

AN ESSAY ON INTUSSUSCEPTION
with an account
And Analysis of 103 Cases.
In two Volumes.

Presented to the Faculty of Medicine
of the University of Edinburgh
for the degree of Master in Surgery.

-By-

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1907.

Vol. 1.



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Chronic intussusception, ileo-
caecal variety, gangrenous at the
apex. Successfully removed.

(Case 64)

INTRODUCTION.

Through the kindness of the past and present members on the staff of the Sick Children's Hospital, Great Ormond Street, I have been allowed to collect and analyse all the cases of intussusception which have been treated in the Hospital since that charity was opened.

As my connection with the Hospital has extended over a period of two years, I have been enabled to observe the disease myself on about 30 occasions. Although I have dealt chiefly with the intussusceptions of children, I have not hesitated to draw on the accounts of the disease as met with in adults, in order to illustrate many points in the nature of the affection, which either have not passed under my clinical knowledge, or reports of which I have failed to find in the medical papers.

The literature on the subject of intussusceptions is already so voluminous, that one can scarcely hope to add much that is new. Nevertheless I have, in this essay, made bold to state the belief that ileo-colic intussusceptions, as at present understood, never occur. I have attempted to prove that they are really enteric intussusceptions which have

started a short way above the valve and then passed through it in the ordinary way. That is to say all intussusceptions grow by the same common mechanism and no special mechanism, of prolapse with a constantly changing apex, need be brought into play to explain the ileo-colic form, see pp. 5 to 14. I believe therefore, that there are only three forms:— ileo-caecal, enteric, and colic, in that order of frequency. I have pointed out what I believe to be the true significance of the dimple so often found as the result of intussusception, and not, as is so often supposed, the cause of this disease. (p.16 et seq.)

I have endeavoured to shew that in my cases and in those of many other writers, the invagination starts more frequently in the ileum than in the jejunum (p.19).

The anatomical facts here stated, are the results of observations made in a large number of children in the pathological department of the hospital (p. 69). The experimental work was carried out under Professor Starling at University College, London. A licence to conduct operations on living animals was held from the Home Office, together with

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certificate E.E. to allow the animals to be kept alive afterwards. This latter was however never used in connection with these particular experiments (p. 77).

Although the experiments were not as conclusive as I had hoped, they were very suggestive as to how the invagination starts.

I have given an analysis of the age incidence, sex, and climatic influences, of a large number of consecutive cases in children; and endeavoured to explain the disproportion of male to females on anatomical grounds (p. 97 to 105).

The exciting causes have been fully detailed (p. 116 to 130). The presence and influence of Meckel's diverticulum has been fully entered into. A resumé has been given of all the reported cases in which the appendix seemed to have been the starting point of the disease.

The existing accounts of the symptoms, signs, and diagnosis, leaves little or nothing to which new can be added. Under the heading of differential diagnosis I have detailed an interesting case of purpura which could not be distinguished from the

affection now under consideration, p.152. The treatment has been considered from nature's standpoint as well as from that of surgery. An attempt has been made to give a short historical account of the treatment of the disease from the earliest times. It is necessarily very incomplete. But accounts of successful surgical treatment are presented, dating as far back as A.D. 1672. The accounts were culled from books and manuscripts in the library of the British Museum.

The deaths in my series are more prominent than they should be. Some of the earlier surgical notebooks of the Hospital are missing or incomplete, so that the records of those cases which recovered are lost to me. On the other hand, the post mortem records have, from the very commencement, been most faithfully written up, so that every case which has died from this disease finds a place in my series. While these facts may render my cases fallacious in calculating the percentage of recoveries, it makes them more valuable as a record of the more complicated and fatal forms of the disease.

Volume II contains the notes in full of the cases discussed in this thesis. They are numbered

according to their date.

The figures, diagrams and charts used to illustrate this work were all drawn by myself, with the exception of some of the coloured plates for the more intricate of which the services of a professional artist were procured.

The references to quotations I have endeavoured to give in every case.

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DEFINITION and DESCRIPTION.

Intussusception is the invagination of one part of the bowel into another. It may occur at any point throughout the moveable part of the intestinal tract, a certain range of movement being essential for the mechanical starting of the process.

For purposes of accurate description certain names are applied to the different portions of the intussusception. As one portion of the gut passes inside another to which it is directly continuous, there must be three complete tubes seen on cross section. The outer tube, or layer, is also known as the ensheathing layer, the sheath, the receiving layer, or the intussusceptiens. The inner tube is known as the entering or third layer. The middle tube or layer is called the second or the returning layer. The middle and the innerlayers, together with their mesentery, are known under the name of intussusceptum or contents of the intussusception. On looking at a Diagram of the cross section of an intussusception, it is seen that the middle and inner layers have their serous coverings opposed to one another separated only at one point by the mesentery. These surfaces, under inflammatory conditions would rapidly lose their naturally slippery character, and in certain cases adhere to each other.

Fig 1.

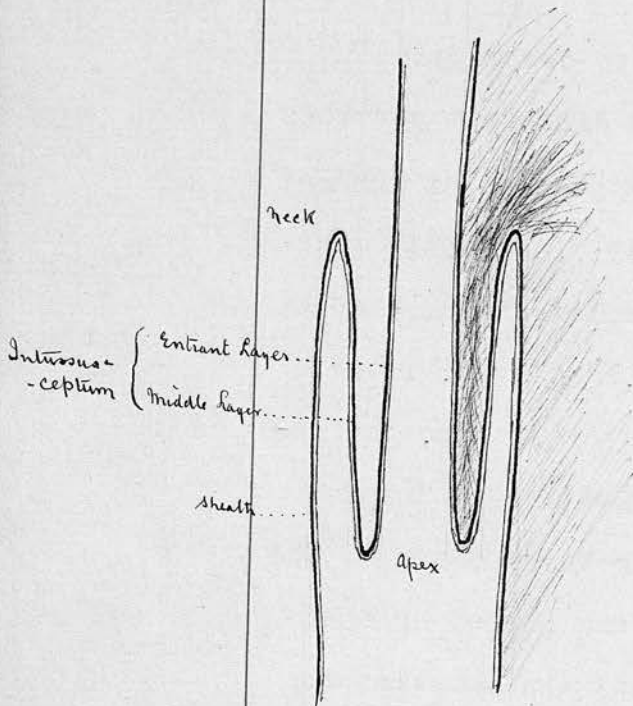
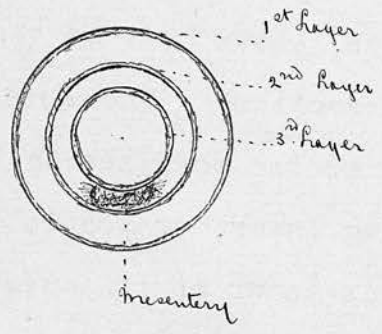


Fig 2.



On the other hand, the middle and the outer layers are opposed by their mucous coats, and never adhere, (see page 62). These surfaces readily slip the one over the other. This is a very important point, as it explains completely the reason why the apex of the intussusception remains constant, or nearly so.

The apex of the intussusception is its most advanced point. The neck is the place where the middle and the outer layers become continuous, and where the bowel and the mesentery enter the middle layer. This point therefore is constantly changing. In rare cases the intussusception may be itself intussuscepted, so that there are five concentric rings of bowel and even a triple intussusception has been described, in which case there would be seven concentric rings of intestine. These complicated forms are due to the ensheathing layer becoming folded on itself. The series of cases about to be enumerated include several instances of double intussusceptions.

Several varieties of intussusceptions are recognised according to the different starting point of each. They are the Ileo-caecal, the enteric, the colic, and the Ileo-colic.

Fig 3

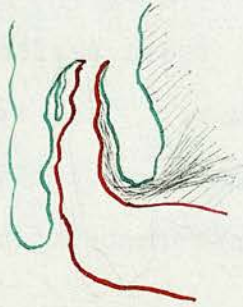
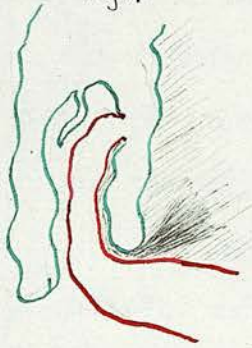


Fig 4



The ileo caecal starts at the ileo caecal valve, the ileum passing into the ascending colon. The apex of this variety is formed by the gut in the neighbourhood of the Ileo caecal valve, for the reasons enumerated below the valve itself is often not situated squarely at the end of the intussusceptum, but drawn by the mesentery to one side, so that the inferior lip of the valve passes further down than the superior lip. In some cases the valve is situated quite to the side, the apex being then formed by the wall of the caecum below the ileo caecal valve. The enteric variety starts in the small intestine, usually in the lower part of the jejunum, but may be met with at any part of the small gut. The colic variety starts in the large intestine, including the caecum, and may even start in the appendix.

In two cases in this series the appendix was turned inside out, and may have been the starting point of the condition. The Ileo colic form is described as commencing at the ileo caecal valve, the ileum becoming prolapsed through the valve. More and more of the ileum is supposed to prolapse into the ascending colon, through the valve, until a blockage occurs, and then the caecum and first part of the ascending colon passes on into the more distant portions of the large gut.



Extensive ileo-caecal intussusception. The stick is in the valve which is some way from the true apex, this being formed of caecal wall.

The apex of the intussusception, therefore, remains a nearly constant point in all forms, except the last, in which it is supposed that until the block occurs, the apex is constantly changing by more small intestine passing into the large. As soon as the block occurs, the apex remains constant as in the other forms.

For many reasons, about to be enumerated, I do not believe that the Ileo colic form, as usually described, ever occurs, and think that the apex in this, as in the other forms, is constant.

Intussusception of other tubes.

Any tube in the body which is provided with muscular walls suited to peristalsis and possessing a certain degree of mobility, can become invaginated.

The smaller the lumen and the thicker the walls, the more seldom will intussusception be met with.

It is well recognised that renal Calculi impacted in the ureter, as it passes through the bladder wall, will cause a certain amount of prolapse of the uretral mucous membrane. A true intussusception of the ureter, was found half way down the right ureter of Mr. Brunel, the builder of the Great Eastern Steamship. The condition was of long standing, and the intussusceptum was as red as a cherry. No cause for this was found, the kidneys were quite healthy. (See Lancet 1897 Aug.)

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S. L. a.

METHOD OF GROWTH.

When once the bowel has become invaginated, the intussusceptum is made to travel along inside the sheath by the peristaltic action of the outer coat. The outer coat is the only one probably in which active peristalsis can occur.

The middle and the inner coats can hardly be expected to be very active factors. They rapidly become congested and oedematous and probably are soon paralysed. The outer coat, on the other hand, is stimulated to action by the presence, in its interior, of the intussusceptum.

Contraction of the circular fibres of the

intestine inhibits circular fibres immediately below, so that the intussusceptum, like any other substance in the lumen of the gut, is ^{always} being passed on into a dilated portion of the bowel.

The longitudinal fibres must act from the neck of the intussusception, as their fixed point, and will draw up the sheath over the intussusceptum like a glove over the hand. This is the more readily done as the slippery mucous surfaces of the intussusciens and intussusceptum oppose one another.

The inability of the intestine to pass on the intussusceptum, stimulates the peristaltic action of the gut. The violent cramping pains, the straining, and the bloody discharge, all bear evidence as to the violence of the efforts. The hand can actually feel the hardening of the tumour through the abdominal wall.

We may assume, I think that there is, during peristaltic efforts, a certain onward squeezing of the mass, and as the pains pass off the mass again recedes. The alternative gain and loss being well illustrated by recalling the similar result in the pains of labour.

Not only does the intussusceptum stimulate the contraction of the sheath to greater efforts, but it sometimes causes antiperistaltic action. It is by this means that spontaneous reduction takes place. How else can be explained the phenomena which present themselves clinically of children who have typical symptoms of intussusception, which suddenly passes off?

It can of course be argued that such are merely due to colic. But in the series of cases now reported, are 3 cases which occurred under my special notice in which at the operation the condition of the bowel indicated that spontaneous reduction had just taken place.

WHY AN INTUSSUSCEPTION GROWS IN THIS PARTICULAR WAY.

From the above description, it will be seen that the apex of the intussusceptum is a constant point, except for the pulling round of the orifice by the mesentery, which may in some cases displace the actual starting point about an inch and a half from the end, and causes it to lie to one side. But with this exception, the apex may be said to be constant and correspond with the starting point. Now why should the apex of an intussusception be

See Plates II

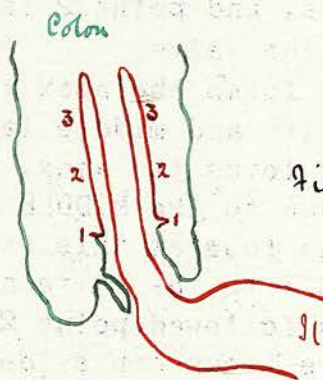
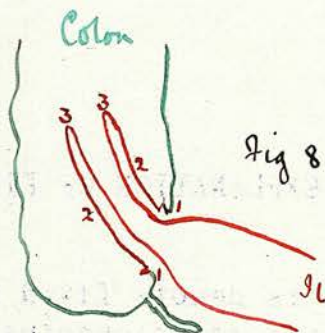
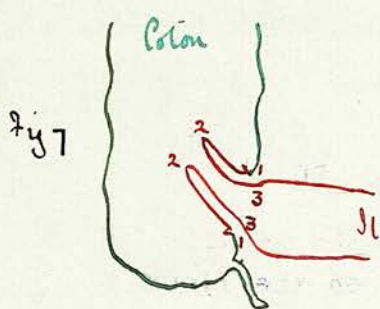
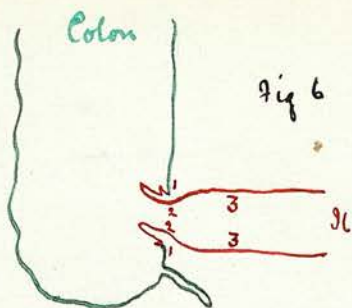
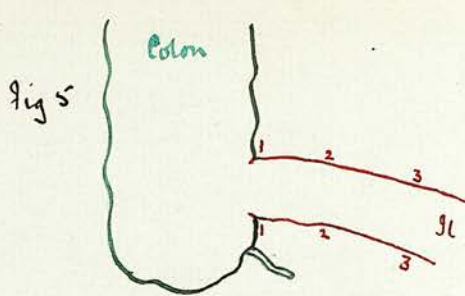
be constant? and why should it not increase by more of the inner layer passing through the middle layer? The reason for this constancy, and there must be one, is, I take it, as follows.

The growth of an intussusception is due to muscular force, and that muscular force is supplied by the muscle in the wall of the intestine itself. With a very little thought it becomes obvious that the only part of the intestine which can influence the progress of the intussusception is the sheath or outer layer. The inner layer might contract, but could merely expell its contents and not move itself. The middle coat is turned inside out, and if peristalsis is possible under this condition, the wave would necessarily pass from below upwards - from the apex to the neck. Any muscular action in consequence which it brought to bear would rather tend to reduce the condition. be expelling the inner layer by the way it came, than to force it onwards through itself. The sheath can not act except on the middle layer, and can have no influence on passing the inner coat through the middle.

The abdominal muscles in the act of straining will, no doubt, help the onward motion

of the intussusceptum when in the rectum, but will act on the intussusception^{um} as a whole and can not well pick out the inner layer. Higher up, the bowel straining can only increase the intra-abdominal pressure which will be equal in all directions.

On examining an intussusception it is seen that the inner and middle layers have their serous surfaces closely opposed to one another, only separated at one place by their respective mesenteries. The least congestion would prevent these layers sliding well on each other, while the oedema at the apex would stiffen the walls and prevent the inner layer rolling round to become the middle layer. As the congestion and oedema increase, it becomes more and more impossible for the inner layer to slide on the middle one, so that if increase in length is to occur the outer layer must roll round at the neck and become the middle layer. This it is easily able to do, for two reasons. First because at the neck the ensheathing layer is not yet congested and is easily pliable. Secondly - and the more important of the two reasons - because the outer and middle layers have their mucous surfaces opposed to one another, and therefore the sheath will always be able to slide easily over the intussusceptum. Even in long-standing cases the



FIGURES TO ILLUSTRATE THE SUPPOSED MECHANISM BY WHICH ILEO-COLIC INTUSSUSCEPTIONS ARE FORMED.

This mechanism is purely theoretical, no one has ever reported ^{having} seeing such a state of matters in course of formation by this method.

EXPLANATION OF FIGURES 5 TO 9

COLON AND CAECUM GREEN, ILEUM IN RED.

(The numbers denote fixed points on the ileum.)

Fig. 5. Normal relationships.

Fig. 6. The mucous membrane at point 1, the valve, has started to prolapse, and point 2 is in process of passing through the valve.

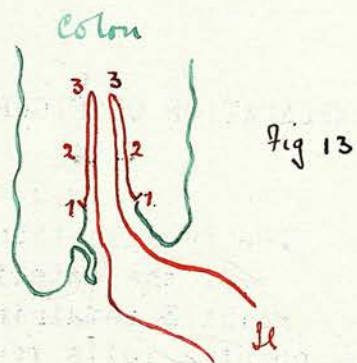
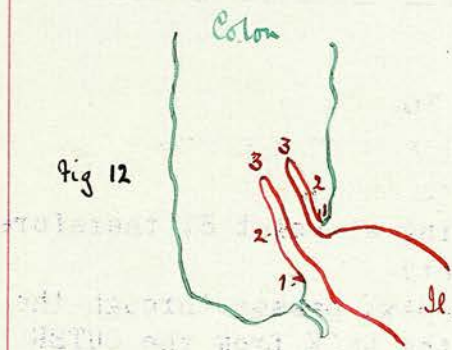
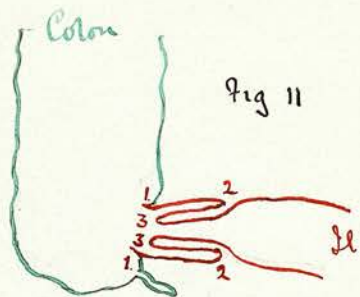
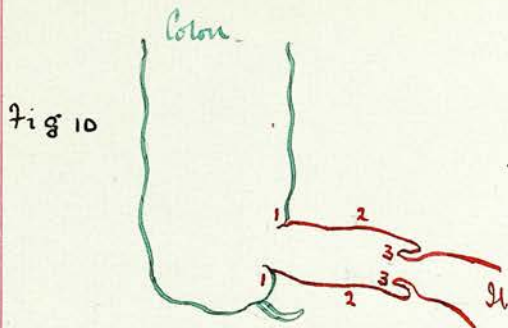
Fig. 7. Point 2 now forms the apex and point 3 is sliding through the valve and middle layer.

Fig. 8. Point 3 now forms the apex, point 2 has rolled round from the INNER to the MIDDLE LAYER. If such an intussusception was found at this stage it would be called an ileo-colic form with the valve not involved.

Fig. 9. Point 3 has followed point 2 round into the middle layer until no more ileum can slide through. Up to this time the apex has been constantly changing, the neck at the valve has remained constant. The apex from now on remains constant while the neck is the place where variations occurs. Point 1, the valve, is rolled round at the neck to lie in the middle layer in accordance with the ordinary mechanism of growth for all other forms of intussusception. If such a specimen was examined at this stage, it would be called ileo-colic with the caecum and colon involved.

sheath can always be moved easily over the middle layer, until stopped by adhesions between the middle and inner layers, or by the swelling rendering it difficult to roll the middle layer round on to the outer layer. This mechanism suffices to explain all the varieties of intussusception, except the Ileo-colic variety. Here it is customary to suppose that the ileum prolapses through the valve and the inner layer slides onwards through the middle layer for a variable distance until blocked by the mesentery, the apex being till then a constantly changing portion of small intestine.

It is a little difficult to understand why this view has been taken and accepted without question. The fact that the valve, in a small percentage of cases, has been found in the middle layer at a variable distance from the apex is the only reason, as far as I am aware, for the theory that the gut has passed in the supposed manner through the valve. But because the only good landmark of the intestine, marking as it does the junction of the small and large intestine, is found in this position, seems wholly insufficient ground for calling to our aid an explanation which is contrary to that accepted in 92% of intussusceptions. Suppose now that an intussusception started, let us



FIGURES TO ILLUSTRATE WHAT I BELIEVE IS THE TRUE MECHANISM BY WHICH ALL ILEO-COLIC INTUSSUSCEPTIONS ARE FORMED.

These figures, though diagrammatic, represent what was the condition found at operation in cases under my immediate notice.

Fig. 10	See Case	97	1 st operation.
Fig. 11	" "	63	
Fig. 12	" "	97	2 nd operation
Fig. 13	" "	32.	

say 6" above the valve, and passed onwards. By the time it had projected in the usual way 3" through the valve, the valve would be at the neck, 3" of ileum being in the inner and 3" in the middle layer. If a surgeon now opened the abdomen and found such a state of affairs, what variety would he consider this intussusception to be? He would without doubt say - this is a typical Ileocolic

See figs. opposite

EXPLANATION OF FIGURES 10 TO 13

COLON AND CAECUM IN GREEN, ILEUM IN RED. The Nos. 1, 2, & 3, mark fixed points on the ileum.

Fig. 10. The invagination starting at point 3, therefore of the enteric variety.

Fig. 11. Point 3 remaining the apex, passes through the valve, point 2 rolls round at the NECK from the OUTER to the MIDDLE LAYER. (c.f. with the ordinary explanation.)

Fig. 12. All the ileum has now passed round the neck from the sheath to the middle layer, if growth proceeds, point 1 the valve, the colon and caecum must pass in.

Fig. 13. Shews the colon, caecum and appendix invaginated.

With this explanation the apex is a constant point, the only constantly changing spot is at the neck, as in all other forms of intussusception.

The stages shewn in Figs. 10 - 13 have been seen in the living, the stages shewn in Figs 5 - 9 can not be proved to have formed in any but the way just given.

that they are enteric intussusceptions starting in the lower part of the ileum, which have passed through the valve. I hold this belief on the following grounds:-

say 6" above the valve, and passed onwards. By the time it had projected in the usual way 3" through the valve, the valve would be at the neck, 3" of ileum being in the inner and 3" in the middle layer. If a surgeon now opened the abdomen and found such a state of affairs, what variety would he consider this intussusception to be? He would without doubt say - this is a typical Ileo colic intussusception, the valve has not yet been drawn in. And let us suppose that the intussusception passes on for another 3", the valve would now be found half way up the middle layer, and the surgeon would now call it a typical Ileo colic intussusception, in which valve & caecum were involved. If the argument used on pages 8 + 9 is correct, and the muscular action of the outer layer of the intussusception is the active force by which it grows in other forms, what new factor is there situated solely in the lower end of the Ileum, which enables the inner layer to propel itself, or the middle layer to propel the inner layer? I believe that the real explanation for all Ileo colic forms is that they are enteric intussusceptions starting in the lower part of the ileum, which have passed through the valve. I hold this belief on the following grounds:-

See figs.
opposite

1. The Ileo-caecal valve is the narrowest part of the intestinal tract. It is the most unlikely place in consequence for the inner layer to slide through the middle layer.

2. The Ileo-caecal form is so common and the Ileo-colic form is comparatively so rare, as to make it very unlikely that the extreme end of the ileum should in some cases for reasons unknown, assume a totally different mechanism of invagination. For in both forms the starting place is supposed to be the same.

3. In an Ileo-colic intussusception there is no way of excluding the possibility of its having been formed in the lower end of the ileum and been protruded through the valve according to the accepted mechanical explanation.

4. Many cases are met with of enteric intussusception which protrude through the ileo caecal valve and which if the condition went on would eventually form typical Ileo-colic intussusceptions. I have a case in my series where the enteric intussusception is actually in process of being formed into the Ileo-colic form; the neck being almost at the site of the valve. If further progression had

been allowed, no one could have said that it was not a typical Ileo-colic intussusception.

5. The production of an Ileo-colic intussusception can be explained on the same principles as any other form if it is assumed that the starting point is in the lower end of the ileum, a short way above the valve, and not at the valve itself.

6. Owing to the mechanical arrangement of the intussusception there is no force which we can imagine that will pass the inner tube of intestine through the middle.

At a time when pathology is becoming daily more intricate, it is a great pleasure to bring forward evidence and arguments which tend to simplify a subject already sufficiently complicated. With this explanation the same mechanism can be used, and I believe correctly, to explain the method of growth in all forms of intussusception.

THE INFLUENCE OF THE MESENTERY.

