression. The author was able to clearly observe the state of intussusception by means of first observing the state of intussusception by the compression technique, and then performing double contrast roentgenography by concurrent aeration through the anal tube.

(c) Angiography for colic intussusception proved diagnostic not only of the location of pathological change but also of the type of intussusception, and further permitted qualitative diagnosis of the forepart of the invaginated portion and also of metastatic foci.

(d) Because of overlapping of the intestinal arteries with each other in a complex manner, angiography was not diagnostic of enteric intussusception.

(e) The direct finding on the angiogram is the arteries supplying the intussusceptum that cross the vasa recta constituting the intussusciptens at right angle.

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