As growth proceeds and more and more of the intestine becomes included, the mesentery has also to pass into the mass.

The mesentery tends to check the onward passage of the gut. Its influence is most felt, of course, along the attached border of the entering and returning layers. The pull which the mesentery exerts makes the intussusceptum assume a curved shape, the concavity of which is towards the root of the mesentery. If the sheath is a tight one, as in the enteric forms, it must become curved also. But in the ileo-caecal forms where the sheath is voluminous, the intussusceptum may ^{lie} be obliquely in its lumen without much influence on its external appearance.

The amount of gut which is allowed to pass into the sheath depends then largely on the length of the mesentery. Where the mesentery is short it is impossible for a very extensive invagination to take place. Where the mesentery is long, several feet may be included.

In the ileo caecal forms it is no uncommon

PLATE. III



Very curved intussusception, great
congestion of the intussusceptum.

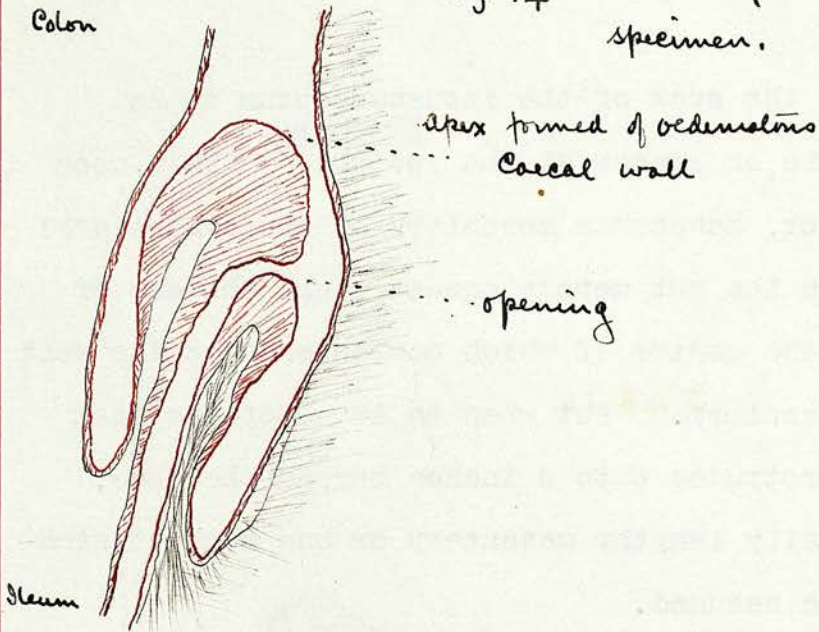
thing for the apex of the intussusceptum to be palpable in, or appear at, the rectum. This does not however, bespeak a mesentery of any exceptional length, as the gut merely passes round the arc of a circle, the centre of which corresponds to the root of the mesentery. But when as is sometimes seen the gut protrudes 6 to 8 inches beyond the anus, an abnormally lengthy mesentery or one much stretched must be assumed.

The journey of the gut round the arc of this circle causes the intussusceptum to be twisted on its long axis like a corkscrew, and this itself may cause difficulty in reduction.

In intussusceptions seen for the first time the presence of a tight abnormal band passing to the neck of the intussusception should be expected.

It has already been stated that the apex of all forms of intussusception remains the same (with the ^{supposed} exception of the ileo colic variety) this is however only partially true, for the drag of the mesentery, besides causing the curved appearance of the intussusceptum, will anchor one lip of the lumen of the gut at the apex; the ^{other} ~~see~~ lip may pass on down some way until it lies immediately below the

Fig. 14 semi diagrammatic from a specimen.



attached lip. The lumen of the gut looking directly towards the side of the sheath, a sliding to the extent of 1 to 1½ inches may take place now along the convex surface of the intussusceptum, whereby the middle layer may slide down on the inner layer as in figures 3, 4 & 14. The result of this is that the opening is situated very obliquely across the lumen and the actual opening may be 1 to 1½ inches from the true apex. This portion of the convex margin it is, which, by becoming oedematous, forms such a great barrier to reduction. As this portion becomes the most oedematous, swollen, and thickened part, it retains more or less of its turned-inside-out-shape after reduction. This appearance has been often noted as a dimple of which mention is often made in reports of cases. The dimple being described as met with in the last part to be reduced. For this reason it has been thought that the dimple was the first part to be invaginated. But I believe that the true explanation lies in the fact that this part, during the later stages of invagination, slips down to become the true apex, and that owing to great oedema, it retains this inverted shape as a dimple on reduction.

If the dimple is examined it will be seen always to be situated on the free margin of the gut

PLATE. IV



Specimen from Case 98.

Shews the caecal dimple which results from ileo-caecal invagination, and the presence of many enlarged glands.

and to be rather a transverse groove than a true round dimple. This will explain the frequency with which it is met in ordinary ileo-caecal forms, the dimple being situated near the free end of the caecum, i.e. the part which would slip down in this particular form. Many ileo caecal forms are wrongly described, I believe, as caecal forms, because the caecum, which has slipped down in front of the ileo caecal valve, is the last part to be reduced and presents this dimple. The laxity of the caecal wall renders it peculiarly liable to slip down.

The Drawing on the Plate opposite, No Was made from a specimen which was only reduced after death.

It shews the formation of the caecal dimple.

This was of course the last part to be reduced and at first the variety was said to be caecal.

It also shews well the presence of large glands in the mesentery.

(From Case No 98.)

The Relative Frequency of the
different varieties of Intussuscep-
tion.

Out of 103 cases I find that the variety could not be determined or was not noted in 13 instances. Of the remaining 90, the ileo-caecal variety claimed 59, the enteric 15, the ileo-colic 15, and the colic 1.

The table is as follows:

Ileo-caecal			59
Enteric	4)	
Jejunum	0	) 15)
Ileic	11	)	) 30
Ileo-colic	15))
Colic			1
			<hr/>
Total			90.
			<hr/>

From this it will be seen that the ileo-caecal form was met with in the bulk of the cases. Of the enteric forms 4 were simply styled enteric without alluding to the part of the small intestine in which they were found, and 11 were met with in the Ileum. As I believe that ileo-colic forms are really ileic,

the number of the enteric variety rises to 30 altogether. These figures agree very closely with those of Leichtenstern. If we take the 199 cases reported by that writer, under the age of 6 years, and analyse them, the following table appears:

Ileo-caecal		119
Enteric 19	}	
Ileo-colic 17	}	36
Colic		44
Total		199.

The percentage of the different varieties quoted in most books are calculated from the 479 cases reported by Leichtenstern and are as follows: Ileo-caecal 44%, enteric 30%, Colic 18%, ileo-colic 8%.

These cases however, include those of all ages. In children the true colic variety is very rare, ileo-caecal on the other hand is very common.

	Colic.	ileo-caecal.	No. of cases.
Dunbar	3.4 %	76.3 %	59
Barker	4. %	63.2 %	49

These figures agree closely with my own, with the exception of the colic variety which I still think is too high in their estimations. Most of the cases which are reported as colic are supposed to start in

the caecum. I have drawn attention already to the fact that because the caecal wall below the valve is the last part to be reduced, it does not follow that this point was really the starting place of the intussusception. These cases are in reality ileo-caecal in which the caecal wall has passed downwards in front of the lower lip of the valve. Colic forms in children other than the so-called caecal are extremely rare. In the enteric variety it is usually stated that invagination of the jejunum is more customary than invagination of the ileum. Treves ~~on the other hand~~, states that the proportion of jejunum to ileum is as 4:1. This is certainly not the case in children. In all my cases where the site is mentioned, the ileum was affected and if to these are added those starting in the lower ileum and called ileo-colic, the disproportion is doubled. Out of 6 instances of enteric intussusceptions, Barker only found one in the jejunum. The proportion given by Leichtenstern is, for all ages, in the small intestine

Ileum	32
Middle	3
Upper Ileum)	
and	)18
Jejunum)

Gay was even more emphatic. This observer gave

Ileum	17
Jejunum & Ileum	3
Jejunum	3

The duodenum, on account of its fixity, is never the starting point of the trouble. It may, however, become involved in an extensive ileo-caecal intussusception as the drag of the meocolon pulls the duodenum, pancreas, and even the pylorus right up and into the neck of the tumour. Delepine (Path. Soc. Trans. 1891 p. 124) reported a case 5 months old where the 1st and 2nd part of the duodenum "had evidently been dragged into the sac by the meso-colon". (See also Bull. de la Soc. Anatom. 1864 p. 37). Cases 3, 14, and 38 all illustrate this point, and in one of them the pancreas was implicated.

Band reports the following extraordinary case (Journ. Gen. Med. Chir. et Pharm. 1805, XXIV. 209). A male aged 24 took pneumonia on Nivose 3rd, and had great colics. On Ventose 28th violent colics and diarrhoea. Germinal 1st, gut prolapsed to the extent of 8 inches. Death followed on the 6th. Post mortem, the prolapsed gut was black like coal burnt (charbonné). At the upper extremity of a tumour one saw the duodenum and small intestine plunge into the descending colon; in the middle lay

the pancreas perpendicular. "The right part of the duodenum adherent to the gall bladder, the left part, or the 3rd part of anatomists, invaginated with the pancreas, the commencement of the jejunum, the meso-colon transverse, and the right part of the great Omentum, in the descending colon. The rectum also contained the end of the ileum, the caecum, the colon ascending and transverse." When reduced this amount of gut included about 5 metres, or over 16 feet.

This is the most extensive intussusception I have seen recorded.

RETROGRADE. DOUBLE AND TRIPLE. INTUSSUSCEPTIONS

1. Retrograde Intussusceptions. By a retrograde intussusception is meant that the lower portion of bowel is invaginated into the upper. Retrograde intussusceptions are very commonly met with in the post mortem room, but very rarely indeed are they met with in life. How they are formed is unknown. It is certain however, that such intussusceptions do occur during life and can give rise to exactly the same symptoms as the descending variety.

Garrie, reported the following case (Lancet 1882. p.647).

A male negro, aged 17, was attacked on October 3rd by a mild intermittent fever, and given Calomel gr.10, Jalap, grs.20. This operated, but next day as the tongue was furred, Calomel gr.15 were given and directions left to give castor oil if there was no result. Early next morning an urgent message came to say that the master thought the slave was dying. The pulse was quick and feeble. The man was totally unable to swallow, though able to move his larynx, his voice was a whisper, which soon became suppressed. The bowels had acted 4 times. The abdomen was distended, and the right iliac fossa

umbilical regions painful on pressure. Death ensued the same evening. At the sectio, where the Ileum and jejunum join, "I found a retrograde intussusception of about 12" in length. The received portion of intestine ^{which} was easily withdrawn, appeared to be in a highly inflamed state, approaching Gangrene, and to contain some hard particles of blood, all of which, the hurry to bury the body prevented my examining thoroughly."

Throughout the case there was no vomiting.

Dr. Harrison, in the Dublin Med. Press. 1845, p.148, reports a chronic case of an adult male, who suffered for months with chronic intestinal obstruction accompanied by agonising colic during the attacks of which the miserable wretch would implore the doctors to "kill me or cut me open". After death the descending colon was found invaginated into the transverse colon, "probably for an extent of 3 or 4 inches". The orifice was like a contracted os^{teri} and the intussuscepted portion was ulcerated.

The following have also reported similar cases. Besnier (These de Paris, 1857, p.52) Nothnagel (Die Erkr^{an}henkungen des Darmes, Vienna, 1896, p.290)

D'Arcy Power, in an infant of 5 months (Trans. Path.

Soc. 1886, p.240) Mott (Peninsula Med. Journal, (Haven met with 3 in 59 cases; Duchaussoy² with 16 in 137 cases

Detroit, 1876, 1., p.157) Langstaffe (Ed.Med.Surg. Journal 1807), Peregrine (Lancet, Vol.1, 1873; p:709)

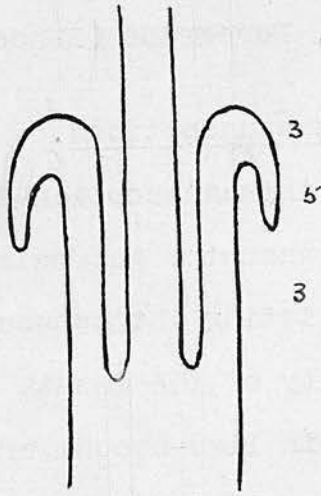
2. Double Intussusceptions.

A double intussusception is the name given to the condition when the gut below becomes folded on the already existing intussusception. It requires a certain laxity of the sheath and is therefore found usually in ileo-caecal or colic varieties. There are two varieties of double intussusception. In the first variety the primary intussusception is descending while the second is retrograde. This is caused by the longitudinal muscular fibres of the sheath contracting and drawing up the sheath over the intussusceptum. The sheath then becomes folded over itself as in fig 15'.

As a good example of this variety, Peregrine's case may be quoted (Lancet 1873, Vol.1,p.109).

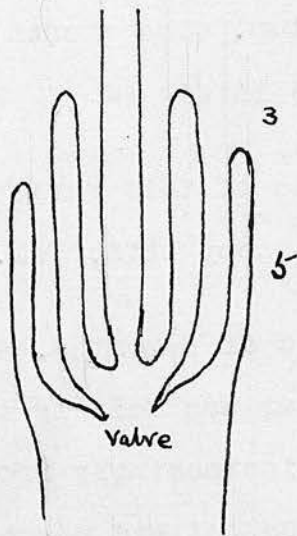
An unweaned child of 6 months, was treated for diarrhoea; a tumour was felt by the mother. The diarrhoea became increasingly frequent, and a portion of gangrenous gut was passed after considerable straining. 21 hours

Fig 15.



Double intussusception, primary onwards
secondary retrograde.

Fig 16



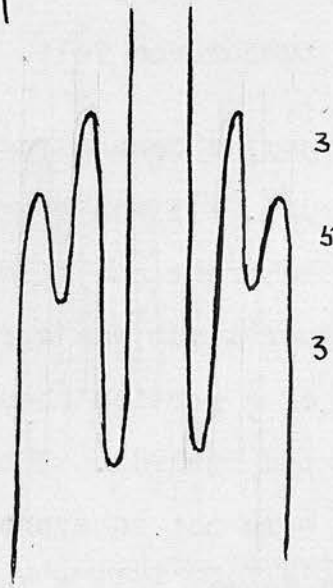
Double intussusception at ileo-caecal valve.
(Ileo-caecocolica)

before death no tumour was felt. There was no vomiting.

At the Autopsy, a descending invagination 5" in length was found. It was congested and the serous surfaces adherent and firmly fixed. 2" down from the upper limit was a rim of gut forming the lower limit of a portion about 1" long which was here invaginated upwards. The serous surfaces of this portion were not adherent. A perpendicular section shewed 3 layers, then 5 layers, then 3 again. The outside one in this case was evidently secondary and probably caused by the straining as the portion of gut was pulled off and passed. M.Sainet (Bull. de la Soc. Anat. 1850, p.314) reported a child of 9 years with a similar condition in the sheath of an ileo caecal intussusception. Langstaffe (Loc.cit.) refers to this condition in an infant 3 months old who died on the 5th day.

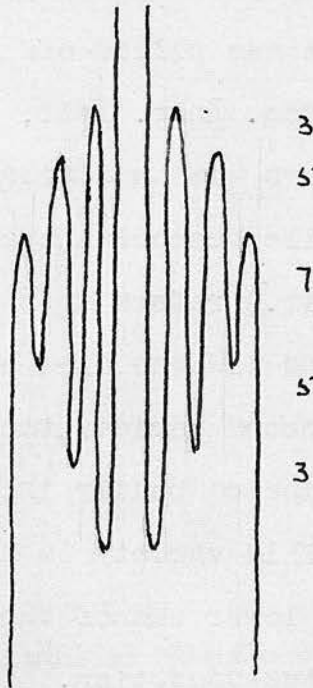
In the second variety, the primary intussusception is invaginated bodily into a portion of the gut below. This variety is not infrequently met with when the lower end of the ileum becomes the seat of an intussusception. The apex of the intussusceptum reaches the ileo caecal valve and on account of swelling of the former or muscular spasm of the latter, can not pass through. The ascending

Fig 17



Double intussusception not at ileo-caecal valve.

Fig 18.



Triple intussusception

colon then becomes invaginated and receives the whole intussusception. This form is sometimes called Iliaca-Ileo-Colica, a name given it by Leichtenstern who described it as a separate form of intussusception occurring at the lower end of the Ileum. It may occur at other levels of the intestinal canal and then differs slightly from what has just been described. Diagrams of each kind are shewn. Cases 55 and 92 are good examples.

M. Moutard Martin (traite Pratique des Hernias Scarpa, p.449) reported a breast fed child with an ileo caecal intussusception. This, when it reached into the transverse colon was invaginated bodily into the descending.

3. Triple Intussusceptions.

Here the sheath of the primary intussusception is folded on itself twice so that there are no less than 7 layers of gut. This condition is excessively rare; as far as I know no case has been described as occurring in an infant. The formation of such a tumour as represented in Fig 18 bespeaks a chronic condition. Bucquoy's case (Recueil des Travaux de la Soc. d'Abserv., p. 192, Paris 1857) was a male, 21 years of age who was taken with great pain after swallowing a quantity of arsenic, in July 1852. Vomiting, diarrhoea and colic continued

with intermissions till he died in June 1853. An abdominal Tumour was felt on several occasions. At the post mortem examination a triple intussusception was found involving the greater part of the jejunum. There was found neither gangrene nor discoloration.

4. Multiple Intussusceptions.

Cases which have presented either at the operation or at the post mortem examination two or more intussusceptions of an obstructive or inflammatory type are of great rarity. No such case has come under my notice nor has one occurred in the hospital. Homolle reported a case (Bull. de la Soc. Anatom. 1870, p.260) where 4 intussusceptions were found. All were situated in the small intestine. All could be easily reduced after breaking down feeble adhesions. They were associated with, and apparently caused by, ulcerated polypoid growths of the intestinal wall. The age and sex of the subject were not stated. D'Arcy Power (Trans. Path. Soc. 1886, p.240) has placed on record two intussusceptions occurring in a male child of 5 months. One was of the ileo-caecal variety in which gangrene had commenced, the other was found in the transverse

colon. It was retrograde and had its walls glued together.

Mr. Waterhouse (Path. Trans. 1898, p.108) reported a girl of 4 years with an intussusception 4 feet about the ileo caecal valve which was easily reduced and a second one which was irreducible in the region of the valve.

PLATE.V.



Two specimens of multiple post mortem intussusceptions.

Fig 1

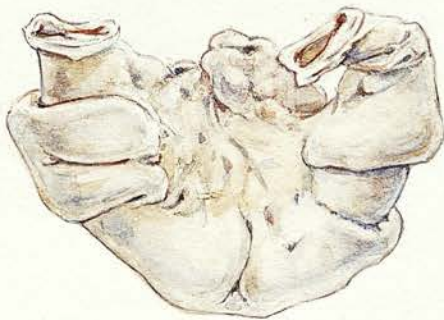
INTUSSUSCEPTIONS OF THE DYING.

Intussusceptions of the Dying, post mortem intussusceptions, agonal intussusceptions, non inflammatory, non obstructive, for these and various other names have been applied to them, differ very markedly from those we have just been studying. In former days, without doubt, they were the cause of many of the curious ideas which were held about intussusceptions. Until comparatively recently the points of differentiation between the two forms of intussusception were not generally known, they were thought worthy of exposition before medical societies in the eighties of last century. They gave rise to the idea that retrograde and multiple intussusceptions were quite common and could often occur during life, although producing no symptoms.

The frequency with which they are met with is difficult to determine and varies with age. They are very commonly met with in infants and children, but appear to become rare as age advances.

They are more frequently met with in cases which have died with a high temperature or have had symptoms of gastrointestinal irritation than in any other conditions. It is said that

PLATE. VI.



Multiple post mortem intussusceptions,
Three seen, an ascending and a descending one
close together.

they are most frequently met with in cases of disease of the nervous system; this statement has, I think, been copied from book to book without verification, my experience in children does not bear it out.

The characters which distinguish intussusceptions of the dying from those we have up till now been considering are, their frequency, multiplicity, direction, lack of symptoms, and absence of all pathological change. If these facts are considered, it is scarcely possible to confound the two forms.

The multiplicity of this form of intussusception is very marked, being the rule rather than the exception. It is very common to find 6 or more present at the same time. I have notes of a child aged 7 mos, in whom there were 20 such. Allan (Austral. Med. Journ. 1883, p.222) exhibited a portion of intestine little more than 3ft. in length, in which there were 10 intussusceptions. The direction in which they occur is not invariable, the majority occur from above downwards, but it is very common to find retrograde ones from below upwards. In the portion of gut shewn by Allan 6 were from above downwards, and the other 4 were double ones, in which one intussusception took

origin from above and the other from below, so that the two intussuscepted portions met inside the common sheath. They are sometimes found double. They are rarely more than 2 in. in length.

They are pale and never congested, there is never any pathological change visible to the eye. In consequence of the absence of adhesions, and oedema, they can be reduced with the slightest traction.

They produce no symptoms during life, as in all probability they are only produced by irregular peristalsis at or soon after death. A great many cases are on record in which various symptoms occurring during life have been laid to the blame of these harmless invaginations. Indeed the literature of intussusceptions in the first half of the last century abounds in such cases.

The site of the invagination is curious in being, as far as I am aware, always in the small intestine. I do not remember ever to have seen one in the region of the Ileo caecal valve or in the large intestine; nor am I able to find such during an extensive search through the literature. These intussusceptions commonly are found in dead

animals. Treves relates that he noticed them in nearly all monkeys put to death at the Zoo.

In the spring of 1906 I shot a series of 25 rabbits, both young and old, and at once opened the abdomen, hoping to see intussusceptions form and dissolve before the active peristaltic movements of the intestines ceased. I never once saw one. See p. 80

SECTION II.

PATHOLOGY.

Strangulation and Obstruction.	Page 35.
Irreducibility.	" 50.
Changes found:-	
(A) Above the intussusception.	" 57.
(B) In the intussusciens.	" 59.
(C) In the intussusceptum.	" 60.
Gangrene.	" 64.

ILLUSTRATIONS.

PLATES. VII to XII.

DIAGRAMS 19 to 22.

PATHOLOGY.

I. STRANGULATION AND OBSTRUCTION.

These two phenomena are so intimately connected that it is convenient to consider them together. The terms are both rather indefinite, for it is impossible to say when congestion ends and obstruction begins, or where the boundary lies between constipation, partial obstruction and total obstruction. For practical purposes we may take the process of strangulation to include the whole series of changes of congestion, arrest of venous return, arterial occlusion, death and sloughing. This process of strangulation is the same as occurs in a hernial sac, and is determined by the same factors. The changes chiefly, if not entirely depend on the condition of the local circulation in the intussusceptum.

Congestion is brought about by a great number of factors, perhaps the most important is the traction off and pressure on the mesentery.

We have seen that as the intussusceptum passes further and further down the intestine, more and more of the mesentery is drawn in, until there comes a time when the mesentery is taut. How soon this point is reached depends on the length of the

part of the mesentery involved, and this varies greatly in different people. The force of traction exerted now by the peristaltic action of the sheath can only produce a stretching of the mesentery, a curving of the intussusception and a tilting of the opening of the bowel to one side. The effect of pressure on the mesentery will be first seen in the thin walled veins, whose diameter will at the same time be diminished by the traction on the vessels. There are no valves in the mesenteric veins, therefore the peristaltic waves will produce no pump-like action to help the circulation. The result of this venous embarrassment will be felt first at the most distant part, namely the apex. Swelling and oedema occur there first of all, and in early cases where reduction is easy everywhere else there will usually be found a thickening and stiffness in the part of the gut which formed the apex of the intussusception. The oedema spreads gradually along both layers of the intussusceptum towards the neck, but it does not do this equally. The inner layer is not in a position to swell as freely as the middle. Owing to the curved shape assumed by the intussusceptum, swelling can take place readily on the free convex margin, but not on the concave, where the structures are crowded together and the layers become folded. The



Gangrenous intussusceptum, ileo-caecal variety with the valve at the apex not tilted to one side. There is a round hole ulcerated through the middle layer.

concave border also is the furthest from the heart and the pressure will be more felt than on the convex side.

The oedema and thickening, instead of producing relief, cause greater venous engorgement and end by completely occluding the veins. The arteries being thicker walled and more resistant are not affected as early as the veins and will continue to pump in blood for some time after the veins have completely collapsed, until the blood pressure in the strangulated portion becomes equal to the pressure in the arteries. The circulation then absolutely ceases.

The remaining phenomena are due to other than vascular changes. The chief factor in their causation being bacterial. The strangulated and oedematous portion can not long retain its vitality and soon becomes a suitable nidus and breeding ground for the bacteria which swarm in the intestinal canal. These micro organisms gaining access to the devitalized tissue, gangrene rapidly ensues. How much is due to lack of circulation, and how much is due to microorganisms is impossible to say. As the apex is the first to shew signs of oedema, so it is also the first to become gangrenous. The

gangrene spreads thence towards the neck of the intussusception, affecting the returning layer to a greater degree than the inner.

Although this has been described as if the strangulation were complete, this is never the case in reality. In a hernia there is a definite constricting-neck to the sac, behind which the strangulation occurs. In an intussusception no such constricting band exists. The condition of each piece of gut differs from that of its neighbour. The nearer the apex, the greater the change, because the greater is the length of mesentery acted upon in the manner we have indicated.

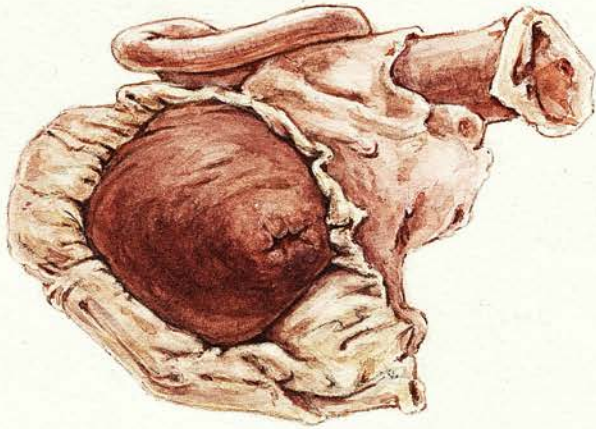
At the same time as this is occurring, obstruction is taking place. It is quite safe to say that there can never be strangulation in this disease without obstruction.

As the congestion and oedema increase, the lumen of the inner tube gradually becomes obliterated. The traction of the mesentery causes the opening to be displaced to one side and presses it against the sheath. The lymphatic glands in the mesentery rapidly enlarge, sometimes to the size of a walnut, and cause complete obstruction by pressure. Lastly

foreign bodies or hard food substances as stones, rice, etc. may block the narrowed lumen of the gut. For many instances of this see page 130

The two conditions strangulation and obstruction are not always progressive. The congestion may be very great and the obstruction complete for some hours and then from some cause become relieved. Haemorrhage into the bowel may relieve the congestion and with it the obstruction. Anti peristalsis may so far reduce the tumour that the circulation becomes re-established. The passage of a foreign body may relieve the obstruction and allow the passage of fluid faeces into the bowel below. In one of my cases the operation was put off on account of the copious passage of liquid faeces when the child was on the operating table.

PLATE. VIII.



Small invagination probably of the lower end of the ileum which passing through the valve is called ileo-colic. Note the great swelling of the apex. The valve and appendix are not implicated in the invagination. Successfully removed by operation.

II. IRREDUCIBILITY.

One of the most striking features about intussusceptions is the tendency they have to become irreducible. No definite statement can be made as to the length of time invagination may exist without this change occurring. Indeed the variations met with clinically are so extreme, that it is mere speculation to attempt to diagnose the reducibility or the reverse, from the length of time the symptoms have existed. It will be seen, that in Case 13 with a 3 days history, adhesions prevented reduction, while after a definite 3 mos. history Dr. Ford was able to reduce an intussusception which protruded 4 ins. beyond the anus. (Lancet Jan. 12, 1897.)

Reduction is prevented by a variety of causes, the chief of which are swelling of the intussusceptum and the formation of adhesions between the opposed serous surfaces.

1. Swelling of the Intussusceptum.

Though exact numbers are difficult to produce, I am quite certain that in children and in all acute cases, swelling of the intussusceptum is of far greater importance in bringing about irreducibility than is the presence of adhesions. The presence of swelling as an absolute bar to reduction in

Path 7

in my series is mentioned on more occasions than is the presence of adhesions. While in those cases which were reduced the complaint is almost constant that although the major part reduced with ease, difficulty was experienced in replacing the last one or two inches. Case 51 is a good example of irreducibility being due to the swelling of the intussusceptum.

The swelling is most marked towards the apex which may become enormously swollen, so that the walls are quite half an inch thick, very stiff and hard. This state of matters renders it extremely hard and in many cases quite impossible to unfold the last and most swollen portion of the gut. Firm pressure applied for some minutes is necessary to expell the oedema and make the gut pliable. Even then rupture may occur in the endeavour to reduce it. Swelling of the intussusceptum is not such a marked feature in chronic as in acute cases. The factors which bring about great swelling are the same as produce obstruction and gangrene, and therefore few such cases reach the chronic stage, although two such examples are reported in this series,



PLATE. IX



Small ileo-caecal intussusception, caecum laid open. The apex is greatly swollen.

cases 14 and 36, both of six weeks' duration.

2. Adhesions form between the opposed serous coats of the inner and returning layers and the included mesentery, as the result of local peritonitis. The extent of the adhesions differ widely. They are most commonly found glueing the peritoneal surfaces together in the region of the apex. This is to be expected as here the condition has existed longer than elsewhere and the baneful results of pressure are most felt at this spot. An intussusception can often be reduced with ease, except for the last two inches, where adhesions may render reduction difficult, if not impossible. Adhesions may be found chiefly at the neck of an intussusception, preventing reduction of even the last part invaginated. This is commoner in Ileo-Caecal and in chronic intussusceptions, without much strangulation, than in other kinds. Lastly adhesions may be found glueing a variable amount, or the whole extent of the opposed peritoneal surfaces. This condition is usually found in chronic cases and is rarely seen in infants. Of the conditions which determine the formation of adhesions very little is certain. In very

acute cases the strangulation produces gangrene and death before adhesions can form. Case 78 was operated on on the 2nd day, when hopeless gangrene was found but no adhesions. In less acute cases they have more chance to form, but are not met with as frequently as is generally supposed. In 89 acute cases treated before the 7th day, they were stated definitely to be present only on 8 occasions. It is possible that they could have occurred in 16 cases, that is in 18 %, and that includes many irreducible cases in which it is stated that reduction of the last part was difficult, though this was due probably to swelling rather than to adhesions. This is a very different statement from that of Treves, who found them present in 48 % of acute cases, and thinks the number should be still higher. In chronic cases, as one would expect, the percentage is high, time, and frequent temporary strangulation, serving to bring about their formation.

In 19 chronic cases treated later than the 7th day, they were met with 13 times, or, 68%. It is possible, however, that this number is too low. In two cases of over 6 weeks' duration, though irreducible, no adhesions were found (cases 14 and 36)

3. Swelling of the included glands.

This is a factor which is met with in all varieties of intussusception, but more often in acute than in chronic cases, and perhaps more often in intussusceptions taking place in the lower ileum and ileo caecal region. Lying in the mesentery in the angle between the last part of the ileum and the first few inches of the ascending colon are a great number of lymphatic glands. These of necessity pass into the invagination with the included mesentery. In intussusceptions of this region, owing to the laxity of the parts, more mesentery and consequently a greater number of glands pass in than in intussusceptions of the colon or the higher parts of the ileum, where the mesentery is shorter.

See Plate
opposite p. 18.

How soon these glands enlarge is not possible to say, but it is a very rapid process, one of hours rather than days. The change is not limited merely to the included glands, but is found in the glands at some distance from the lesion. This enlargement, as far as I have been able to judge, is a very constant occurrence, though seldom stated in the

1. *Med. Chir. Trans.* vol. 61. p. 301

notes. In ~~two~~³ of my cases, the glands, by pressing ~~towards~~ⁱⁿ the wall of the gut, seem to have been the cause of the intussusception.

4. The Curvature of the Tumour allows swelling to take place more on the convex than on the concave surface. This may bring about irreducibility. Actual twisting of the intussusceptum has been reported, making reduction impossible on the 5th day, although there were no adhesions of any importance. (Royes Bell, Lancet, Vol. I, 1876, p. 12)

5. The Folding of the Sheath, in double intussusceptions may grip the primary intussusception so tightly that attempts at reduction may fail, or only succeed after great difficulty. See cases 59 and 92. The case reported by Handfield Jones and Herbert Page¹ is a good account of the difficulty presented by this complication.

6. Intussusceptions of the lower end of the ileum which project through the Ileo-caecal valve, may be so gripped by the edge of the valve that reduction is impossible.

344 A

PLATE. X



Portion of ileum from an intussusceptum
shewing the enlargement of the lymphatic
tissue in Peyer's patches.

7. The presence of a tumour, such as polypus, may prevent reduction in the same way as do the presence of enlarged glands. Other growths, such as sarcoma (Case 9) or epithelioma (University College Museum No. 5, 592) may act in the same way and bring about a similar result.

3. 1.

A. CHANGES FOUND ABOVE THE INTUSSUSCEPTION.

1. The Gut. In acute cases the intestine above the intussusception may present no morbid appearances whatever. A certain amount of gas and fluid faeces may be found and nothing else. This is very commonly the case in the acute enteric variety. On the other hand the gut above the neck may be congested, purple, and shew subserous haemorrhages. Indeed, this is not such an uncommon appearance as is supposed. It is due to the fact that the intussusception changes in size and the bowel, which one moment forms a portion of the intussusceptum and subjected to pressure, may at the operation, owing to a partial reduction, be found lying above the neck. The hardening and relaxation of the tumour which can sometimes be felt, is, I believe, associated with slight advance and recession of the intussusceptum.

In ^a subacute case dilation of the gut is found immediately above the neck owing chiefly to the accumulation of gas.

In chronic cases, the bowel is hypertrophied to meet the need of increased power to drive on the contents through the narrowed lumen. This is merely the ordinary change found above the site of

6.2.

any chronic obstruction. Occasionally the gut just above the neck as well as being thickened is thrown into a series of folds or puckers which lie at right angles to the long axis of the intestine. There is hardly ever any large accumulation of faeces, found, even in adults and almost never in children. In acute cases, death occurs before any collection is possible, and fluid faeces can always be passed along the lumen in chronic cases. Rarely a foreign body, such as indigested rice has been found blocking the lumen of the tube and causing obstruction (Gay). See also page 130

2. The Mesentery. In nearly all cases the mesentery found just outside the neck ^{of the} intussusception is found to contain lymphatic glands which are more or less enlarged. It is not uncommon to find marks of congestion, such as discolouration and subserous haemorrhages, in the mesentery just above the neck. The explanation of these appearances is the same as in the similar condition found in the gut, namely temporary inclusion in the intussusceptum. Attention has already been directed towards the displacement of organs, the stomach, duodenum, and pancreas, which may occur in extensive ileo-caecal intussusceptions.

Thrombosis of the mesenteric veins was met with in one of Barker's cases, after reduction. How far this had spread is not stated. The child died.

B. CHANGES IN THE INTUSSUSCIPENS.

In acute intussusception there is very little change in the sheath near the neck. It may however show signs of having been temporarily implicated in the intussusceptum. In enteric forms and ileo-caecal forms occurring in very young children, the sheath may be stretched and fairly tense over the contained invagination.

The apex of a highly curved intussusceptum is liable, not only to cause localised ulceration, but actual gangrene and perforation of the sheath. Through this perforation the intussusceptum may escape into the abdominal cavity. Rupture of the sheath when it occurs is often a rapid process.

- Case 11. 9 Days. 2 partial Ruptures, 1. Complete.
(injections)
- Case 64. 5 Days sheath gangrenous, intussusceptum very curved.
- Case 57. 13 weeks, Descending colon ruptured on attempted reduction.
- Case 74. 7 days, trans^{verse} colon, already ruptured, the intussusceptum projecting through the sheath and general peritonitis present.

Case 89. 6 days. Descending colon ruptured.

Small intestine ruptured at the neck,
on attempting reduction.

In 4 of these cases, the average duration was 7 days, and in two the presence of existing general peritonitis testified to the rupture having taken place some little time previously. All were of the ileo caecal variety. If the sheath becomes folded on itself double and even triple intussusceptions may form. These rare varieties have already been dealt with.

C. CHANGES IN THE INTUSSUSCEPTUM.

Many of the vascular changes which occur in the intussusceptum have already been dealt with under the heading of Strangulation, but there still remain some points to be noted.

With the interference of the circulation through the veins, the blood pressure in the capillaries rises to nearly that of the arterial pressure.

The capillaries not being structurally capable of resisting this high pressure, burst, and subserous and submucous haemorrhages occur.

These haemorrhages are the source of the bloody discharge which is so characteristic of the disease.

Oedema takes place first at the part most situated furthest from the heart, namely the apex of the intussusceptum. Here the obstruction to the circulation is first felt. A thick knob-like swelling of the apex often forms a serious obstacle to reduction even in the cases of short duration. The swelling then spreads up along the convex margin. On the concave side, the traction of the mesentery compresses the tissues and throws the gut into transverse folds tightly wedged together.

Of the two tubes which form the intussusceptum, it is only the returning layer which is in a position to swell much, and that only along the convex border which is both furthest from the heart and unsupported except of the comparatively lax sheath.

The swelling according to Dunbar and D'Arcy Power who have both examined specimens microscopically, is chiefly due to lymphatic and haemorrhagic collection in the loose submucous coat of the bowel.

The enlargement of the middle layer leads to great thickening of its walls. In a case of 9 weeks duration Sidney Jones found the thickness of the walls of the middle layer varied from $\frac{1}{3}$ to $\frac{1}{2}$ an inch. (Path. Soc. Trans. Vol.111, p.179).

The inner tube though congested is not capable of much swelling owing to the tense condition of the middle layer. In old standing cases fibrotic changes are seen to occur with consequent shrinkage. Mr. Pitts (Lancet June 1897) reported a girl $2\frac{1}{2}$ years old with an 18 months history of intussusception where the lumen was reduced to the size of a goose quill. A like change sometimes is found even in acute cases, but is not so common as in chronic.

Associated with the intussusceptum, are sometimes found, tumours which have probably been the cause of the invagination. Amongst these the polypoid adenomata found in the intestinal wall are the most common. Homolle (loc.cit.) reported a case in which four such growths had each caused a separate intussusception.

Sarcoma occurred, and was evidently the cause of the intussusception, in one of my cases.

Other tumours such as columnar celled carcinoma and cylindroma have been reported in adults (University College Museum, No.5592). See also Decker.¹⁾

Tubercular ulceration of the ileo caecal valve has been found in one case. by Filliter.⁴⁾

Among the cases reported by Rafinesque, were found examples of soft friable adhesions connecting

the mucous surfaces of the sheath and the middle layer.

The most striking change seen in the intussusceptum is undoubtedly the presence of gangrene.

PLATE. XI

Specimen shewing gangrene starting at
the apex and spreading back along the
middle layer.

(Case 7)

GANGRENE.

It is impossible to give an exact date as to when gangrene sets in. Every case differs from its neighbour. The chief factors influencing its onset are the size of the intussusceptum and the tightness of the sheath. Thus, in the small intestine, gangrene ensues at an early date, even when the invagination is small. In the ileo-caecal form, on the other hand, gangrene may be delayed weeks and months, and the ^{us}intussusceptum may protrude beyond the anus. In the first case the sheath is necessarily a tight one, while in the second, the colon forms a lax commodious covering which interferes but little with the blood supply.

From purely anatomical considerations one would expect to find gangrene most frequently in the enteric forms which had started in the lower part of the ilium and passed through the tight ileo caecal valve and become the so-called ileo-colic variety.

The gut was already gangrenous or soft enough to be torn very readily in 18 cases. Of these 9 were ilio caecal; 6 were enteric, 4 of which had passed through the ileo caecal valve. In 3 the variety was not stated. This proportion bears out the foregoing supposition. In none were

58 Intussusception lying in the rectum, ileo-caecal valve near the apex not tilted. Rod passes into the appendix which has sloughed through a hole in the caecal wall. Traction of the meso-colon drew the pylorus down to the neck. No adhesions
(Case 14)



A 2

details given as to which coat was most affected. Excluding chronic cases the average duration of the disease was 5 days to the time of operation. In two the duration was only 48 hours. From a survey of the literature I am certain that a greater proportion of the pieces of gut passed come from the small intestine than from the large.

My experience is that gangrene commences first at the apex where the vascular changes are first and most severely felt. This is well exemplified in case 14 where the gangrenous end could be seen at the anus. From the apex it spreads back along the returning layer towards the neck. Both D'Arcy Power and Dunbar are agreed in this statement. Treves, however, believes that it usually commences at the neck. Where the condition of the gut inside an intussusception is uncertain, and attempts are made at reduction, the presence of gangrene first becomes apparent ^{at the neck.} This must be so if the anatomical relations of the various parts are kept in mind. For as reduction is brought about, the gut which forms the neck is constantly changing, as the returning layer becomes rolled over to form the sheath. It is quite common for a large amount of the intussusception to be

Plate XII

reduced before gangrene appears. As reduction goes on, the softened gangrenous area comes into sight and naturally enough it is first seen at the neck. As the neck is often the first portion of gut where gangrene becomes evident, it may perhaps give rise to the false impression that it was the first part to become gangrenous. In very acute strangulation, where the neck is very tight, as in the interic forms, the intussusception possibly dies as a whole and the gangrene in these cases may really start at the neck itself.

We may now note the various ways in which gangrene may occur. Death of the intestine may take place by pieces which are shed off bit by bit and passed without recognition. Very often, however, the gut is passed in one or more large and easily recognised pieces. As a rule the returning layer becomes gangrenous sooner than the internal layer, but sometimes the opposite happens to be the case. This variation has an important bearing on the anatomical relationships of the portion of bowel passed. Gangrene of the inner is said to proceed that of the middle layer, most frequently in ileo-caecal forms. Another factor in the relationships of the pieces passed is the presence or absence of adhesions. If adhesions

Fig 19

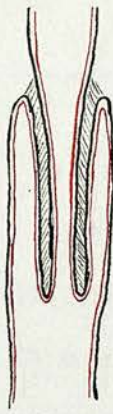


Fig 20



Fig 21



Fig 22.

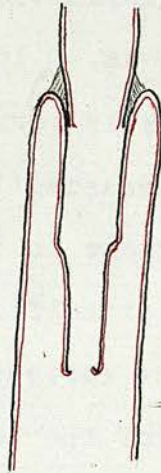


Fig. 19. Adhesions preventing the separation of one tube before the other.

Fig.20. ^{middle} Outer tube free at apex and neck, being passed first.

Fig. 21. ~~Outer~~ Middle tube free at neck, still attached at the apex, a long tube is the result, the mucous membrane inside.

Fig.22. Inner tube free at neck but attached at apex, a long tube is the result with the mucous membrane outside.

are absent and one tube dies before the other one, and is separated at the apex and neck, this portion may be passed some days before the other. If, however, adhesions are extensive, the tube which dies first must wait for its fellow to separate and both come away together.

If the ~~outer~~^{middle} tube separates first at the neck, but remains attached to the inner tube at the apex till the latter comes away, one long tube will result. This will be passed with the mucous surface internal fig. 21. If the inner tube separates first at the neck and not at the apex, then a long tube will be passed, turned apparently inside out, i.e. with the mucous surface external, fig 22. Another fairly common way for the bowel to be passed is in one or more flat pieces. The explanation of this being that the gut has given way along the convex border of the intussusceptum, where the morbid processes advance most rapidly.

As a rule the gut is passed in a still recognisable condition so that the site of the intussusception can be roughly estimated.

Curious appearances are sometimes met with in the portions passed. Thus sephalation had taken place at one or two spots in a tubular piece of intestine $2\frac{1}{2}$ to 3 ins. long, reported by

Jeaffreson (Dublin Med. Press, 1845, p.388). Dr. Dayton (Ibid 1845, p.411) reported the passage of two pigmented pieces of bowel 12 and 4 ins. long respectively after a 4 weeks illness. The gut was divided in its whole length and the mucous surface was dotted over, and in places almost covered with small dark granular patches, hard and resembling grains of sand. There were in addition patches from $\frac{1}{2}$ to 1 in. in diameter, in which the entire coats were changed into a dark mahogany coloured substance "not dissimilar to thick turtle shell either in hardness or appearance." Similar appearances are reported in the Lancet Vol. V, 1863, p. 409. In some cases the cause of the intussusception, such as a Meckel's diverticulum or a polypus have been passed along with the gut. As much as three metres of bowel have been passed at a time (Cruveilhier).

In infants natural cure by sloughing is very rare. They are, as a rule, overwhelmed by the acuteness of the process before sufficient time has elapsed to allow of separation. But in spite of this such cases have been reported in infants though I am not so fortunate as to include a single case in my series. For examples of this see Peregrine's case, aged 9 mos. (Lancet 1873, Vol.1, p.109). Wiggan reported one, a boy aged 7 mos. (Lancet Aug.1897).

SECTION III.

ANATOMICAL AND EXPERIMENTAL

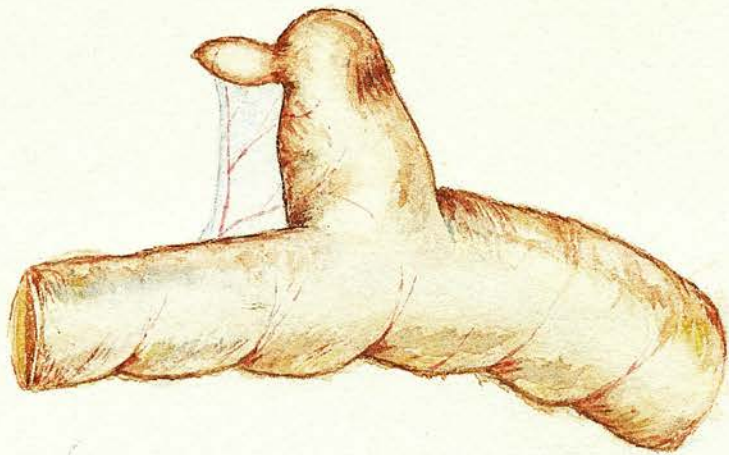
INVESTIGATIONS.

Anatomical Considerations.	Page	69.
Experimental investigation of the immediate cause of intussusception.	"	77.

ILLUSTRATIONS.

PLATE XII.
Diagrams 23 to 33.

PLATE. XIII



Meckel's Diverticulum with a small
pouched extremity, no terminal process.

The specimen has a complete mesentery
which contains the ending of the superior
mesenteric artery.

The lumen of the ileum was much
smaller above than below its attachment.

Distance from the ileo-caecal valve
20 ins.

ANATOMICAL CONSIDERATIONS.

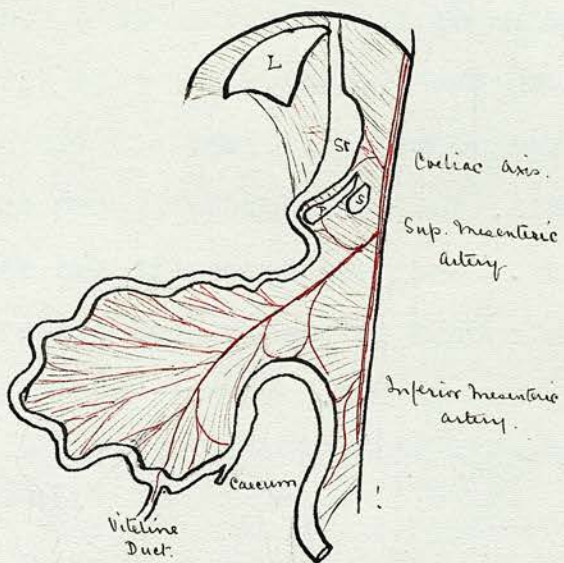
The gross anatomical forms and relationships of the abdominal viscera are so familiar that only a few points need be alluded to.

The mesentery of the infant is relatively much longer than in the adult. D'Arcy Power found the average length to be 8 to 9 inches in 44 bodies.

On drawing on the intestine of a young infant, I have noticed the frequency and ease with which the peritoneum can be made to slide off the posterior abdominal wall, thereby increasing the length of the mesentery. The subcutaneous tissue is so lax that the peritoneum in some places slides quite loosely over the fascia. This is especially the case in the region of the inguinal rings and lumbar regions.

The root of the mesentery extends as in adults from the left side of the body of the 2nd lumbar vertebra to the right iliac fossa. This length of the mesentery accounts for the long distances intussusception, even of the enteric variety, can travel. Prolapse of 4 to 6 inches of bowel is no uncommon feature of ileo-caecal forms. The excessive length of the mesentery is of great benefit in operating; for, in infants, the wound can be made almost

Fig 23.



Primitive Intestinal Canal
(modified from Morris' anatomy)

in any part of the abdomen and the intussusception brought out of the wound without undue dragging.

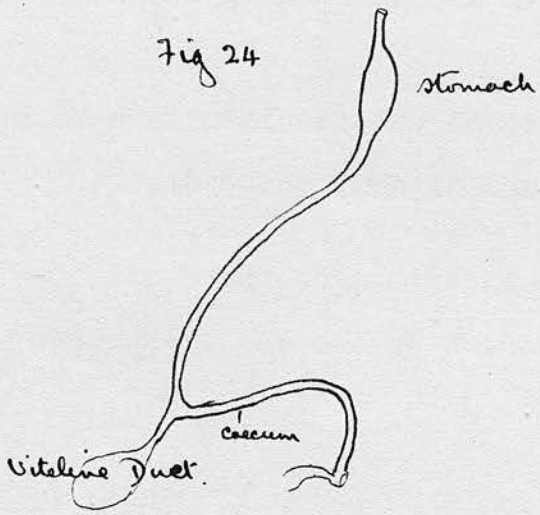
On examining the lower end of the small intestine I have been struck by the way it narrows towards its lower end.

In 10 bodies of children under 12 years, I find that if the gut be emptied and pressed flat, the cross measurement of intestine within 3 ft. of the ileo caecal valve is quite 10 to 15% smaller than the measurement of the small intestine higher up.

The occasional presence of a Meckel's diverticulum in this region recalls the special morphological importance of this portion of intestine. The intestinal canal in its simplest form is a simple loop into the apex of which the vitelline duct opens in the **faetus**. It is towards this duct that the superior mesenteric artery is directed. In the vast majority of cases, the duct disappears altogether. Its site can however, often be demonstrated by examining the apparent ending of the superior mesenteric artery.

This artery is usually described as ending

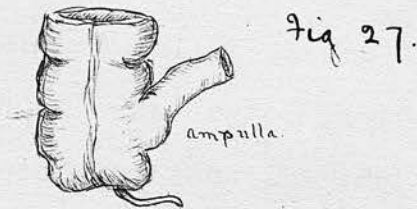
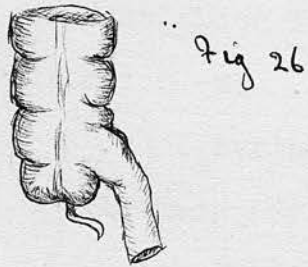
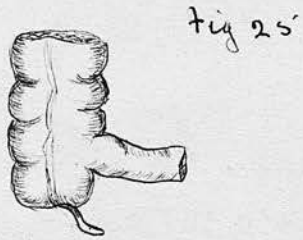
Fig 24



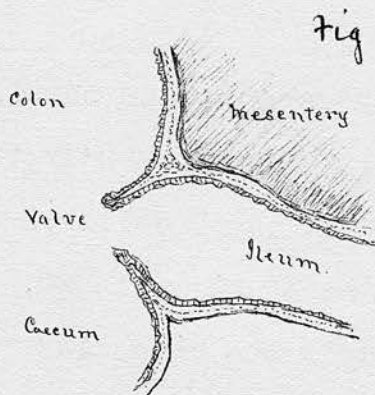
showing Primitive
loop with the Viteline
duct opening into the
apex.

by anastomosing with its own branch, the ileo-colic, but if it is examined closely the ending can often be made out among the arterial arches. Opposite this ending a small notch or kink is often to be seen in the gut wall. The notch is the remains of the apex of the primitive loop. This is the site at which congenital stenosis or absence of the gut is most frequently seen. I have examined specimens of two such cases. I have alluded fully to the presence of a Meckel's diverticulum under the heading of Causes of Intussusception, page 128 and will not dwell longer here on the subject. I may however, just add that the notes relating to the only specimen of inverted Meckel's diverticulum causing an intussusception, in the museum of the Sick Children's Hospital, Great Ormond Street, are not to be found.

The angle which the lower end of the ileum makes with the caecum is important. D'Arcy Power examined this in the bodies of 38 children and found the angle to be a right angle in 20, in 15 the ileum sloped up towards the ascending colon and in 3 the axis of the small intestine pointed downwards towards the caecum. Naturally an intussusception would be more likely to form when the ileum



The three types of Ileo caecal junction.



Semi diagrammatic sketch
of a section through the
Ileo-caecal junction
to show the ampulla.

sloped up towards the ascending colon, than when it sloped downwards to the caecum. In the latter case when an invagination formed the natural peristaltic action of the large gut would tend to reduce it. I examined 23 bodies for this factor and my figures were as follows.

Ileum opening into large gut at a right angle	6
Ileum sloping up towards ascending colon	15
- - - down towards Caecum	2

There is one point which discounts this observation rather, and that is that the narrow ileum slightly dilates before opening into the large gut. There is as it were a slight ampulla behind the lips of the valve. This is very well marked in the rabbit where it forms a prominent portion of the gut. In man the walls of this part of the intestine are stiffer than that of the ileum above. I do not know if they are thicker as I have not had sections cut. This ampulla, if I may use the name, always lies at right angles to the gut. The slope of the ileum if present is into this and not into the wall of the colon itself.

At birth and for the first 4 months of life the narrow palvis does not contain any small intestine. After the 4th month, the small intestine begins to pass into the palvis. The 4th, 5th and 6th

months are the months when most intussusceptions are met with. The proportion of males with this disease is twice (at least) that of females in young children. Noting these facts in dealing with the question of the sex influence, I have ventured to suggest that the descent of the intestine into the pelvis is an important factor in the case. For the female pelvis will be partly filled with the small uterus and appendages, and therefore the small gut will descend neither so easily nor so soon as in the male. I think that the descent of the gut has a great bearing on the angle the ileum forms with the large intestine. I have not yet collected enough figures of the different sexes, taken before and after the 4th month, to be sure of this fact. But I feel sure there must be some anatomical explanation to account for the difference in the sex incidence at this age.

In the caecum and ascending colon the most remarkable thing to be noticed is their free mobility. As a rule the lower part of the ascending colon is like the caecum wholly surrounded by peritoneum and therefore mobile. I am aware that this is contrary to the statement of Treves, who asserts that the presence of the ascending colon is commoner in late life than at birth; but it agrees with the observations

of Leichtenstern. In the small infant the ascending colon is very short, the caecum is situated rather high in the right Iliac fossa or may not even have reached as low; the liver is relatively very bulky, and reaches well down so that there is scarcely any space for an ascending colon. The figures drawn up by Treves for the relative frequency of the mesenteries of the large gut are as follows:

Descending Meso-colon	22%
Ascending Meso-colon	12%
Both	14%.

These figures relate however to adults. From a series of observations I am conducting as to the patency of the inguinal and femoral canals at different ages in children, I have come to the conclusion that the presence or absence of a meso-colon is of no importance under one year. For if the colon were bound down on each side, the peritoneum is here so loosely attached to the underlying tissues that the formation and drag of an intussusception would rapidly produce a very respectable meso-colon. To such an extent is this the case that the duodenum and even the pancreas have been drawn into the neck of an intussusception.

The frequency with which ileo-caecal intussusceptions are met with compared with other forms, has

led to very careful examination of this region by very competent observers. The anatomy has been very minutely described by Professor R.J.A.Berry; Mr. Lockwood and others. Mr. D'Arcy Power and Dr. Dunbar have examined this region microscopically, but without any very positive result. The mucous membrane has been noted to be redundant and moveable owing to the laxity of the submucous tissue

This may, in a prolapsed condition, be the starting point of an invagination. But I can not subscribe the simile of Leichtenstern, which compares the ileo-caecal valve to the anus, and the formation of an intussusception with the formation of prolapsus recti. He thinks that tenemus and increased muscular force produce both affections; if the caecum is mobile an ileo caecal invagination results, if on the other hand the caecum is bound down then the small intestine is gradually pushed through the valve with the formation of an ileo colic intussusception.

The conditions, at first sight the same, are, on examination, essentially different.

An intussusception grows by the muscular action of its sheath; a prolapsed rectum has no sheath. The mass is protruded from the anus by the vis a tergo of the raised ^{intra}~~anti~~ abdominal pressure due to

straining, a voluntary act set up by rectal irritation. A rise in intra abdominal pressure would produce no effect on an intussusception unless it had reached the rectum. The raised pressure would be equal on all sides of the tumour and would have no influence in one direction more than in another. In the one case the muscular action is voluntary, and in the other quite beyond any control of the will.

77

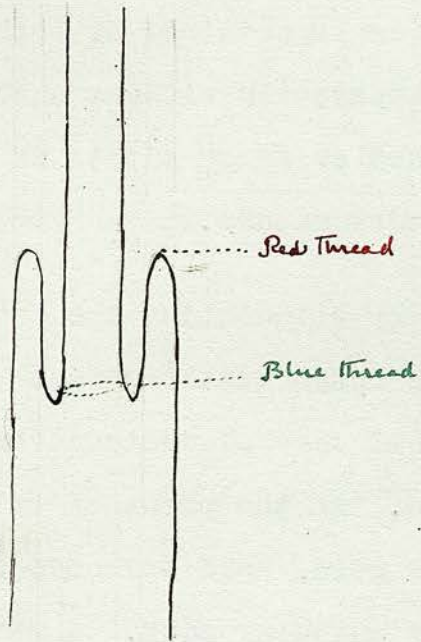
EXPERIMENTAL INVESTIGATION OF THE IMMEDIATE
CAUSE OF INTUSSUSCEPTION.

Since Nothnagel's paper ¹ appeared on the formation of intussusceptions by electrical stimuli in the laboratory, little or no progress has been published as the result of investigation of the subject. The results obtained by Nothnagel have been accepted apparently without question and no one has published evidence either of a confirmatory or a contradictory nature.

Nothnagel by stimulating the intestine of the rabbit with the interrupted current by means of electrodes placed very close together, noted the following facts. At the point of stimulation, the gut becomes pale, hard and cord-^{like} from contraction of the circular muscular coat. A strong wave of contraction passes upwards from this point for a considerable distance. This wave was found to pass either gradually into normal intestine or else to come to an abrupt stop. In the latter instance a small intussusception forms of a retrograde character, the uncontracted passing over the uncontracted gut. These retrograde intussusceptions are only of momentary duration.

1. (Beitrag zur Physiologie und Pathologie des Darmes, p.42 Berlin 1884)

Fig 28.



Immediately below the place where the electrodes were applied a real descending intussusception was found to form. The normal gut turning itself upwards over the contracted portion, so forming a descending intussusception. This increased at the expense of the intussusceptiens. This is illustrated by the following description.

At one point in the bowel a fine blue thread was drawn through the serous coat and then cut short. Lower down a red thread was in like manner placed in position.

The electrodes were applied to the blue thread; an ascending contraction followed which might or might not end in forming a retrograde invagination. Below a typical intussusception formed. The blue thread remained stationary in the contracted bowel. The red thread moved upwards in relaxed gut wall which passed higher and higher until both threads disappeared. On cutting the intussusception open the red thread was found lying in the middle layer. These invaginations disappeared of their own accord after existing for a little time.

By stimulating the bowel above the intussusception, no effect was obtained. Stimulation of the sheath simply made the intussusception more rigid.

But stimulation of the gut just below the intussusception, brought about an ascending contraction which at once reduced the invagination.

Nothnagel also tried the effect of paralysing a portion of the gut and then stimulating.

Three to six inches of gut were crushed so as to completely arrest all motion. Stimulation applied above the inert segment only produced the usual ascending wave. Stimulation, however, of the gut, immediately below the crushed part, produced a typical descending invagination.

This invagination of necessity grew solely at the expense of the sheath, which as it were, climbed up the paralysed inner tube.

These experiments seemed to show conclusively that intussusceptions could be formed either by simple spasm or by severe injury which paralysed the gut. It was the wish merely to see the actual formation of an intussusception which caused me to carry out any experiments.

The frequency with which post mortem intussusceptions were said to occur in animals which died from other than natural causes, suggested to my

mind that the easiest way of studying the subject was to eviscerate an animal immediately after death and to watch the formation and dissolution of the intussusceptions.

With this end in view, in the spring of 1906, I shot 25 rabbits. Some were shot with a small solid Morris tube bullet and some with snipe shot (No. 8) so as to reduce the risk of injuring the intestines. All were wild rabbits as the hutch rabbit is an animal very inferior in energy and vitality to its wild cousin. The ages of the animals varied from a month to upwards of a year. Specimens of both sexes were investigated.

Immediately after the animal was shot the abdomen was opened in the middle line and the intestine watched in situ or after turning them out of the abdominal cavity; careful notes were then kept of the details. In not a single case was an intussusception found to form. This being so, the publication of the exact details of each animal would be a waste of time. The results obtained were roughly as follows:-

Peristaltic action was present in every case and was thought to be slightly more active in the

Rabbit's Intestine

Fig 29



Local contraction

Fig 30



Dilation above local
contraction

Fig 31



Dilation above + below
local contraction

Fig 32



a node.

younger than the older animals. The movement did not seem to be affected by occasional injury of the intestine by the passage of a bullet or shot. The peristalsis gradually subsided, dying away first in the more exposed parts of the gut which became dry, glazed and cold. Shielded portions of gut which were still moist retained motion for upwards of 2 hours, and even later than this a pinch could elicit a sluggish contraction. As a rule the large gut was at rest before the small, which was at all times the more active.

Although no definite intussusceptions were seen, "Nodes" appeared in the intestine during peristalsis which had all the appearance of small invaginations and which quite deceived me until a more careful investigation revealed their true nature.

These "nodes" were caused by strong contractions of the circular muscular coats over quite local areas. Immediately below this tight constriction the intestine was relaxed and dilated owing to the inhibition of the muscular coat. When the peristaltic wave passing downwards from above, reached this spot, it failed to pass the tight constriction or even to relax the contracted muscular coat. This contracted area seemed to act as a block

to the onward passage of the wave. Behind each wave of contraction a wave of reactionary dilatation followed, so that as the wave passed into but not through the block, the portion of intestine immediately above became dilated. As a result of this there was, centrally placed, a narrow contracted portion with a relaxed and dilated area on each side.

These two dilated areas came into opposition with each other, overlapping, and hiding the contracted portion.

As many as four or five peristaltic waves would be thus blocked and gave one the impression that more and more intestine was passing into the "Node". After a period of one to two minutes the apparent invagination dissolved as the local contraction became relaxed and the gut resumed its normal aspect.

The true nature of the "Node" was easily demonstrated if at any time the opposed surfaces of the two dilated areas were gently separated. It was then evident that there was merely an intervening contracted ring and that no true invagination had formed.

This appearance will be again referred to in describing some more elaborate experiments performed

Fig 33. Peyer's Patch in intestine
of Rabbit.



on live animals under more favourable circumstances in the laboratory.

I believe that the formation of these nodes are what many observers have seen and described as invaginations.

Another noteworthy point was the behaviour of the gut in the region of masses of lymphoid tissue which are seen in its walls. These masses seem to correspond more or less with Peyers patches in the human intestine. They are found on the free border of the intestine, but have certain noteworthy differences. The patches in the rabbit, are relatively larger, thicker and rounder than those in man. They make that part of the wall of the gut in which they occur, stiff and incapable of active participation in peristalsis. The thinner and more pliable intestinal wall, when relaxed, sometimes overlapped the edges of the Peyers patch all round its circumference, so as to give rise to the appearance of an ulcer with a flat surface having large rolled over edges. This appearance suggested the possibility of the Peyers patch forming the starting point of an invagination. But this was never realised. Flicking, pinching, and crushing the intestine only seemed to promote peristalsis,

See Plate

intussusceptions never.

A series of experiments were performed, under licence from the home office, in the Physiological department of University College London. These experiments were carried out under the guidance of Professor Starling, to whom I am indebted for much kind help and many valuable suggestions.

The experiments were practically a repetition of those carried out by Nothnagel. Since Nothnagel's time a considerable amount of work has been done and knowledge gained as to the factors governing the movements of the intestine. Professor Starling is among those who have been most active in this branch of investigation.

DESCRIPTION OF AN EXPERIMENT.

A rabbit was placed under ether. The animal's head was fixed over the edge of a bath containing saline at the temperature of the animal's body. A carefully regulated Bunsen burner served to keep the temperature at the same level. Laparotomy was performed and the abdomen opened in the middle line from the ensiform to the pubis. All bleeding was

controlled. The animal was turned on its side and the intestines allowed to come out of the abdominal cavity and float free in the saline, where they could easily be observed.

Various portions of intestine were chosen, and piece of cotton thread passed with a needle through the mesentery near the gut and knotted in such a way that the upper and lower ends of this portion of intestine were easily distinguished. If this was not done it was very hard to tell the upper from the lower end even by the peristaltic wave. A Lechance cell was attached to a primary coil and from a sliding secondary coil wires were led off to needle electrodes. The points of the electrodes were separated from each other by a distance varying (in different experiments) from one to two millimeters.

The primary coil was set in action. A selected portion of intestine was supported by the hand near the surface of the saline, and the electrodes placed lightly on the surface. The distance between the primary and the secondary coils was noted in each case. To begin with very weak currents were used. At a distance of more than 9 c.m. little or no effect was produced, so that after this was ascertained each application was started with the primary

coil at this distance from the secondary. The electrodes were applied several times and the effects noted in each case, time being given after each application for the gut to resume its normal action. The secondary coil was then moved 2 c.m. nearer the primary coil and several applications again made. This was repeated again and again until the secondary coil had been pushed home, moving it 2 c.m. nearer each time.

The whole performance was begun again at another part of the intestine, and so on till all the intestinal tract had been investigated. These experiments took between two and three hours and involved several hundred applications of the electrodes.

The animal being under ether and the temperature of the water maintained throughout the experiment; when the experiment was over the animal was killed while under the anaesthetic.

It would only weary to reproduce the experiments in detail, the more so as no startling result was obtained in any. The following short account will give an idea of the method, and the results will be then discussed.

Experiment I.

Male rabbit full grown. Had been fed. (arrangement of apparatus and exposure of intestines as described).

Effect of stimulation of upper part of small intestine.

Distance of Secondary from Primary coil.

- 12 c.m. Very slight local constriction (3 applications)
- 9 c.m. Local constriction, wave of contraction passing up for about half an inch and dying away. Wave passing downwards as an ordinary wave of peristalsis, The local constriction lasted about half a minute and passed off (4 applications).
- 7 c.m. Local constriction and waves as before, once a "Node" formed owing to relaxation on each side of the contracted portion. The relaxed portions meeting over and hiding the contracted segment, no invagination (5 applications).
- 5 c.m. Stronger local constriction extending over a slightly wider area; once it narrowed down to a very thin band but was not swallowed (3 applications).

3.c.m. Stronger local constriction, the gut becoming pale and anaemic from the emptying of the blood vessels; longer time taken for the contraction to pass off.

1.c.m. As before, appearances more marked; no intussusception.

Coil pushed home. About an inch thrown into strong contraction pale and stiff. Peristalsis goes on above and below as before. Below there is a small area of relaxation. After 10 to 15 seconds the area of local constriction decreases by about half, but it requires some minutes to pass off altogether.

These observations were repeated again and again at intervals lower down the gut. Special attention was paid to the gut just about the region of the ileo-caecal valve, but no different appearances were found there. No intussusception was produced either in the large or small intestine.

The animal was then killed.

Experiment 2.

Male rabbit full grown, not fed for six hours. (arrangement of apparatus, anaesthetic, and exposure of intestines as described).

The ordinary peristaltic movements were seen to be taking place. By the advice of Professor Starling the inhibitory influence of the splanchnic nerves was removed. This was done by turning the animal over performing laminectomy in the upper dorsal region and exposing the spinal cord. The cord was then severed and the lower end destroyed by pushing a thin piece of whalebone down the neural canal.

The well known effect was immediately seen. The intestines, freed from the tonic inhibitory action of the splanchnic nerves and under the control only of their motor nerve the vagus, became greatly excited in their action. Wave after wave of swaying peristalsis followed each other in rapid succession. The gut moored to the body by its mesentery, seemed endowed with very much the same continuous snakelike motion as is seen in long green weeds at the bottom of a swiftly flowing stream.

On the upper and lower ends of the coils, were placed distinguishing marks.

Stimulation was then proceeded with.

Secondary from primary coil.

Local contraction at point of stimulation and wave passes up a short way, downwards into an ordinary peristaltic wave. Very limited sphere of action. Movements elsewhere not interfered with (4 applications).

9 c.m. The same thing, a Node obtained once rapidly dissolved again (4 applications)

7 c.m. Local contractions stronger stimulation seems to increase the motion below, nodes obtained occasionally. On stimulating at a point more than 2 inches below node no effect obtained, at a point nearer than this the wave passing up dissolved the node. C.f. Nothnagel, stimulating just above the node caused it to dissolve immediately (especially when the current was still stronger).

3 c.m.	The same effects were produced)) as in the last experiment.
1 c.m.	" " " " ")	
pushed home	" " " " ")	
home	" " " " ")	

The different parts of the intestinal canal were tried without producing a result differing materially from these recorded. No intussusceptions were formed. Nodes were seen also appearing without the gut being stimulated.

The animal died from an overdose of ether half way through the experiment, but this did not affect the intestinal movements in any way.

Experiment 3.

Female rabbit, pregnant . (arrangement of apparatus as before) In this case the spinal cord was divided in the upper dorsal region and the lower end destroyed, before the intestines were exposed.

The same method of investigation was applied here and given up after 2 hours. No positive result was obtained.

Experiment 4.

Male rabbit full grown, had not been fed for 24 hours. Conditions the same as in the last experiment. The cord was divided and the lower end destroyed before the intestines were exposed.

After a two hour trial with no positive result the experiment was abandoned.

Experiment 5.

Two foetal rabbits shortly before full term were investigated but the intestines did not exceed the size of thread worms and proved useless.

Time and the closing of the physiology department did not allow me to prosecute these investigations further. I shall, however, at the first opportunity investigate the behaviour of crushed and injured gut. The injured gut in the shot rabbits behaved in no way different as far as I could judge, from the normal. I hope also to try shortly the behaviour of the intestines when an artificial intussusception has been produced. It is said, I think by Pawlow, that intussusceptions so made in the dog, may even be stitched in position to prevent reduction, and the dog appear none the worse therefor. The intestine of this animal is however peculiar in the great amount of muscular tissue it possesses. This may enable it to overcome any tendency to obstruction.

CONCLUSIONS.

The results of these experiments then differ very much from those of Nothnagel but I believe that what I have called nodes he has termed intussusceptions. These were frequently produced by electric stimulation. But they are also produced without such stimulus, as I had already seen many of them in the rabbits I shot. I believe they are of perfectly natural occurrence. Cannon in his work on the intestinal movements of cats draws attention to what must be the result of such local contractions, viz. segmentation of the food. His investigations were carried out by photographing with the X-Rays the position of quantities of food which contain large amounts of Bismuth. The outline of the shadow cast by the bismuth indicated the state of the walls of the intestine whether contracted or otherwise.

He found that in addition to the ordinary peristaltic action which passed on the food, local contractions took place which segmented the food into short lengths.

I believe that the local contractions I have mentioned are those referred to.

The nodes are just what one would expect from

the fact that there are two relaxed portions of gut on either side of a contracted piece.

But nevertheless though I do not attach to these the name of intussusception, they are very suggestive of the mechanism by which an invagination might readily come about, namely local contraction of the circular fibres ending abruptly above and below, while the contraction of the longitudinal fibres, are more diffuse in their action. The longitudinal fibres acting from the local contraction as their fixed point, draw up the lax gut over the local constriction. Once started the longitudinal fibres continue to pull more and more sheath up over the intussusceptum. In each contraction they would take as their fixed point, the existing neck of the intussusception. If the gut was quite free and had no mesentery the apex of the intussusception would remain stationary at the position of the first local contraction. The sheath and gut below would do the moving, climbing up as it were, over the intussusceptum. As in the body however, the lower part of the gut is more or less fixed the peristaltic action pulls the intussusceptum downwards in a swallowing manner.

I am of opinion therefore, that the way an

intussusception is brought about is by inco-ordination of the circular and longitudinal muscle fibres in the intestinal wall, whereby the longitudinal fibres are able to pull one part of the intestine over an area where the circular fibres are in action.

I believe that to produce invagination, a slight irritation is necessary. This increased the action of the muscles and incoordination ensues. A small invagination results and this goes on growing until the intussusceptum is large enough to become acted on like a foreign body or polyp in the inside of the gut. On the other hand, violent irritation is equally able to produce the invagination but the strength and rapidity of the contractions reduce the invagination spontaneously before the intussusceptum is large enough to act as a foreign body. A glance at the chart opposite page shews that during the months of July, August and September, when the violent irritation caused by epidemic diarrhoea is at its height, the numbers of intussusceptuons fall.

The borderland between the physiology and the pathology of the intestinal action is, I imagine, a very narrow region. It is probable that what I have described as the formation of Nodes goes on

normally in the intestine and results in the segmentation of the intestinal contents, as seen by Cannon. Possibly the formation of Nodes or even of slight invaginations is not infrequent, their dissolution in the great majority of cases being physiological, but in the minority the ^{inco-}ordination is just sufficiently upset to allow the growth of the intussusceptum to proceed until the narrow borderland is past. The mechanism is so delicately balanced that at times the least thing may tilt the scale. The strangeness of some new propriety milk, the piece of soaked rusk, or the grain of grey powder may be just sufficient to transform a hitherto physiological process into a pathological condition fraught with the gravest danger to life.

Injury to a portion of the gut paralysing a segment, whether caused by a blow or by ulceration may enable the lower active portion to swallow the upper and paralysed segment of intestine.

SECTION IV%

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AGE INCIDENCE.

As the age of the child varies, so also does the liability to suffer from intussusception. The relation of age to incidence of the disease is remarkable and constant. Of my 103 cases no less than 75 were not more than 12 months old. Other statistics tally very closely with these figures, thus in 61 cases occurring in University College Hospital, London, Mr. Barker¹ found 40 were 12 months and under. In 59 cases from the Royal Hospital for Sick Children, Edinburgh, Dr. Dunbar² found a still higher percentage were infants, only 6 of that number exceeding that age.

But we can differentiate still further and say that certain months of life are the ones above all others, in which intussusception is to be feared. This period is from the beginning of the fourth to the end of the 6th month.

Among the 75^{of my} cases of 12 months and under, 37 or about half occurred at this age. Leichtenstern found among 593 cases of all ages, not less than 80 intussusceptions took place at this time. The following are a few quotations dealing with this point in children.

¹ Archiv. für Klin. Chirurgie Bd. 71. Heft 1.

² Scottish Med. & Surg. Journ. Aug 1906

Authority.	Number of Cases under one year.	Those from 4 to 6 months old.
Lewis Smith	29	18.
Hansen	39	22
Pitz	91	55
Barker	40	22
Dunbar	53	32.

The fourth, fifth and sixth months therefore are to be regarded as the suspicious period, for any child which is brought for treatment when suffering from pain, diarrhoea and vomiting.

In drawing up statistics it is often very fallacious to trust to a collection of published cases, for a larger proportion of successes will naturally be published, and the failures not drawn attention to.

We have, however, the 60 consecutive cases from University College Hospital, and 59 similar cases from the Royal Hospital for Sick Children, and if to these are added the cases here published, we have the handsome total of 222 cases of 12 years old and younger. With these a very fair average may be struck, of the age incidence in children.

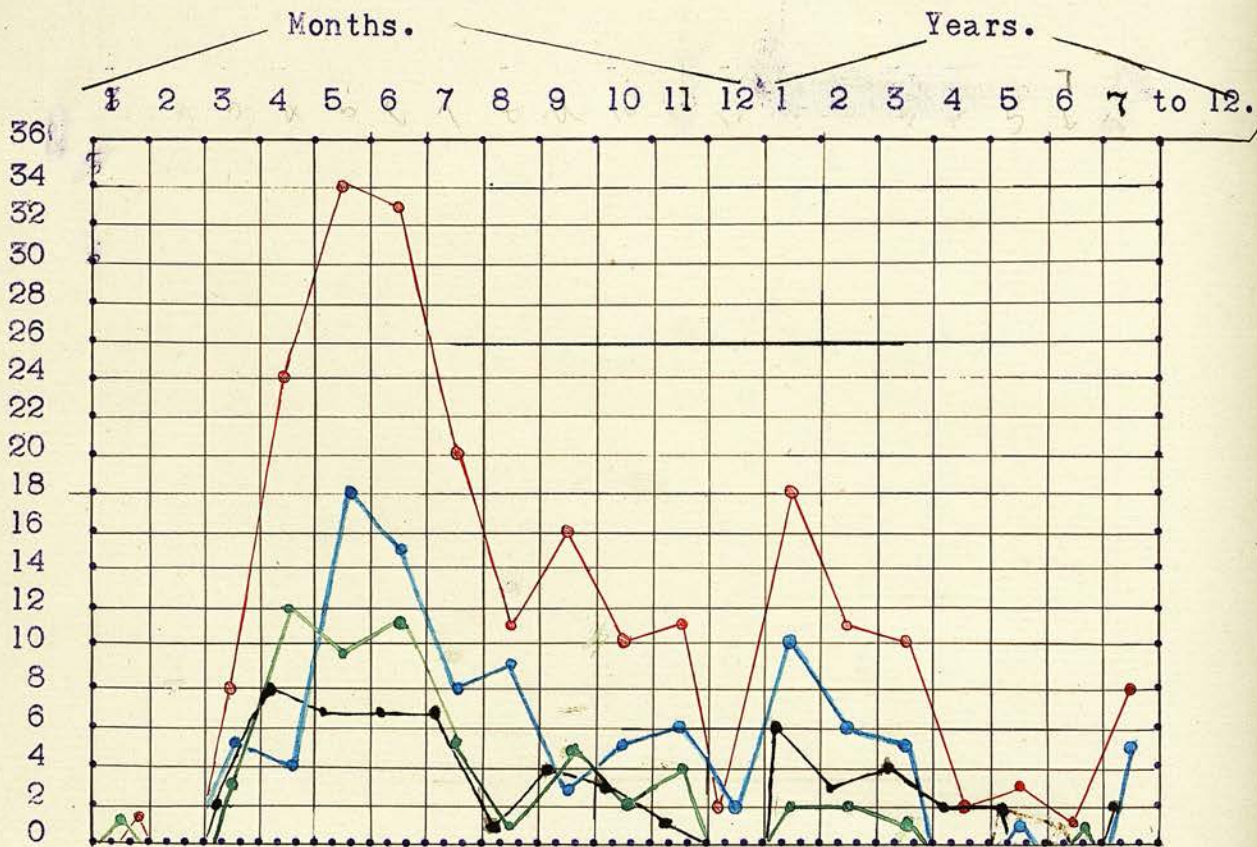


CHART TO SHEW AGE INCIDENCE.

Mr. Bakker's series in black.

Dr. Dunbar's in Green.

Great Ormond Street Hospital's in Blue.

The Common Chart for all three in Red.

Cases.	months.												years.						
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	6-12.
Mr. Bar- ker's 60.	.	.	2	8	7	7	7	1	4	3	1	.	6	3	4	2	2	1	2
Dr. Dun- bar's 59.	1	.	3	12	9	11	5	1	5	2	4	.	2	2	1	.	.	.	1
Author's 103 (1 un- known)	.	.	5	4	18	15	8	9	3	5	6	2	10	6	5	.	1	.	5
Total 222.	1	.	10	24	34	33	20	11	12	10	11	2	18	11	10	2	3	1	8

If a monthly curve is compiled from these figures, (see the chart opposite) it is seen to rise abruptly from the 3rd month and mounting rapidly, it reaches its highest point at the 5th and 6th months, falls rapidly to one third its height at the 8th month, and then remains steady till the eleventh month and again falls with abruptness. There is a steady fall during the first four years of life, more being met with in the first than any of the subsequent years of life. The number of cases met with in the first as compared with the second six months of life is as 2 is to 1.

The youngest case was a male 6 weeks old, he was operated on and recovered. In my cases the ages of the 5 children above 6 years were $7\frac{1}{2}$, $9\frac{1}{2}$, $9\frac{1}{2}$, 11 and 12 respectively. In one case only was the age not stated.

THE SEX INFLUENCE.

In 102 cases in which the sex was noted the males were 66 and the females 36. This is not an accidental proportion for the males exceed the females in all tables drawn up with reference to this disease, and that sometimes by the extent of 3 to 1.

The proportions found by a few writers are here quoted:-

	Name.	Males	to	Females.
1.	Lewis Smith	2.2	to	1
2.	Rilliet	3.4	to	1 (children)
3.	Brinton	2.3	to	1
4.	Duchanssoy	3.5	to	1 (Adults)
5.	Haven	1.9	to	1
7.	Pitz	1.8	to	1 (under 13 yrs)
8.	Leichtenstern	1.8	to	1 (All ages)

Name.	Males	to	Females.
9. Barker	2.8	to	1 (children)
10. Dunbar	3.	to	1 (children)

Why this sex difference should be so marked in every case, is difficult to say, the more so as it is most marked in young children before difference in the sex configuration becomes ^{developed} ~~marked~~. The only way I can account for it is that in the female, the uterus, small as it is in the infant, is sufficient to fill, to a very large extent, the narrow pelvis. The lower part of the ileum does not therefore occupy the basin of the true pelvis, as often as it does in the male. This makes the angle which the ileum forms with the colon more often a right angle in the female than in the male. D'Arcy Power first drew attention to this fact in trying to explain the frequency of intussusception at the ileo-caecal valve, shewing that if the ileum formed an obtuse angle there was more likelihood of an intussusception passing up the colon than when it formed an acute or even a right angle. He did not however, attempt to account for the difference of sex by this means.

Climatic Influences.

Intussusception occurs in all climates and countries. I have no figures to shew that there is any difference in the incidence of the disease between hot and cold countries. Mr. Barker has however, told me that in Germany the surgeons seldom meet with cases of intussusceptions even in the large hospitals. The reason of this may be that breast feeding is more generally resorted to in Germany than in this country.

The seasons have all in turn been blamed for the onset of this affection, according as one or other of them predominates in the cases collected by each individual. Comparing Mr. Barker's, Dr. Dunbar's and my own cases again we have the following table.

Cases.	January	February	March	April	May	June	July	August	September	October	November	December
Dr. Dunbar	5	7	8	4	4	5	3	3	3	4	7	5
Mr. Barker	2	2	8	3	3	5	2	4	1	3	1	4
Author's	4	9	12	12	13	7	12	7	5	9	5	8
Total	11	18	28	19	20	17	17	14	9	16	13	17.

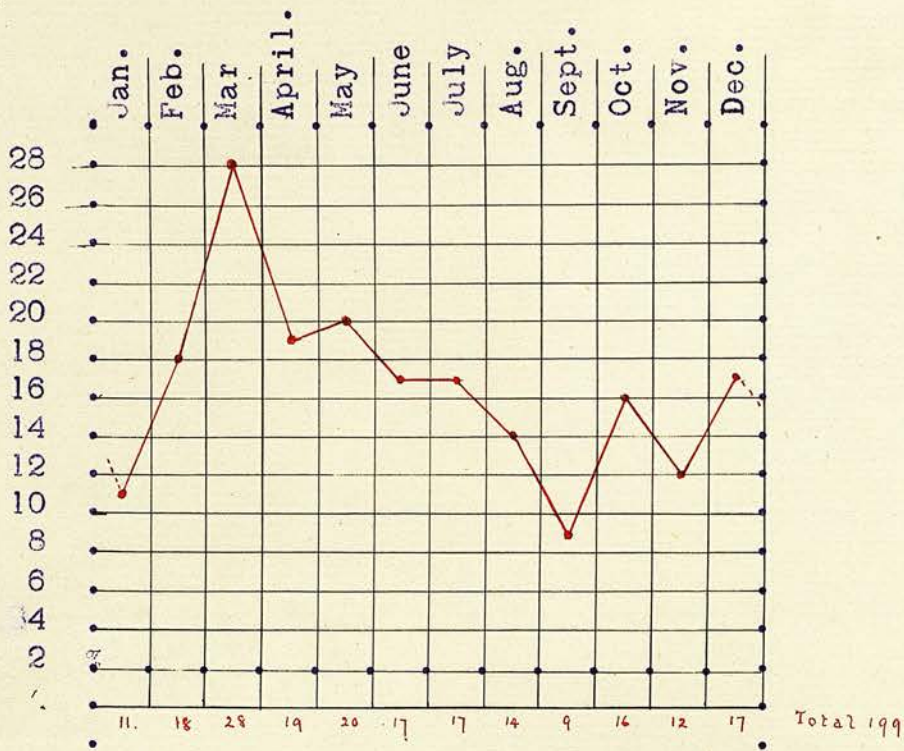


CHART SHEWING THE EFFECT OF THE SEASON.

199 cases (consecutive) from the Royal Hospital for Sick Children, Edinburgh; University College Hospital, London; and Great Ormond Street Hospital; all the cases being under 13 months.

The most noteworthy fact is the decline in the number of cases during the months of July, August, and September, when infantile diarrhoea is most prevelant.

age 7.

The curve of the total number of cases is low in January, rises to its height in March, then gradually declines till it reaches its lowest in September and finally rises slightly towards the end of the year. It is interesting to note that during the hot months July, August, and September, when gastero-intestinal troubles in infants, are at their height, the number of cases of intussusceptions steadily diminishes. This goes far to prove that serious gastero-intestinal disorders are not great predisposing or actual causes of this complaint.

No.	Sex.	Date.	Age	Duration		Stool	Tumor	Rectum	Any	Operation		Variety.	Result.	Cause and Remarks.
				w.	d.					h.	Resection				Reduction
1.	M.	Nov. 4 '69	3	12		x	x	x	0			Ileo Caecal	D. R. x x	
2.	M.	Ap. 25 '76	5	5		.	x	x	0			Ileic	x	constip. Gangrene
3.	M.	Aug. 8 '77	$\frac{5}{12}$	4		x	.	x	x	nei-ther		Ileo caecal	x	Breast fed. Gut had ruptured sheath.
4.	M.	Jan. 4 '83	$\frac{6}{12}$	2	6	x	.	.	0			Ileo caecal	x	Died before operation.
5.	F.	Sep. 18 '85	2	7		x	x	x	x	x		Not stated	x	Adhesions, septic peritonitis.
6.	F.	Aug. 18 '87	$\frac{11}{12}$	2		x	.	x	x	x		Ileo caecal	x	Died of shock. Three attacks of colic in three weeks.
7.	M.	Mar. 23 '88	$\frac{5}{12}$	6		x	x	x	x	---		Not stated	x	Gangrene. Artificial anus made below intuss.
8.	M.	June 14 '88	$\frac{6}{12}$	5		x	.	x	.	.		Not stated	x	Gangrene.
9.	M.	Oct. 12 '88	$9\frac{1}{2}$	months		.	x	.	.	.		Ileo colic	x	sarcoma. Wide spread rounded sarcoma.
10.	F.	Mar. 22 '90	$\frac{8}{12}$	13		x	.	.	.	.		Ileo caecal	x	Gangrene.
11.	M.	Ap. 8 '90	$\frac{8}{12}$	9		x	x	x	.	.		Ileo caecal	x	Sheath ruptured
12.	F.	Sep. 25 '90	$\frac{3}{12}$	1	20	x	x	x	.	.		Not stated	x	
13.	M.	Feb. 5 '91	$\frac{4}{12}$	3		x	.	.	0	.		Ileo caecal	x	died within an hour of admission, irreducible from swelling.

No.	Sex.	Date.	Age.	Duration.	Operation.						Variety.	Result.	Cause and Remarks.	
					Blood	Effusion	Rectum	Any	Resect	Resection				
			W. d. h.								D.	R.		
14.	M.	Ap. 7 '91	$\frac{10}{12}$	6	*	*	*	.	.	.	*	*	Ileo Caecal	mechels divertic. Appendix projecting from anus, irreducible from swelling.
15.	M.	July 6 '91	$\frac{7}{12}$	4	*	*	.	.	.	.	*	*	Ileo caecal	While suckling, Mechel, irreducible from swelling.
16.	M.	July 18-20 1891	..	Unstated	---	---	---	---	---	---	*	*	Ileo colic	irreducible.
17.	M.	July 24 '91	$\frac{11}{12}$	12	*	.	*	*	*	.	*	*	Ileo colic	While suckling
18.	M.	July 11 '92	12.	Unstated	---	---	---	---	---	---	*	*	Ileic	Longstanding.
19.	F.	Feb. 16 '93	$\frac{5}{12}$	2	*	*	.	.	*	.	*	*	Not stated	Manna. Manipulation, was re-admitted 14 mos. later and died from no obvious cause.
20.	M.	Feb. 23 '93	$2\frac{1}{2}$	11	*	*	.	*	*	.	*	*	Ileo caecal	Straining at stool; constipated. Reduction difficult owing to enlarged glands.
21.	F.	Mar. 1 '93	1	3	.	.	.	.	.	.	*	*	Ileo caecal	Chorea. Injections ruptured bowel.
22.	M.	Mar. 11 '93	$2\frac{3}{12}$	$1\frac{1}{2}$ years	*	*	*	*	*	*	*	*	Ileo colic	Breast fed. Barker's operation Lumen of intussusceptum size of a goose quill.
23.	M.	May 17 '93	$7\frac{1}{2}$	3 4	*	*	0	*	*	*	*	*	Enteric	Two previous attacks spontaneous cure; gut nearly sloughing.

No. Sex.	Date.	Age.	Duration.		W.	Blood.	Tumour.	Rectum.	Operation.				Variety.	Result.		Cause and Remarks.
			d.	h.					ANY	Healed	Healed	Healed		D.	R.	
24. F.	July 4 '93	$\frac{7}{12}$	2									Enteric	*	.	Died very shortly. Thought to have gastro-enteritis.	
25. M.	July 6 '94	$\frac{5}{12}$	2	6		*	*	*	*	*	*	Ileo Caecal	*	.	Died same evening.	
26. M.	Sep. 6 '94	$\frac{7}{12}$		25		*	*	.	*	*	*	Ileo Caecal	*	*	Died Sept. 13, wound burst 10th day.	
27. M.	Mar. 11 '95	$\frac{9}{12}$	1	4		*	*	.	*	*	*	Ileo caecal	*	*	Brother died of intussusception.	
28. M.	Oct. 10 '95	$\frac{8}{12}$			2	.	*	*	*	*	*	Ileo caecal	*	*	Stretched himself backwards. Mesenteric glands very enlarged; took varicella and Diptheria.	
29. M.	Dec. 17 '95	$\frac{8}{12}$	2	3		*	*	.	*	*	*	Ileo caecal	*	*		
30. F.	Feb. 11 '96	$\frac{5}{12}$		22		*	*	.	*	*	*	Ileo caecal	*	*	Bloaters. The appendix was apparently turned inside out. The caecum was opened and appendix removed. There was a history of 3 previous attacks and a brother had been operated on for it.	
31. M.	Feb. 3 '97	$\frac{5}{12}$	1			*	*	*	*	*	*	Ileo caecal	*	*		
32. M.	Feb. 27 '97	$\frac{10}{12}$	9			*	0	*	*	*	*	Ileo caecal & appendix ?	*	*		
33. M.	Ap. 26 '97	$3\frac{1}{2}$	3			*	*	.	*	*	*	Ileo caecal	*	*		

No. Sex.	Date.	Age	Duration	Blood	Fever	Rectum	Operation.			Variety.	Result.	Cause and Remarks.
							W.	d.	h.			
34. F.	June 17 '97	$\frac{5}{12}$	3	.	x	x	x	x	x	x	D. R.	Breast fed. Gangrene.
35. F.	June 17 '97	$\frac{5}{12}$	9 $\frac{1}{2}$	x	x	x	x	x	x	x	x	Ileo caecal Ileo colic
36. M.	Dec. 5 '97	3 $\frac{1}{2}$	6	x	x	x	0	0	0	x	x	Ileo colic
37. M.	Feb. 9 '98	1 $\frac{1}{3}$	3	x	x	x	x	x	x	x	x	Ileo caecal
38. M.	June 8 '98	$\frac{5}{12}$	1	x	x	x	.	.	.	x	x	Ileo caecal
39. M.	July 16 '98	$\frac{6}{12}$	12	x	.	.	.	.	.	0	x	Not stated
40. M.	Oct. 31 '98	$\frac{9}{12}$	1	x	x	x	x	x	x	x	x	Ileo caecal
41. M.	Dec. 2 '98	1 $\frac{1}{2}$	8	x	x	.	x	x	x	x	x	Ileo colic
42. F.	Ap. 9 '00	$\frac{6}{12}$	4	x	.	.	.	.	.	x	x	Ileo colic
43. M.	Ap. 4 '01	2	not stated	not stated	not stated	not stated	not stated	not stated	not stated	x	x	Enteric
44. M.	May 11 '01	11	1	.	.	.	x	x	x	x	x	Ileo caecal
45. M.	May 12 '01	$\frac{11}{12}$	5	x	.	.	0	0	0	x	x	Ileic

No. Sex.	Date.	Age. Duration		Blood	Turnout	Rectum	Any	Operation.			Variety.	Result.	Cause and Remarks.
		w.	d.					h.	Hodg	Hodg				Hodg
46. F.	May 24 '01	6	1		*	.	*	*	*	Ileo caecal	D. R. *	Biscuits.	
47. M.	May 26 '01	7	1		*	*	*	*	*	Ileo caecal	*	Very difficult to reduce.	
48. M.	July 16 '01	5	2	10	*	.	*	.	*	Ileo caecal	*	Injection burst the colon; end to end Murphy's button.	
49. F.	Nov. 26 '01	8	1	14	*	.	*	*	*	Ileo caecal	*	Bronchitis. History of previous attack.	
50. M.	Dec. 23 '01	6	1		*	*	*	*	*	Ileo caecal	*	Diarrhoea.	
51. M.	Jan. 11 '02	8	2	8	*	*	*	.	.	In valve region.	*	Artificial anus made.	
52. M.	Feb. 14 '02	7	2		.	*	*	*	*	Ileo caecal	*	Breast fed. Reduction very difficult owing to swelling.	
53. M.	Ap. 25 '02	6	9		*	.	*	*	*	Ileo caecal	*	Potatoes. Breast fed. Gut tapped and left hanging out of wound, hopeless.	
54. M.	Mar. 13 '02	8	3		*	?	*	.	.	In valve region.	*	Double. Sewn to abdominal wall and opened.	
55. F.	May 5 '02	6	5		*	*	*	.	.	Ileo caecal	*		
56. M.	May 13 '02	6	2		*	*	*	*	*	Ileo caecal	*		
57. F.	July 31 '02	10	3	12	.	.	*	.	*	Ileo caecal	*	Gut burst, end to end anast. Maunsell's method.	

Operation.

No.	Sex	Date.	Age		Duration		Blood	Tumour	Rectum	Any	Reduction	Resection	Variety	Result		Cause and Remarks.
			w.	d.	h.	D.								R.		
58.	M.	Nov. 21 '02	10	12	1	6	.	✗	.	✗	.	✗	Ileo caecal	✗	D.	wound. burst 7th day gut put back local peritonitis infarct of lung.
59.	M.	Dec. 31 '02	3	12	4		✗	✗	.	✗	✗	✗	Not stated	✗		gut ruptured during attempts at reduction.
60.	F.	Jan. 4 '03	4	12	3		✗	✗	.	✗	✗	✗	Not stated	✗		
61.	F.	Feb. 21 '03	10	12		8	✗	✗	0	✗	Reduc-	✗	Not stated	✗		
62.	M.	Mar. 30 '03	2	12	2	12	✗	✗	✗	✗	✗	✗	Ileic	✗		
63.	F.	Apr. 20 '03	5	12	2		✗	✗	✗	✗	✗	✗	Ileo caecal	✗		
64.	M.	Aug. 5 '03	5	12	5		✗	✗	.	✗	.	✗	Ileo caecal	✗		Gangrenous; end to end suture.
65.	?	Aug. 12 '03	5	12		6	✗	✗	✗	✗	✗	✗	Ileo caecal	✗		
66.	M.	Dec. 21 '03	5	12	3		✗	✗	.	✗	.	✗	Not stated	✗		
67.	F.	Dec. 22 '03	2	12	1	16	✗	.	.	.	.	.	Ileo colic?	✗		membrane found in oesophagus.
68.	F.	Dec. 25 '03	6	12	1	6	✗	.	.	✗	✗	✗	Not stated	✗		

No.	Sex.	Date.	Age.	Duration.			Bleed.	Tumour.	Rectum.	Operation.			Variety.	Result.	Cause and Remarks.
				W.	d.	h.				Any	Reang	Resec				tion
69.	M.	Jan. 23 '04	1 1/2	2	h.	*	.	.	*	.	.	Ileic	D. *	Spontaneous reduction.	
70.	F.	Mar. 31 '04	12/5	3		*	*	.	*	*	.	Ileo Caecal	*	Powder day before.	
71.	F.	May 4 '04	12/5	2		0	*	.	*	.	.	Ileo colic	*		
72.	F.	June 24 '04	12/7	1	6	*	*	.	*	*	.	Ileo caecal	*		
73.	F.	Aug. 12 '04	12/3	not stated	--	*	--	*	*	*	.	Colic	*		
74.	M.	Oct. 5 '04	12	4		*	.	.	*	.	.	Ileo caecal	*	Constipated. Gut already burst.	
75.	F.	Oct. 29 '04	12/6	not stated	*	*	*	.	*	*	.	Ileo caecal	*	See case 77.	
76.	M.	Nov. 30 '04	1 1/4	1	6	*	*	.	*	*	.	Ileo colic	*	Deep layers of wound gave way.	
77.	F.	Ap. 8 '05	11/12	not stated	---	*	---	*	*	*	.	Not stated	*	bond of adhesion same as 75	
78.	F.	Ap. 25 '05	12/9	2		not stated	---	*	*	*	.	Not stated	*	gangrene.	
79.	M.	May 13 '05	8/12	1	22	*	*	.	*	0	*	Ileic	*	gut burst in two places during attempts at reduction.	
80.	M.	May 15 '05	11/12	2	8	*	*	.	*	*	.	Ileo caecal	*	Crust.	

No. Sex.	Date.	Age.	Duration.	Operation.				Variety.	Result.	Cause and Remarks.
				Blood	Tumors	Hectm.	ANY			
81. M.	May 29 '05	$\frac{4}{12}$	w. d. h. $10\frac{1}{2}$	*	*	.	*	Ileo caecal	D. R. *	Breast fed. Wound burst 10th day and swab then sewn up in abdomen.
82. M.	July 6 '05	$\frac{6}{12}$	1	*	*	.	*	Ileo caecal	*	Breast fed. Bronchitis.
83. M.	July 27 '05	$\frac{7}{12}$	4	*	*	*	*	Ileo caecal	*	Neprotic dimple.
84. M.	Aug. 4 '05	$\frac{2}{3}$ $\frac{12}{12}$	1 6	.	*	.	*	Ileo caecal	*	Constipation. Spontaneous reduction.
85. M.	Sep. 4 '05	$\frac{10}{12}$	1 2	*	*	.	*	Enteric	*	Spontaneous reduction; twice explored.
86. F.	Sep. 5 '05	$\frac{11}{12}$	not stat- ed.	*	*	.	*	Ileo caecal	*	Toxaemia.
87. M.	Oct. 5 '05	$\frac{1}{12}$	1 *	*	.	*	*	Ileo caecal	*	Diarrhoea.
88. M.	Oct. 27 '05	$\frac{9}{12}$	14	*	*	*	*	Ileic	*	Had 2 previous attacks cured by air and water injections, see later.
89. F.	Nov. 13 '05	$\frac{3}{12}$	6	*	*	.	*	Ileo caecal	*	Breast fed. Gangrene torn in two places. Paul's tube tied in.
90. F.	Dec. 18 '05	1	6	.	*	*	*	Ileo colic	*	Breast fed.

No. Sex.	Date.	Age.	Duration.		Blood.	Tumour.	Rectum.	Operation.			Variety.	Result.	Cause and Remarks.
			w. d.	h.				Any	Reduction.	Resection.			
91. M.	Ap. 17 '06	$\frac{1}{2}$ 12	.	14 $\frac{1}{2}$	*	*	.	*	*	Ileic	D. R. *	Same as 88. There had been another attack cured spontaneously in Feb. mesentery stitched.	
92. M.	May 29 '06	$\frac{8}{12}$	1.	6	*	*	*	*	*	Ileocolic	*	Double. On June 2 wound burst and gut escaped but was replaced.	
93. F.	June 4 '06	$\frac{11}{12}$	5		*	*	*	*	*	Ileocolic	*	Breast fed.	
94. F.	July 2 '06	$\frac{2}{12}$	1	7	*	*	*	*	*	Ileocaecal	*	History of an attack 3 weeks previously.	
95. M.	Aug. 29 '06	$\frac{5}{12}$	20		*	*	*	*	*	Ileocolic	*	Breast fed.	
96. F.	Dec. 30 '06	$\frac{4}{12}$	1	6	*	*	.	*	*	Ileocolic	*	Wound burst Nov. 4. Re-opened lateral anast. done.	
97. F.	May 21 '06	$\frac{5}{12}$	23		*	*	0	*	*	Enteric Ileic	*	Breast fed. Enteric recurred next day; again reduced.	
98. F.	Oct. 30 '06	$\frac{6}{12}$	3		*	*	*	*	*	Ileocaecal	*	Diarrhoea. Died during operation.	
99. M.	Mar. '07	$\frac{5}{12}$	20		*	*	0	*	*	Ileocaecal	*	Bowels troublesome. Wound burst 7th day.	
100. F.	Mar. '07	$\frac{2}{12}$	6		*	*	0	*	*	Ileic	*	2 feet resected.	

No.	Sex	Date.	Age.	Duration.	Operation.				Variety.	Result.	Cause and Remarks.
					Blood.	Tumour.	Rectum.	Any				Reduction.	Resection.
101.	M.	Mar. 11 '07	7	w. d. h. 12 20	✕	✕	✕	✕	Ileo caecal	D. R. ✕	Grey Powder.
102.	M.	Ap. 2 '07	6	12 4	✕	✕	0	✕	Ileo caecal	✕	Abdomen opened a second time and tubes tied in.
103.	M.	Mar. 24 '07	5	12 2	✕	✕	✕	✕	Ileo caecal	✕	Gangrenous.

EXCITING CAUSES.

Exact statistics of the number of cases in which an exciting cause can be assigned, are very difficult to obtain.

The child is so often brought to the hospital in a very serious condition. The house surgeon elicits the main points of the history, examines the child and finds the tumour. Interest in the smaller dietetic details is then lost in the hurry to remedy the condition as soon as possible. And when the notes come to be written up afterwards the mother is not at hand to be questioned. For this reason the food of the child or its occupation immediately before the onset, seldom find a place in the notes.

Out of 103 cases, a cause could be assigned on 34 occasions, and in some of these the cause was evidently fanciful. In 69 nothing was known to account for the onset.

No cause assigned	69
Improper feeding (including steak, bloaters, fruit, crusts) or change of diet from breast to patent foods)	9
Constipation, straining or medicines given	8
Diarrhoea	8
Enlarged glands (found p.m.)	3

A strain or injury	1
Mesenteric band	1
Bronchitis, Chorea, Diphtheria (each 1)	3
Tumours (Sarcoma)	1
	<hr/>
	34.
	<hr/>

Out of these 69 which could not be accounted for, 57 were under 13 months old, at least 18 were fed exclusively on the breast, and many more, perhaps the majority were fed on the breast with the addition of patent foods. Nearly all the children were thriving well. It is noteworthy that acute intussusception rarely attacks spare thin children. Wiederhofer asserts that most cases of intussusception are met with in perfectly healthy children. The accounts of my cases fully confirm this assertion.

We have seen what a huge proportion of intussusceptions are met with in children under 13 months old, and that of these, twice as many occur in the first as in the second 6 months of life.

Now the proportion of children who are breast fed must be far larger in the first than in the second six months.

Therefore we can argue that in the majority of cases it is not really bad feeding which has caused the onset. We must then look at the condition of the gut and consider its anatomical arrangements and relationships and enquire into these and the physiology of its nervous mechanism to see if we can account for the determination of the disease.

The anatomical considerations have already been dealt with, page 69 . The physiological considerations remain.

The Physiology of the intestinal movements.

Lying between the two layers of muscle which are found in the intestinal wall, is the nerve plexus of Auerbach, composed of non medullated strands which cross each other. At the point of crossing are nerve cell stations acting as nerve ganglia. From the ganglia of this plexus fine fibres pass inwards to the submucous coat where lies the plexus of Meisener. This plexus controls the movements of the villi.

The movements of the intestine are of two kinds.

In the first place, if seen in a warm saline bath the gut displays a constant swaying or waving motion, which travels rapidly down the intestine. This movement is myogenic, i.e. it is due to the rhythmic nature of the muscle cells, and is passed on from one cell to another.

The movement has no action on the onward passage of food.

The second form of motion is the true peristaltic waves which pass down the intestine in a slow manner, the portion of gut below that which is in contraction being always in a relaxed condition. It is these waves which pass on the intestinal contents. This action therefore is a co-ordinated one involving contraction at one spot and relaxation at the point immediately below .

The movement is abolished by painting the intestine with nicotine, as the ganglion cells are thereby paralysed. The swaying movement however continues. The peristaltic waves are therefore true co-ordinated movements and are presided over by the local nervous mechanism in the gut wall and not controlled by the central nervous system. They continue when all nerves are cut.

In addition to these movements, strong local contractions occur at irregular intervals for the

purpose of segmenting up the food.

If we consider the ordinary nervous mechanism of an infant we find that for all co-ordinated actions its control is very imperfect. Sucking and swallowing seem to be the only two actions of the newly born. All the rest are gradually acquired through a process of education. The bladder and rectum are quite out of control. The ease with which the stomach ejects its contents is familiar to all.

Gradually the nervous system becomes educated to the control and management of these functions. But if in the infant, there is imperfection in actions which ultimately become perfectly co-ordinated, how much more imperfection is to be expected in the nervous control of the muscular action of the intestinal tract which, even in the adult, is never really under the management of the central nervous system.

The movement of the intestinal canal is the only example in the body of reflex action in which the central nervous system does not participate. The action is governed by the plexuses of Auerbach and Meisener, situated in the intestinal canal (Starling, Elements of Human Physiology, p.363).

Up till the time of birth there is little or no action in the intestinal walls. There is no call for it. After birth the intestine has to undertake the double function of absorbing the nutriment for the system and of passing on the indigested residue and excreta. That the latter function is but poorly carried out is evinced by the condition of constipation as commonly met with in breast fed babes and by the ease with which diarrhoea is set up. May not the want of control in co-ordination of the intestinal peristalsis be a great factor in the production of intussusception? I think it is. I say factor, because it can only be partly the cause. If it were the only cause it is obvious that the younger the child, the less perfect the in-co-ordination, and the more frequent would be the invaginations. It is true that more occur in the first than in the 2nd. six months of life, but invaginations before the third month are rare. In the first three months it may be that the in-coordination is so great that invagination to any extent does not take place, or if it does the same want of co-ordination prevents its growth and brings about its dissolution. Many observers have remarked on the possibility of small transient intussusceptions

being the cause of the temporary attacks of screaming, struggling and straining in small infants. These attacks, when the child holds its breath and becomes cyanosed are the "internal convulsions" so familiar to mothers. If this is really the cause, the term is not inappropriate. That intussusceptions do form and dissolve naturally is proved by some of the cases in this thesis.

Most of the cases of intussusceptions under one year seem to occur between the 4th and the 7th month. This may be accounted for by the fact that this time corresponds to the period when the mothers are beginning to augment the food the intestine is used to, either the breast or some prepared milk, by bread, biscuits, crusts, or by more out-of-the-way articles of diet. The co-ordination which we may suppose has been educated to deal with the child's ordinary food is now upset by these strange substances. Although this change of diet is rarely thought worth mentioning as the cause of the disorder, it may quite well account for the onset of many of the cases in which no cause is assigned.

See Chart.
p. 99.

2. Improper feeding or change of diet was assigned as the cause in 8 cases. Substances like steak, bloaters, apples, and other indigestible materials are more than enough to upset the coordination when

given to infants.

3. Constipation etc. In only 6 cases was constipation mentioned as a possible cause of the trouble, not a very high figure when the members of constipated children are brought to mind. In one case the symptoms came on suddenly when the child was actually straining at stool (Case 20). In two cases the symptoms came on soon after the giving of medicinal substances for the relief of constipation.

It is quite conceivable that an impacted scybalous mass might initiate the invagination.

4. Diarrhoea and enteritis only claims to be the cause of 8, but I think this number is rather below the average. In looking through the literature the impression given is that in children looseness of the bowels preceded the symptoms more often than in 8% (See Lancet Vol. 1, 1876 p.12, Path.Soc.trans. vol.viii, p.177; St.Bart's Hosp. Reporter 1876 p.95).

But the figure can not be a very high one as the numbers of cases diminish during the months of July, August, September the time when infantile diarrhoea is rampant. It is possible that the diarrhoea which is sometimes given as a cause may really have been an early effect of increased peristalsis, which caused first the diarrhoea, and

afterwards the intussusception.

5. Enlarged glands seem to have been the primary cause of the invagination in two and possibly in 3 cases. If the glands situated close to the mesenteric attachment enlarge they may press inwards the adjacent wall of the gut and thus start an intussusception. See Plate IV and XIV

6. Injuries have often a definite association with the onset of intussusception. This association is more often met with in adults, who can give an account of their injuries. Scarpa (Traite. Pratique des Herniae, p.443) records the case of an adult aged 40, who while drunk was knocked down by a cab, the wheels of which passed over his abdomen between the umbilicus and the pulvis. Great abdominal pain accompanied by all the symptoms of intussusception ensued. On the 16th day, 4" of ileum with the mesentery attached were passed per rectum. Case 1 of Dr. William Thompson's series (Ed.Med. and Surg.Journal Vol.44, p.296) is a good example of the same thing where a soldier shewed signs of intussusception immediately after receiving severe blows in the abdomen. He also recovered after passing a quantity of gut per anum.

It is not difficult to understand how an atonic and partially paralysed piece of gut after an injury might get swallowed by an active neighbouring piece.

Hernia, Cholera, and enteric fever may cause such injury to the bowel wall as to give rise to intussusception.

It is so easy to see the connection between the onset of the symptoms and exertion of an ordinary nature, yet such is often the cause ascribed. The symptoms have developed suddenly while children have been jumped in someone's arms¹. In babes such exercise is often followed by rejection of the stomach contents.

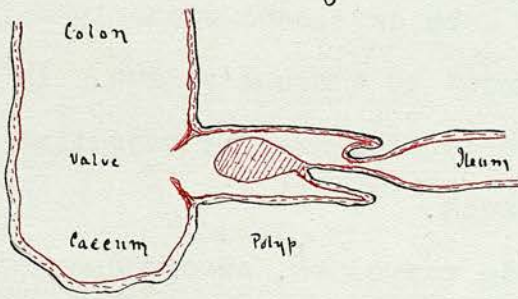
Gymnastic exercises², severe and sudden muscular strains³, and even fits of whooping cough⁴ have been blamed for the onset of the symptoms. In many of these cases it is probable that the exercise was merely coincident as in case 71 where the twist which was supposed to cause the trouble preceded by many hours the onset of any symptoms.

7. Mesenteric Bands though not necessarily injuring the gut wall may so interfere with the intestinal movements as to be the cause of the intussusception.

¹(Traite Clinique et prat. des Mal. des Enfants, 1861 t.1, p.806. 'Lancet, Vol.1, 1877, p.273. New York Med. Record, 1896 p.73)

²(Lancet, Vol.1, 1893 p.651. ³Lancet Vol.11, 1888, p.315. Trans. Clin. Soc. 1889 p.282)

Fig 34



Intestinal Polyp causing
invagination

A good example of such an instance is case 77, where the band causing the intussusception was an ~~appendix~~ ^{appendix Epiploica} ~~epithelium~~ which had become adherent after an operation, which had been performed 6 months previously to relieve an acute intussusception. Joseph Bell (Ed. Med. Journal p.53, 1882) reported a similar case.

8. Of the three diseases Bronchitis, Chorea, Diphtheria, to each of which the cause of one intussusception is assigned, the bronchitis and the Diphtheria were concurrent and I think nothing more. The chorea certainly improved before the onset of the symptoms, but the nervous instability may have had something to do with the muscular incoordination of the intestine, as well as with the movements of the limbs.

9. Tumours when small and projecting from the wall of the gut in the form of polypi are liable to be grasped by the intestinal peristalsis and the gut wall to which the pedicle is attached becomes the starting point of an invagination. Such tumours when present are a common cause of invagination. They may occur in any part of the intestine, and

PLATE. XIV.



Ileo - caecal intussusception associated with a sarcomatous growth. To shew the great enlargement of the glands in the neighbourhood. Part of the intussusception has not been shewn, only the apex has been drawn, the stick passed through the valve.

(Case 9)

are most frequently met with in the lower ileum. They may be single or multiple as many as 30 have been counted in one individual the largest being associated with an intussusception. They have been the cause of 3 separate intussusceptions simultaneously. (Homolle) In some cases a polyp has been present but the intussusception has occurred independently either above¹ or below² its attachment. 3. A subserous lipoma has been known to start the invagination.

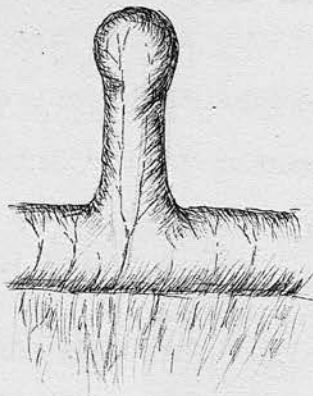
Tumours of a more serious nature are not so frequently the cause of intussusceptions on account of the early rigidity imparted to the intestinal wall. After adhesions form, invagination of the growth becomes almost impossible. Case 9 seemed to have been caused by a round celled sarcoma. An intussusception preserved in the museum of St. George's Hospital from a child ⁵/12, was caused by a similar growth. Treves mentions having removed segment of bowel containing a small chronic intussusception associated with a lympho sarcomatous growth of the bowel. (Loc. cit. p.184) The two last mentioned were both Ileo caecal in type. Instances of carcinomatous growths being the cause of intussusception are hardly to be expected in children, but many have been reported in adults. Bryant recorded 3 (Med. Chir. trans. 1894 p.169) cases. Mayo Robson

1. (Hewett Path. Soc. trans. Vol.1 p.95)

2. (Lockwood, Ibid. 1892, p.74)

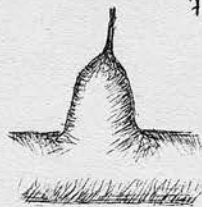
3 Ballotta. Ippocratico Jano. 1869, 3. S., XV, 145.

Fig. 35



Different Types of
Meckel's Diverticulum.

Fig. 36



(B.M.J.Vol.11, 1895. p.963) and Symonds (B.M.J. Vol.1, 1895 p.638) have each reported cases.

10. A Meckel's Diverticulum has been known on several occasions to have been the starting point of the invagination. The percentage of bodies in which these embryonic remains are found is very difficult to ascertain, as many pass unnoticed at the post mortem examination and many more probably escape mention in the notes. I examined the post mortem Records of 5500 children under 12 years of age in the Hospital for Sick Children, Great Ormond Street, and only found 33 Meckel's diverticuli.

The result of the analysis of the cases was as follows. Males 24, Females 9. This difference in the sexes seems to be too marked to be accidental. The average distance above the valve calculated from the 26 cases in which it was measured, was 29 ins. the furthest was 53 and the nearest was 12. Only one was attached to the umbilicus, and that was patent and discharging faeces. Two had internal attachments, one from tubercular peritonitis and the other for no obvious cause. Both these caused death by strangulating a loop of gut. Twenty eight were unattached, and in four of these terminal cord like projections were described, in one the communication with the bowel was merely capillary



PLATE. XV.

An inverted Meckel's Diverticulum.
It was found post mortem and had given
rise to no symptoms during life.

and the contents were a clear greenish fluid. In one there was no opening even into the intestine and it contained white pultacious material. The correctness of counting this last as a Mechel and not as a ^rdemoid is queried in the notes. Two of the unattached diverticuli were associated with intussusceptions of the ileo caecal valve. These two diverticuli were situated each about 30 inches above the valve and to neither could the cause of the disorder be fairly ascribed. A Mechel's diverticulum has been known to become inverted and project into the bowel and so become the starting point of an invagination. Specimens No. 1819 in Guy's Hospital Museum and No. 2718A in the R.C.S. Museum are examples of such conditions. Adams (Path.Soc. Trans.1892 p.75) reported the case of a male, aged 42, taken ill April 27, recovered. Again taken ill on May 18 and died on June 9 - peritonitis and intestinal obstruction. An inverted Mechel 8" from the ileo caecal valve caused an ileo colic intussusception. The diverticulum was turned inside out.

11. Undigested Masses of food and Foreign bodies. We have already dealt with the possibility of intussusceptions being caused in young infants by the giving of unaccustomed articles of diet, we deal

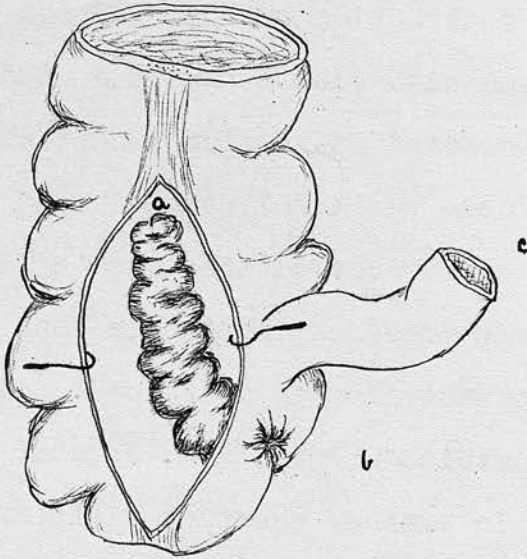
here with masses of unsuitable or undigested food actually found in the neighbourhood of the intussusception either at the operation or on post mortem examination. Gay reported a case where the ileocaecal valve was blocked by a mass of undigested rice (On intestinal obstruction by invagination London 1862) Baur and also Dubois reported masses of cherry stones associated with intussusceptions. Le Moyne mentions a case where undigested beans, and Treves where a mass of chewed nuts were apparently the cause. A large piece of tendon has been known to cause intussusception in an animal. The case of the "Human Ostrich" (Brit. Med. Journal Vol.1, 1894, p.963) is another example. This man swallowed all sorts of articles to gain a livelihood and eventually died of perforative ^{peritonitis} appendicitis. A sharp hook he had swallowed had dragged in the bowel wall and so formed an intussusception.

I know of no such causes reported in children. Hughes (Guy's Hospital Reports 1856, 11.59) reported an intussusception associated with lumbrici.

12. Appendix. It is possible though rare for invagination to take place primarily in the appendix. When this organ is turned inside out and lies in the lumen of the caecum and colon, ~~that~~ it will act

M^r. Pitto's Case

Fig 37



Caecum laid open on its inner side ..

a. apex of invaginated appendix.

b. Depression at root of appendix.

c. Lower ileum.

Drawn from a paper sent me very kindly
by M^r. Pitto.

like a polypus and so cause invagination of the adjacent portion of bowel.

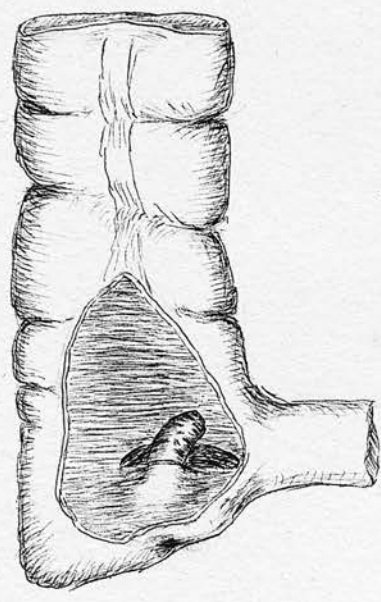
1. The best published example of this condition is Mr. Pitt's case (Lancet June 12.97) a Female, $2\frac{1}{2}$ years, suffered for $3\frac{1}{2}$ months from the classic symptoms of chronic intussusception. The condition was however unrecognised till the gut was protruding 4" beyond the anus. A Doctor replaced the bowel and kneaded the abdomen, when suddenly with a gurgling sensation the tumour entirely disappeared. Four days later the pain returned and the symptoms continued for 11 days, gradually becoming worse. Recurrence was diagnosed and the abdomen opened. Caseous glands the size of cob nuts were found adherent to the mesentery. An intussusception was reduced with ease, but no appendix was found. A dimple into which the meso-appendix disappeared indicated its base, while the organ itself was felt inside the caecum. The caecum was opened and the appendix removed, and the gut closed. Complete recovery ensued.

The other cases reported up to date are:

1. McKidd (Ed. Med. Journal 1859) Plate XVI

A male 7 years, used to pass worms, and after intermittent pain for a month died. At the post

D. M. Kidd's Case.



Represents the parts in situ
seen through an artificial
opening in the intestinal wall.

The invagination has been
pushed through the
artificial opening, + the
valve brought into view.



mortem examination a lump was found in the caecum, no trace of an appendix seen, but it was found inside the caecum lying free upwards and inwards across the valve. The base was $2\frac{1}{2}$ " in circumference length 2" twisted into a spiral, and partially gangrenous.

2. Waterhouse (Path. Trans. 1898 p.108)

A girl 4 years suffered from intussusception. Manipulation under Chloroform, caused the tumour to disappear only to return 5 days later. The abdomen was opened and an intussusception found 4 ft. above the Ileo-caecal valve, this was easily reduced. Another was however present in the region of the caecum. The appendix was partially gangrenous and in trying to reduce it the caecum ruptured. The caecum was excised, death followed. The appendix could not be reduced even outside the body.

3. Rolleston (Ed. Med. Journal 1898)

Male 32, died from a perforated gastric ulcer. At the post mortem examination the mucous membrane of the base of the appendix was found prolapsed into the caecum. This was caused by a hard faecal mass which was endeavouring to escape from the lumen of the appendix. It is conceivable that this in a further stage might have caused invagination of the whole appendix or the adjacent wall of the

large intestine.

4. Greig Smith (abdominal Surgery Vol.11 p.678) states "In one of my fatal cases the appendix was intussuscepted into the caecum, and this, after death, was found unreduced." The reduction had only been attempted by injections.

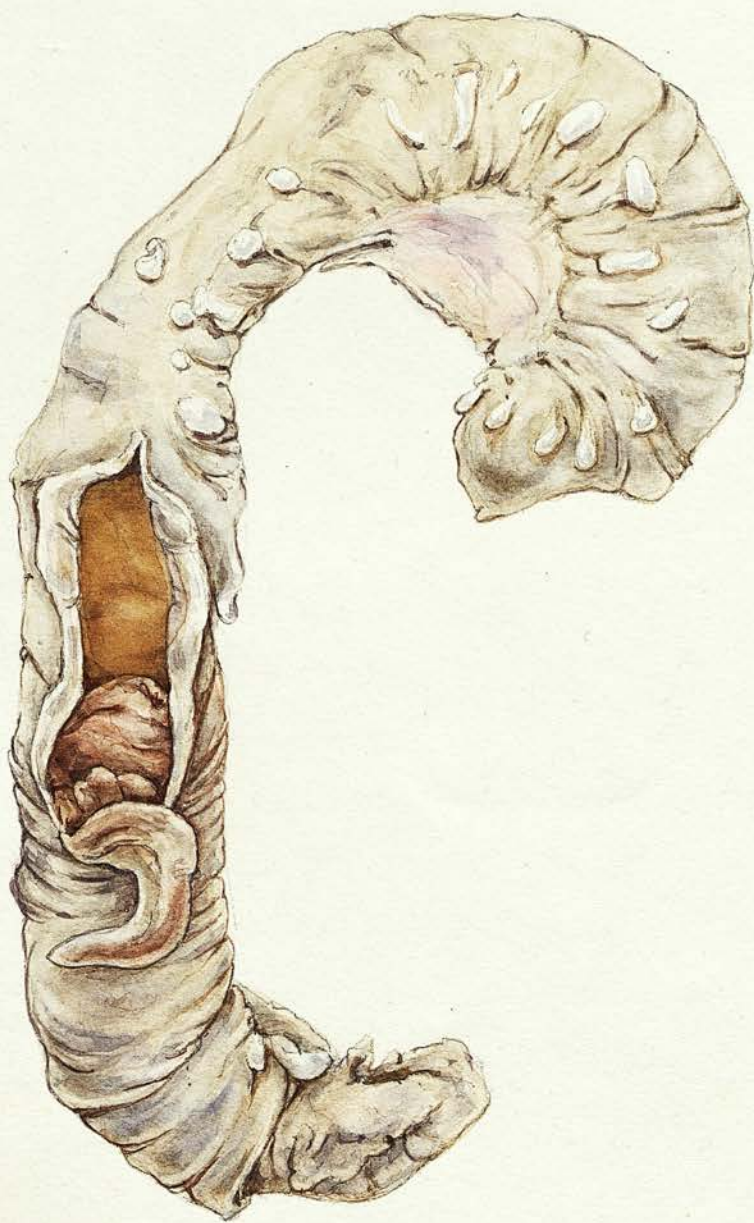
5. Treves (Intestinal Obstruction p.181)

Girl 12 years, Chronic intussusception. "Being convinced that the mass projecting into the caecum after reduction of the ileo caecal invagination was a tumour, I excised the swelling. It proved on examination to be an enormously thickened appendix. It measured 2" on its long axis and its transverse diameter, as measured after section, was $1\frac{1}{4}$ ".

6. McGraw (B. M. J. ^{1897.} Vol.11, p.956)

Male aged 7 years, took cholera in June; got well but was subsequently liable to great abdominal pain lasting several hours for which as much as $\frac{3}{4}$ grains of morphia had to be given. The condition got worse and on October 27, the abdomen was opened and a freely moveable caecum withdrawn. The appendix and half the caecum were invaginated into the rest. The thick invaginated part was excised with a good result.

PLATE XVIII



The appendix is inverted and turned inside out.

7. Wright and Renshaw (B. M. J. 1897, Vol.1 p.1470)

Male 2¹⁰/12 with a years history of diarrhoea alternating with constipation. On December 5th diarrhoea, on December 7 pain began and tumour felt, spasms and colic. January 7 operation. The tumour was thickened caecum to which the ileum and appendix were matted. The base of the appendix was pushed inwards carrying with it the caecal wall "forming a depression about the size of the first joint of an adult index finger, from which the appendix sprang like the stalk of a mushroom". The lumen of the intussuscepted part was obliterated. The child recovered.

8. Chaffey, quoted by McGraw, see above. (The references I have are the Lancet 1888 and 1887, but I could not find the case).

Child 3 years. An intussusception was supposed to have been reduced by manipulation, but recurred and death followed. At the post mortem examination evidences of chronic inflammation were found "with the place of the caecum occupied by a rounded tumour about 3" by 2" composed of the caecum partly invaginated into itself along with the ileo caecal valve.

9 and 10. In two cases here reported the appendix projected beyond the anus in one, having ruptured

Fig 38

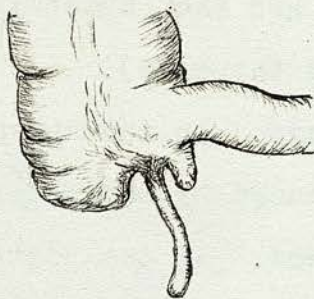
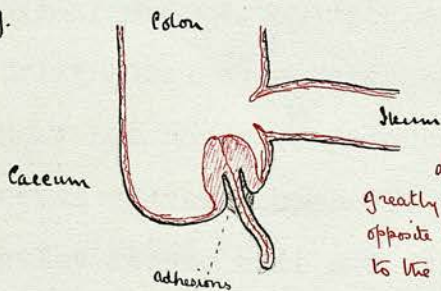


Fig 39.



after spontaneous reduction of an ileo-caecal invagination
greatly thickened submucous tissue
opposite the dimple, which corresponds
to the base of the appendix.

Possible Explanation of McEraw's Case.
(Cholera?)

through the caecal wall into the lumen of the gut. It did not however appear to have been the primary cause of the intussusception. In the other case the appendix was turned inside out and was possibly the cause of the trouble.

No case has been published in which the cause of the appendix being turned inside out has been satisfactorily explained. Rolleston's case is the nearest we have to one. A concretion at the entrance might cause prolapse of the mucous membra^{ne} and start the movement. In the cases in which the appendix was not turned inside out I have another explanation to offer. In these the intestinal symptoms are of some standing. It is quite possible that an ileo-caecal intussusception started and became reduced spontaneously. If now the dimple in the caecum corresponded to the attachment of the base of the appendix, adhesion would easily form and so fix the base in a slightly prolapsed position in the caecal wall. This might at any time start an intussusception which however would now be primarily caecal and not appendicular.

SECTION V.

Symptoms.	Page	136.
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Diagnosis	"	150.
Differential Diagnosis.	"	152.

ILLUSTRATIONS.

Diagram 40.

Symptoms!

S Y M P T O M S.

There is perhaps no disease which has more pronounced symptoms than acute intussusception in an infant. In older children, in adults and in chronic cases, the symptoms may present a wide range both of variety and intensity. In acute intussusception in infants the symptoms are characteristic in their insistance and can neither be overlooked nor quelled.

1. The History is nearly always that of an extremely healthy child. One may almost state the paradox that acute intussusception is a disease which attacks fat healthy children. Up till comparatively lately this has not been generally recognised as mention has always been made of the one or two cases in a series in which stomach troubles have preceded the sudden onset. Stress has been laid on these occasional symptoms in the hope of finding therein a cause for the malady. It is remarkable with what unanimity the notes in my cases describe the infant as "fat and well nourished". The weights of the bodies going to the post mortem room also bear out this statement.

In a considerable number of cases a vague

Sympt. 2.

malaise immediately preceding the onset is remembered by the mother when questioned closely. The disease sometimes ensues after severe intestinal disorders such as Cholera, typhoid, strangulated hernia recently reduced, and other conditions in which one would expect the intestinal movements to be irregular. Occasionally there is a clear history of strains, jerks, or slight or severe injury.

The onset is usually very sudden.

2. Pain and Screaming. The child for no apparent reason suddenly begins to scream with pain and draw up its legs. This in the majority of instances, enables the exact duration of the disease to be ascertained.

The onset seems to bear no relation to the time of day or the taking of food. The mother often states that the child suddenly wakes screaming when immediately before it had been sleeping peacefully.

It is very rare for the pain to be preceded by any of the other symptoms. The pain after a short while tends to assume a rhythmic character. Between the paroxysms the child may enjoy a considerable amount of comfort, only to be again taken

Dr. Prof. J.

after a very variable interval with what must be, if we judge by the screaming and behaviour of the child, the most acute agony. In chronic cases and in adults where some of the chief symptoms are absent, pain is the one that seems to be most constant. During the paroxysms the baby rolls about and alternately stretches itself and draws its thighs up over its abdomen and kicks violently. Older children will besides, press their hands over the stomach in the region of the umbilicus or throw themselves prone upon the floor.

A better clinical word-picture of the sufferings endured could, I think, scarcely be given than is found in the Doctor's letter describing the symptoms of Case 1. In this case the pain was attributed to chronic lead poisoning.

3. Vomiting rapidly succeeds the onset of pain, indeed in very young babies the vomiting may commence in the very first screaming bout.

In children of this age once vomiting starts it never again passes off. Food may be taken with comfort to begin with between the attacks of pain. Mothers frequently feed the child in order to soothe it, but the stomach rejects its contents with the return of the spasms. Later on the stomach becomes

Sym. 4.

able to tolerate nothing and the child refuses to take food.

In older children the same thing occurs in acute cases. In chronic cases, the symptoms are those of temporary incarceration rather than strangulation. Every few days attacks of pain, vomiting, and discharge of blood occur. These attacks may last for only a few hours or several days, and then pass off completely or in part. As a rule there are occasional colicky pains and vomiting is always liable to occur. Knowing this one child used to bolt his food with voracity in order to get it down between the attacks of pain. Any one of these attacks of incarceration are of course liable to pass into acute strangulation, and then the ordinary vomiting so characteristic of obstruction is met with. As the vomiting continues it gradually becomes yellowish from bile staining, and towards the end may become very offensive as the contents of the small intestine are evacuated. The exact definition of faecal vomiting is hard to give and I hesitate to say that young children or infants have faecal vomiting. But the mothers on being questioned often state that the vomit was yellowish with stringy mucus and smelt like the child's stools.

Symph. 5.

In comparatively few cases have I been able to detect a faecal odour about the vomit.

Blood Stained Evacuations are present in the vast majority of cases. They are mentioned as occurring in about 80% of my cases and in many, in which no mention of a bloody discharge was made, the notes were absent or only very imperfectly taken. If careful statistics are made a discharge of blood from the anus would, I believe, be found in over 90% of all cases in children.

The appearance of the blood varies from within half an hour of the onset of the symptoms in acute cases to days and in chronic cases to weeks after the commencement of the disease. Bearing in mind that the escape of blood is due to strangulation and congestion caused by the growth of the intussusception, it is obvious why the discharge of blood is seldom, if ever, the first symptom noted.

In ileo-caecal forms where there is little strangulation, the intestine may even appear at the anus without sufficient congestion to cause effusion of blood. In such cases, however, there is nearly always great tenesmus and straining and a free discharge of mucus from the fruitless efforts of

Sympt. 6.

the large intestine to rid itself of its contents.

In many cases where no blood has actually been seen to pass, the finger, after rectal examination, will be found blood stained.

If we are to believe the mothers, as much as a teacupfull can be passed at a time by a baby of about 6 months old.

In the majority of cases obstruction is absolute and no faecal matter passes after the first discharge of blood. With the first discharge of mucus and blood some faecal material is often mixed. This comes from the bowel below the intussusception which is early evacuated during the tenesmus. So constant is obstruction, that one is very apt to be misled if the bowels act well. Case 1 is an example of this. Case 80 came under my own observation, here after palpating the abdomen and feeling a lump under the edge of the liver, such a quantity of faeces was passed that although the child was then on the operating table, it was decided to wait events. As no improvement occurred the operation took place later. The passage of faeces may have been due to my palpation or to the fact that a discharge of blood had taken place shortly before

Synch. 7.

and that may have relieved the congestion and reopened the lumen of the inner tube.

P H Y S I C A L S I G N S.

As the child's chance of recovery so largely depends on the early recognition of the disease the physical examination of a child which presents any of the symptoms of intussusception, can not be too carefully carried out. The hope of recovery diminishes with the hours that pass before reduction takes place.

The general condition of the child will vary with the time that has elapsed since the onset.

Early in the case, say in the first 12 hours, the general condition is good, its strength but little diminished, and it cries loudly and kicks and rolls about vigorously during the pains. Later on it becomes exhausted, lies in a collapsed and apathetic state, and the face rapidly assumes an abdominal look.

The face becomes pale and waxy, the eyes are expressionless, sunken, hollow and surrounded by dark rings. The lips are pale and usually open and the mouth has a drawn expression. In infants under one year the fontanelle is depressed as in all collapsed conditions.

My. Spas. 2.

The state of apathy is liable to deceive one unless the abdominal look of the child is marked.

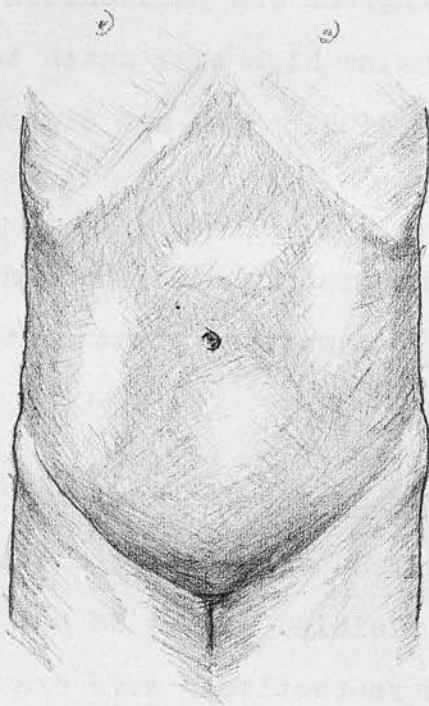
The respirations may be slightly hurried and the pulse quicker than normal. The temperature early in the cases is seldom raised and may even be subnormal until gangrene and peritonitis sets in when it rises and remains high till death takes place. The chief physical signs are of course found in the abdomen.

The abdomen is moderately distended and moves as a rule freely on respiration, great distension is rare.

In spare children of 7 or 8 years and upwards and adults, with thin abdominal walls a distinct tumour is sometimes visible. Cases 36 and 64, aged $3\frac{1}{4}$ and $9\frac{1}{2}$ years respectively were examples of this. In infants the disease seems to affect the plump and well nourished and with the exception on one case I have never seen a tumour.

Palpation must be conducted with extreme gentleness as it is liable to start the pains. The whole abdomen should be carefully examined, special attention being paid to the right Iliac fossa, the two flanks, and the region below the lower margin of

Fig 40



To show the 4 common situations
at which the tumour is palpable.

July 3

the liver. In infants and children under 12 years a tumour is in nearly every case to be felt if a careful examination is made. This is not however the case in adults where the recesses of the abdominal cavity are not ~~as~~^{so} accessible. Thus Leichtenstern only met with it 222 times in 433 cases of all ages. In only 13 of my cases was it definitely stated that no tumour was felt, and of these the gut protruded from the rectum in 3 cases. In the majority of the others peritonitis had rendered the abdominal wall too rigid for palpation to reveal anything. In 15 cases no mention of a tumour was made. Of these the apex protruded from or could be felt at the rectum in 7. Of the remaining 8 no notes were found of the examination in 4. In 70% of my cases the presence of a tumour was noted. The position of the tumour was as follows:-

Right side	16 occasions.
Middle	13 occasions.
Passing transversely across	7 "
Left side	31 "
Merely mentioned	3 "

This gives its appearance nearly twice as frequently on the left than on the right side, while those situated about the middle, were in the majority of cases above the level of the umbilicus. The character of the tumour is of some importance; it is

Fig. 4.

firm, often freely moveable, and may be made to disappear under the liver when situated above the umbilicus. Its shape is characteristic as it is longer than it is broad, and slightly curved upon itself. Sometimes it forms a complete circular turn like a snail-shell. See self. [^] Its shape in fat children is best appreciated Plates

by palpating with the flat of the hand. Usually the tumour is slightly bent on itself with the concavity towards the centre of the abdomen. The commonly used simile of "sausage-shaped" is a very apt description. If the hand be kept on it for some minutes it can often be felt to harden perceptibly and at the same time the child may give evidence of feeling pain.

The right iliac fossa is naturally the site of the caecum and any removal of this part of the gut should cause emptiness of this region. This emptiness is named after the French surgeon who first described it in the early part of last century, the "signe de Dance". Although of extreme importance in large children and adults, it is of not much use in infants in whom the caecum can always be displaced on deep palpation. It is however an important point in the differential diagnosis between this affection and appendicitis. In the latter disease

¹ Dance. Mémoire sur les invaginations morbides des intestins
 Report. Gen. d'Anatom. et de Physiolog. 1826. T. 1, p. 206.

Hy 5 pm 5

fulness instead of emptiness is felt.

The two flanks must be well searched as in the majority of cases the tumour is felt in one or other of these situations. The lower border of the liver must be made out clearly and any lump felt just below this is very suspicious. This is perhaps the most difficult of all the regions to be certain of, as the tumour retreats readily under the liver edge. Lastly the pelvic region should be examined on the left side. This should be performed in a bi-manual manner with one finger in the rectum. It is extraordinary the help this gives in a small infant. For the whole of the lower part of the abdomen can be searched by this method up to the lower pole of the kidneys. Indeed in one case where no intussusception was present, the lower pole of the right kidney was actually mistaken for an invagination until the mistake was pointed out.

Percussion of the tumour will give out a perfectly dull note.

In cases where gangrene has set in, the abdomen is held too rigid to allow anything to be made out by palpation and then percussion will sometimes suffice to locate the obstruction. When there is diffuse peritonitis the presence of free fluid may be

detected.

Examination of the child is never complete unless the finger be passed up the rectum. A tumour can be felt per rectum in 40% of cases. In not all these is the tumour in the rectum itself, but it can be felt there or through the rectal wall, when the abdomen is palpated with the other hand.

In examining the rectum of an infant, the fingers should all be extended. The well lubricated forefinger is introduced slowly into the rectum, and gradually pushed up to its full extent. The long finger lies in the fold between the buttocks. If the three inner fingers are flexed they come in contact with the child's buttock and the forefinger is deprived of nearly an inch.

When the apex of an intussusception is felt, the following points should be noted. The finger can be made to pass up all round its margins. In some cases the lumen of the gut opens at the lowest part and then gives to the finger the feeling of a patulous osuteri. But as a rule the opening is at the side and may be an inch or more from the true apex, in which case the tumour feels very much like a large polypus, with a smooth soft surface. Even

See Plates.

when no blood has been seen to pass the examining finger will be found blood stained on withdrawal.

In 8% of cases the gut was noted prolapsed to a greater or less extent beyond the anus. But I recollect other cases in which no mention of the prolapse is made in the notes. In many more the gut was noted to be just internal to the sphincter. Wiggin met with prolapse 5 times in his 103 cases. Leichtenstern met with the condition in 41 out of 220 cases. It more commonly appears in ileo-caecal than in any other form.

Six to eight inches are the most that appeared in any one of my cases but larger amounts have been recorded. The gut is always much congested and the end may be gangrenous. The opening may be at the tip or a little way up the side, the opening into the appendix may be seen. In one case the appendix itself appeared, the colic wall having ruptured. See Plates.

D I A G N O S I S.

In the majority of cases of this disease the diagnosis is extremely simple and yet it is comparatively seldom that a child is sent to the hospital with this correct, or the child is only sent after much valuable time has elapsed and its chances of recovery much diminished. An infant with a history of sudden pain, screaming, followed shortly afterwards by vomiting should always bring the typical onset of intussusception before us.

The passage of blood in the motions of an infant, if accompanied by acute symptoms, is almost invariably due to intussusception. Paroxysmal pain, vomiting, and the passage of blood form a tripod of symptoms which can hardly support any other diagnosis. The blood stained motion would naturally lead to the examination of the rectum, and if the apex of the intussusception is found, all doubt is at an end.

The symptoms progress so rapidly that even if no diagnosis is made and the child treated for colic, it is very soon obvious from the general condition and aspect of the child, that something far more serious is present. The abdominal look of the

child should make one pause and consider the nature of the symptoms and at once proceed to a systematic examination. If there is any doubt about a tumour being felt in the abdomen, it is ones duty to give a general anaesthetic and make quite sure. If the child is screaming and struggling either from pain or from a stranger's handling, it is often impossible to make a diagnosis without the use of a general anaesthetic. A brief examination is often all that is required, and with the finger of one hand in the rectum and the other hand on the abdomen the matter can be settled there and then. In intussusception prevarication is fatal. If a diagnosis can not be made with certainty it should be remembered that intussusception is the cause in more than 75% of the cases of acute obstruction met with in infants. Indeed in children who have survived the first two weeks of life, in which imperforate anus, and congenital occlusion of the gut each claim a small per centage of victims, what is there that can cause acute obstruction. The field is narrowed down to strangulated hernias and strangulations by bands and Mechel's diveticula.

The Differential Diagnosis is therefore limited

1. Ileo-colitis in infants sometimes assumes such a severe form that blood is passed in the stools.

Q. 3.

The rapid collapse, sunken appearance, the character of the stools, and the vomiting, which accompanies this affection, makes it extremely difficult to differentiate the one from the other. In one case under my notice the child was admitted to the ward devoted to infantile diarrhoea and the incorrectness of the diagnosis was only revealed when the gut protruded at the anus.

But in the majority of cases a diagnosis can be arrived at by considering the following points. Severe diarrhoea of this nature is rarely met with except in July, August, and September. The onset is not accompanied by sudden screaming. The motions contain faeces and are not merely blood and slime, although in some cases the motions from intussusceptions may contain faeces. The sunken look is more marked and the fontanelle more depressed from the loss of fluids. The temperature is more frequently subnormal. And lastly nothing is felt either in the abdomen or in the rectum.

2. Appendicitis of a perforative nature may occur in quite young infants, **A** breast fed babe of 6 weeks old died of this disease in the wards under my care. Vomiting and a lump in the right iliac fossa are found. But obstruction is rare, diarrhoea being the

rule in children, no blood appears in the stools. The temperature is high from the start. The local tenderness is more marked. The lump is fixed not moveable. A recto-abdominal examination reveals its true nature.

3. A Rectal Polypus frequently gives rise to blood and mucous in the stools and may cause a certain amount of straining. The polypi are almost without exception situated within reach of the anus and a digital examination reveals their presence. If soft, however, they may escape detection until a speculum is used. The history is usually one of frequent small haemorrhages. The general severe symptoms are always lacking.

4. Prolapse of the Rectum should always arouse suspicion, and it is never sufficient to send the mother away with directions as to strapping the buttocks. The finger should always be introduced and the continuity of the mucous membrane with the skin round the anus demonstrated. The non observance of this precaution has led to serious mistakes. Not only has an intussusception been mistaken for a prolapse of the anal mucous membrane but the diagnosis has been acted on and the apex of the intussusception amputated. In a child of 15 months, 4 inches

of intussusceptum were cut away. (New York Med. Journ. July 1877). The child recovered. In adults the protruded gut has been mistaken for piles and cut away. (Boston Med. Journal July 6 1876, and Mag. fur Gesam.Heilk.Rust. S. 253 Berlin 1817).

5. Purpura may cause melaena, and give rise to difficulty. I had under my care a girl of 9 months with a history of diarrhoea and vomiting for 6 days. On the 8th day dark blood was passed several times, and on the same day a rounded tumour was felt, for the first time, in the caecal region. An operation was decided on but no intussusception was found. The caecum and the lower ileum contained a large blood clot. After the operation the wound continued to bleed in spite of adrenalin. The child died. At the autopsy blood was found throughout the intestinal canal and even in the stomach, but no bleeding point. I have seen one other similar case.

6. Tubercular Peritonitis can only be confounded with the more chronic forms of intussusception, and the presence of two or more separate lumps, or the presence of general tubercle will help the differentiation.

SECTION VI.

TREATMENT.

Spontaneous Reduction.	Page	155.
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Modern Methods.		
Treatment by distention.	"	170.
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TREATMENT.

Considering the feeble methods Nature has at her disposal for the treatment of this disease, the prompt and energetic action of the medical man is of paramount importance.

Let me first direct attention to the methods Nature adopts.

1. SPONTANEOUS REDUCTION. It is usually said that Nature has but one method of curing this disease, namely by the sloughing and casting off of the intussusceptum. This, however, I am quite sure is wrong. I believe that many intussusceptions form which are spontaneously rectified before they give rise to any other symptoms than pain and colic. A few, however, go beyond this stage. Case 50 is, I think, an instance, a male 6 months old, with history of sudden onset of pain and screaming and the passage of blood per rectum. After a 30 hours history, the child suddenly got quite well and went to sleep, and was not troubled further. No treatment was pursued. It may of course be questioned whether such a history is sufficient for such a diagnosis. I think it is in view of subsequent cases here mentioned. Case 84, a male aged 3 $\frac{2}{12}$, history of 30 hours duration, sudden onset of pain, no blood passed, tumour easily

felt on right side. At the operation no invagination found, but the lower two inches of ileum and caecum, with the adjoining mesentery, were congested and showed subserous haemorrhage. The gut had evidently been invaginated and spontaneous reduction had taken place shortly before the operation. Case 85, Male $\frac{10}{12}$, indefinite history for 8 days and an acute history for about 10 hours, spasmodic screaming, passage of blood twice, a tumour felt. At the operation the tumour was quite reduced, numerous quite fresh haemorrhages and petechiae being seen. One of these was the size of a half-penny.

Case 69 leaves nothing to cavil at, the typical symptoms of sudden onset, pain, passage of blood and the presence of a tumour were all noted, yet, on opening the abdomen the invagination was already reduced, but not without leaving unmistakable signs of its formation, including the presence of the dimple so often mentioned.

Case 88 is a good example - twice he was cured of acute symptoms by means of injections; twice he was operated upon and the intussusception reduced, a fifth attack was cured. without any treatment at all. I do not think the cases need be multiplied further: quite a number

28

of the histories of my cases revealed the fact that there had been typical symptoms lasting for some hours on previous occasions. Probably invaginations cured in this manner are of small size, and the parts have not become too swollen to reduce with ease in response to an extra strong anti-peristaltic wave. But the haemorrhages in the cases I saw shewed that the congestion was by no means trivial. The difficulty in reduction would lie always in unbending the stiff and oedematous apex. But when spontaneous reduction is admitted, the number of cases which so recover, with urgent symptoms, are very small indeed. Perhaps 3 to 5%, but not more. The longer the history, the less likely is such an issue to be brought about, the longest of the cases quoted was 30 hours, most of the others were less than 12 hours.

There is, however, evidence to show that even chronic cases may be spontaneously reduced.

In one of the cases caused by an inverted appendix, page 131 No. Dr. Ford was able to put the bowel, which had prolapsed some inches from the anus, back into the rectum. After kneading the abdomen a little, he heard a gurgle and the tumour disappeared. This was after a 3½ months history.

Nothnagel reports a still more conclusive case of a man aged 50. He was taken ill in April 1892 with violent pains in the stomach, nausea and vomiting. These pains lasted off and on for nearly 4 months. Waves of peristalsis could be seen, although the bowels were regular. The man became much emaciated, but refused operation. After a while all the symptoms vanished and his health returned. He remained quite well till November 19 1893 when all the old symptoms returned, and he wasted rapidly from the pain, vomiting and sleeplessness. The bowels were again perfectly regular. A tumour was found having all the characters of an intussusception. At the operation an ileo-caecal invagination was discovered and easily reduced, no adhesions having formed. At the apex of the intussusception was a polypus.

2. SPONTANEOUS EVOLUTION.

By this is meant gangrene and sloughing of the intussusceptum, and the passage of the dead piece of bowel per rectum. This is nature's commonest method of performing a cure. A method clumsy in the extreme and fraught with the gravest risk.

The pathology of gangrene of the intussusceptum has already been given. ^(Page 64) This method of cure is often

met with in adults. According to Leichtenstern it is met with in upwards of 45% of cases left to themselves above the age of 11. But in only 2% in those under 1 year and in 6% in those between 2 and 5 years. Not a single instance is met with in my series. It must be remembered also that many of Leichtenstern's cases are those reported and therefore the proportion of the recoveries will be considerably above the average.

Consecutive cases from intestinal ulcers would I am sure give a much smaller percentage of cures.

Wiggin (Lancet Aug. 1897) reported a male of 7/12 who passed a slough on the 4th day and recovered. Quite a number of cases could easily be collected of spontaneous evolution in children a few years older.

Alexander Monro (Primus) (Phys. and literary Essays 11, 353 and works p.674) reported a boy aged 12 who passed 13 inches of bowel with the mesentery attached, after a year's history. He died 6 weeks later. The preparation is in the Anatomical Museum of Edinburgh University.

J. M. Bowman (Ed. Med. and Surg. Journal 18, 492) related the case of a girl of 11 reduced to such a state with pain, faecal vomiting etc., "there ^{that} was every symptom of approaching dissolution. On

the 6th day in the evening, a portion of colon, caecum and mesocolon, measuring 13 inches, was passed by stool, with much black foetid fæculent matter, to the amount of 6 quarts". Perfectly good health was ultimately recovered.

F. Bush (Med. and Phys. Journal 1, 468. Dec. 1823) a boy aged 12, death expected on the 4th day, but blood and fæculant material passed and relief was obtained. On the 8th day, 15 to 18 inches of ileum were voided. His recovery was rapid. 12 weeks later he died of Typhus in 14 days. Post mortem - considerable puckering and contraction was found where the slough had separated, and the parts united, yet there appeared room for the faeces to pass.

Levi Gaylord (American Journal Med. Science Feb. 1830) ^{reported} a boy 6 years, passed 27 inches of bowel on the 7th day, and recovered .

M. Salgues (Journal de Med. Chirurg. 1758 VIII, p.266) a boy 15 years passed 20 inches of small intestine on the 14th day, and 6 inches next day. After this he was unable to walk unless in a semi-bent position and suffered severe pain after meals. "He neglected the rules of diet prescribed for him and died of indigestion 2 months after his accident"!

See also Peregrine's case of an unweaned child, page 26.

¹. American Journ. Med. Sciences. Vol 12. p 372.

². Path. Soc. Trans. Vol. 19, p. 207

3. Hilton Fagge. Guy's Hosp. Repts. 1869

4. Path. Soc. Trans. vol. XIII, p. 86

7.7.

I have a great many references to similar instances but the condition is relatively so rare in children that we need not discuss the matter further than to draw attention to the fact that with the escape of the bowel the risks do not cease.

Peritonitis, ¹haemorrhage, ²Pyæmia, ³local abscess, and blockage³ of the intestine lower down by the gangrenous slough, have all been reported as immediate dangers, while subsequent rupture, chronic ulceration, cicatricial contraction,⁴ faecal fistulae, and short circuiting are among those more remote. Two curious cases are reported of gangrene of the left lower limb. Both were ileo-caecal and the gut was expelled on the 11th day. A few days later in the one case and 2 days later in the other, pulsation ceased in the artery and the limb became gangrenous. Amputation, followed by recovery, was performed in the one case. I am not certain of the fate of the other, my notes simply say the leg sloughed off (Haberston, Diseases of the Alimentary canal and Dr. Smith of New York reference incomplete). Treves states that two such cases were reported by Rafinesque they may have been the same two.

3. HISTORICAL.

Having considered nature's methods, let us turn

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to those adopted by medical men. Did time and space allow, a most interesting chapter might be devoted to the different agencies adopted by man throughout the course of centuries.

By the ~~other~~^{older} writers there was little or no attempt made to differentiate between the different causes which produced obstruction. Obstruction was then mentioned under the generic term of volvulus, which included all forms even strangulated hernias. From time immemorial the treatment of such cases has been a constant puzzle. The treatment, formed on the teachings of Hippocrates, Diocles, and the ancient fathers, did not recommend operation, and we have to come down to the middle ages before a separate treatment was proposed and carried out for the relief of invagination. To Paul Barbette of Amsterdam is conceded the honour of first impressing upon the profession the absolute need of operation in certain cases. He writes the vermicular movement of the intestines renders them loable to engage in intussusception, above all when they are troubled with violent spasms, then the course of the excrements is no longer open below. This malady, is termed Miserere mei or ileus. When the ordinary means are ineffective (here follows

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descriptions of clysters, fomentations, opiates, etc.) is it not better, he asks, to open the muscles and the peritoneum, ^{and} ~~to~~ disengage the intestine rather than condemn the patient to perish? (Oper. Chirurgico-Anat. 1672 de abd. partib. intern. lib. X Cap.2. "An non etiam praestaret, facta dissectione musculorum et peritonaei, digitis susceptum intestinum extrahere, quam morti aegrolantem committere." Here then is the proposal to operate for the reduction of intussusception plainly made. The suggestion seems to have created some stir at the time as many writers of the day refer to it.

Bonet (Sepulchretum Anatomicum lib. 3 sect.14 de dolore iliaco) adds, in speaking of Barbette, the account of many cases of volvulus which caused death.

The following probably was an intussusception. The Baroness de Lantiwas ill and like to perish of the "iliac passion". A young surgeon who had followed the armies, presented himself and promised an assured cure, if the patient would only submit to operation. This was accorded. He opened the belly and drew out much intestine before discovering the twisted portion. This he untied ("nodos dissolvit") and put back in its place. The abdomen

was closed, and the wound healed happily. The lady bestowed a pension on her deliverer.

This is believed to be the earliest existing record of the fulfilment of Paul Barbette's proposal. Doubt has however been thrown on the nature of the operation by M. Pinault, a minister of the Church of Geneva, who was present at the operation. This gentleman describes the case as one of hernia. Most writers do not, however, attach much importance to the witness of a layman as to the nature of an unusual operation. Operations for strangulated hernia had often been performed, and with some success, a clergyman could hardly be expected to give minute details of a new method. Many authors refer both to Barbette's proposal and to Bonet's description of the operation. Rivinus, Dissert, Med. 24 de Volvulus. These 55, lips 1710, p.458.

Schar . Dissert. Medico-Chirurg. de Morb. a sit. intest. praeternat. Cap. 1. Sec. 12. lips 1721.

Hoffman. Dissert. Med. de passion iliac. Sec. 27, 1716.

Van Swieten. Comment. in aphor. Boerrhav. T. III p. 964.

If there is room to doubt the nature of Bonet's case, there can be no hesitation in accepting that of Oosterdykins Schacht. quoted by Velse and Hèvin'.

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A woman aged 50, for whom all remedies had been tried to relieve "the iliac passion", consulted Nuck. This renowned physician diagnosed intussusception of the intestine as the cause. He engaged a skilful surgeon, whom he directed to open the belly four fingers breadth to the left of the umbilicus, and withdraw the intestines, great care being taken to foment them with warm milk while the volvulus was sought for.

On following the advice of Nuck, the surgeon met with all the success promised by that eminent man. For scarcely had he drawn out the intestines, when by a happy chance, he met with the part from which all the symptoms of the patient had their origin. The coils were neither inflamed nor adherent. After having greased them well with oil, he easily disengaged the obstruction and replacing the guts, ^{closed} ~~replaced~~ the abdomen.

The patient, snatched from the doors of death, enjoyed after a little while, perfect health, and survived more than twenty years.

I find in the Ed. Med. Journal. of July 1825, a quotation from Hufeland's Journal in which it is stated that Fuschsius of Olpe was the first to

operate successfully for intussusception. No date is given. His case is as follows. A male 68, duration of illness 11 days. Laparotomy was performed. As reduction was difficult, the bowel was incised for 2 inches and the fingers introduced. About two feet of bowel were thus disengaged. The wound in the gut was closed, and the threads which were left long hung out of the abdomen. Recovery ensued. The surgeon states that in his next case he intends to cut short the threads and close the abdomen.

Operative treatment in spite of such cases, did not make progress, indeed it is a wonder in the pre-anaesthetic and pre-Listerian epoch, how any had the hardihood to undergo the knife. Many surgical works discuss the question and either quail before its dangers and responsibilities, or do not admit of its practical value. Others again utterly condemned the opening of the abdomen, even in the most desperate straits. They regarded with abhorrence the idea of groping among the intestines of the living, and stigmatised the procedure as barbarous and cruel.

Bearing in mind the difficulty of diagnosis at that date, and the limited knowledge they then

possessed of the pathological processes, it is no wonder that a surgeon hesitated to dogmatise on the cause of any particular obstruction.

Simson, Professor of Medicine in the University of St. Andrews, reported the opening of several bodies of people dead from volvulus.

He remarked on the great inflammation which he always found, occupying simultaneously the different tunics and the thickness of the intestine.

In one case he had found more than a foot of ileum, bright red, pushed into the caecum and colon and all placed on the left side. The coils were matted together into a hard mass the size of a fist.

In another case he found the caecum and a great part of the colon engaged the one in the other.

In a third, the ileum was found entering itself in four different places, the largest not exceeding four inches. The inflammation was very great everywhere.

It appears to me, said this writer, that the inflammation is the primary cause of the malady, and it is necessary therefore to resort to ample bleedings rather than exhibit the violent purges

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and quicksilver recommended by Ruysch, which seem to me to be most dangerous remedies.

Ambrose Pare in his 6th book of operations of Chirurgery quotes Marianus Sanctus as having seen several what had escaped death from "iliac passion" by taking 3 lbs. of mercury with water. This, by its weight, untwisted the intestine, which was entwined and folded, and drove on the excrementitious material. At another place he mentions a patient who drank 3 ounces of almond oil mixed with water and white wine, and then swallowed a leaden arquebus ball, polished and whitened with quicksilver, after which he felt better. The ball was passed, and by and by the pain was all gone. "Such things must greatly aid the colic."

Lazare Riviere, Prax. Medic. lib. 10, cap.2 de iliaco affectu, condemning these methods mentions another form of obstruction, namely by bands, which press on the intestinal canal like a true ligature. These, if one can diagnose, call for prompt gastrotony. The if in this worthy man's sentence remains prominent to this day.

The uncertainty of the pathology and diagnosis of this affection remains up to a much later date than is supposed. John Hunter, shrewd observer though he was, wrote to the effect that the diagnosis

of intussusception was never certain till after death. In the Dublin Med. Press. 1845, p.388, a heated discussion was held over the discharge of pieces of intestine during dysentery, a sloughed intussusceptum having been displayed at a medical meeting.

The treatment up to quite recent times therefore, has been vague and most varied. Operation was again proposed by M. Langier (the reference I have is Bull. Chirurg. T. 1, p.245, this is wrong; some other papers by this author I have trace of). Later Maisonneuve in his treaty on obstructions, advised gastrotomy.

Most practitioners seem to have followed the maxim of Celcus - It is better to hold to a doubtful remedy than to hold to none at all.

~~Stitches~~^{sticks} have been introduced into the rectum to reduce the prolapse. Pounds of mercury poured in while the unfortunate child was shaken head downwards. Huge opiates, fomentations, and leeches by the score applied to the prolapsed ^{gut}~~back~~ and the region of the anus, and severe depletion by means of blood letting, all figure prominently as methods, not only advised, but actually carried out. Enough has, however, been said and one gladly ends a dark

section which records the honest endeavour of serious men to relieve their fellow sufferers, in the face of results which must have been calculated to abash and discourage the most persistent.

My best thanks are due to the Secretary of the British Museum for the issue to me of a special ticket and leave to work in the Reading room, as many of the works referred to are in none of the other libraries in London.

4. MODERN METHODS.

Leaving then the methods of a past generation, we approach the discussion of what is considered the best treatment nowadays. The answer is, without doubt, immediate laparotomy and manual reduction of the tumour under the eye of the surgeon. But there are perhaps some still who hold that the treatment by distention of the gut is superior to operation. Let us deal with this form of treatment first. It is the treatment still found in nearly all text books.

a. Treatment by Distention. At an early date, a great many intussusceptions can be treated quite successfully by means of injections of air, gas,

water or oil. The injection is given by means of an ordinary enema syringe or by a douche can held a little distance above the level of the body. In favourable cases the pressure of the water drives back the intussusceptum and reduces the invagination. The procedure is simple. To the lay mind it is devoid of danger, and therefore infinitely preferable to operation. What then are its disadvantages.

1. It is utterly unreliable, as we have no means of telling when the injected fluid or gas has performed its work. The tumour is felt to lessen, and may disappear, as far as palpation is concerned, and it is hoped that reduction has taken place. But in the majority of cases the symptoms do not ~~re~~bate and careful examination a few hours later betrays the presence of the swelling.

Even when palpation is performed, under deep anaesthesia, the surgeon has been completely deceived. Unfortunately the signs of rupture of the gut by the injection - a sudden giving - and increased tumidity of the abdomen - will also stand for those of reduction. The early numbers of my cases were all treated by injections, none were reduced. In fact only one in the whole series, was reduced by combined manipulation and injection. The manipulation consisted, I believe, of kneading the abdomen.

Mr. Barker, (Brit. Med. Journ. Vol. 2, 1896, p. 629) reported the details of 15 cases treated by himself. In 8 injections were tried. All were failures. In 6 the reduction was apparent, not real.

Dr. Wiggin (Loc. cit.) in 72 instances in which injection was practised, met with 54 failures or 75%.

However favourable may seem the case, there must always remain in the mind of the medical man, a doubt as to whether the last few inches have really been reduced; for if not, their valuable time has been wasted.

2. It is usual to say that injection is useless in enteric forms, and we have no way of telling which particular variety is present. Enteric forms high up the small intestine, are quite beyond the reach of injections, but this is not so with intussusceptions of the lower ileum, which project through the valve. Case 88 is an example: He was operated upon twice and an intussusception of the lower ileum reduced in each case. On two other occasions he was cured by injections, once of air and once of water. On a fifth occasion he recovered without treatment. I must suppose that all these intussusceptions started at the same

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place - the lower ileum - on both occasions when operation was conducted, this was the site, and yet injections cured him.

3. Loss of time in those cases where this line of treatment has failed, may be, and often is, the cause of the loss of life. The administration of the anaesthetic at the time of the injection, does not lessen the severity of this apparently innocent measure. It used to be said that injection reduced the condition, but the same cause which brought about the invagination in the first place caused a recurrence in a few hours. We can quite safely say that 99% of such recurrences were examples of non-reduction of the last and most oedematous part of the tumour. Recurrence within a few hours was only met with once in my 103 cases (No. 97).

4. We are quite unable to prognosticate whether any particular invagination is suitable for treatment by injection.

Injections can be of no use in intussusceptions of the upper part of the small intestines.

They are of no avail, where from any of the causes before enumerated, the condition is irreducible. If there is a rent in the sheath nothing could

be more unfortunate than the use of injections.

To this already formidable list of disadvantages, must now be added the dangers.

These consist in the rupture of the gut and the flooding of the peritoneal cavity with the septic intestinal contents.

If we knew exactly how much the colon of each separate individual would hold, and how much that capacity was diminished by the presence of the invagination, we should then have a means of controlling our actions. As it is, we have none. Great differences exist in the capacity of the colon of different individuals and different ages. Mr. D'Arcy Power in his Hunterian lectures to the Royal College of Surgeons of England in 1897, goes minutely into the details. It would avail nothing to quote the figures here. Mr. Mortimer (Brit. Med. Journ. Feb. 1897) and Mr. Mole (Lancet Vol.1 1891, p.1144) conducted a series of experiments on the cadaver to find the amount of pressure needed to rupture the intestine. It was then pointed out that the colon ruptured with a five to eight foot head of water. Rupture usually being met with in the transverse colon near the splenic flexure.

If the fluid was allowed to enter too rapidly, the bowel was apt to kink, and then the water passed no further and never reached the site of the invagination. Wiggin, laid down (New York Med. Record Jan.1896) after a full investigation, that the height of water should not exceed three feet; for an infant, 30 ounces was, he found, a sufficient quantity.

If then, there is serious risk of rupturing a healthy colon, what shall we say of the soft inflamed and injured portions just liberated from the neck of the intussusception.

We must also remember that it is the last part, the apex, which presents often such a serious obstacle to reduction, here then the pressure must be raised to its highest limit, and here the pressure will act equally on the healthy and the semi-gangrenous parts, if perchance such be present. The strength of a chain is that of its weakest link . Who can comfortably take the responsibility of gauging the strength of the weakest part of the intestinal wall, the condition of which he cannot foresee and the plight of which he has no means of ascertaining. In case 48. a 2 foot head of water burst the colon. In Case 21, a life was placed beyond hope of recovery by the same means. There are others in my

series. Mr. Knaggs (Lancet Vol. 1 1887 p.1125) reported seven cases in which rupture had taken place in infants from 5 to 7 months. In one only 9 ounces of water were used. Enough has, however, been said to demonstrate the inaccuracy and danger of the transaction.

With this indictment against it, are we justified in using the method in any circumstances? I think we are. But, I would strictly limit its use to those acute cases in the outlying districts where surgery is not available and to those cases only during the first 6 hours. There must be very few places in this country where a child is not within 6 hours journey of a hospital. A 6 or even 12 hours journey and delay is I think preferable to the risk either of the injection itself or of the delay in case of its failure. In chronic cases injections may be used at a later date. Cases have been reduced with ease after some weeks duration. But the risk of some local patch of gangrene, ready to give way under the slightest pressure, is very great.

B. The Operative Method.

Of this there is little to relate, the sooner the operation is done the better. Slight narcosis is all that is required. The usual aseptic precautions are of course observed. The incision in an ^{child} infant is conveniently made over the right rectus which is either split or drawn aside. In small infants the whole abdominal cavity can easily be reached from the middle line but here the wall is so thin, and the subsequent straining so great that a hernia is liable to form, or the wound may even burst open. A three inch incision is made and the peritoneal cavity opened. The intussusception is sought for first in the position in which it has been previously felt. As soon as found, it is brought to the surface and reduction attempted. The long mesentery usually allows the tumour to come easily to the surface. It was Jonathan Hutchinson who first brought before the profession the correct method of reducing an intussusception (Med. Chir.trans. Vol.57 p.631). A considerable amount of anxiety must always exist until reduction is satisfactorily accomplished. Except in the simplest and most recent cases pulling on the extrant

gut must be strictly avoided. The lower end of the tumour should be grasped in the whole hand while the upper end is steadied and the mass straighted. By squeezing the lower end of the sheath, a two-fold result is produced, the intussusceptum is partly squeezed out of the intussusciens and at the same time the sheath is peeled off at the neck. This action is repeated until in favourable cases the whole of the intussusceptum is reduced. The last part is usually much congested, very stiff and oedematous and a dimple on its free border betrays the part of the gut which formed the true apex. The dimple being the most oedematous and thickened part the gut here naturally tends for some time to keep its inside-out-shape. Rapidity is a very great factor in this operation. In cases of gangrene or adhesions, these appear first at the neck as the intussusciens is peeled off the intussusceptum. Should the invagination for any reason be hard to reduce no undue force must be allowed or the squeezing may burst first the serous and then the other coats of the bowel.

In invagination near the ileo caecal valve, the appendix should always be made out, as it may be inverted and the cause of the trouble. Its presence

inside the caecum can always be palpated. If found inverted, the caecum must be opened and the appendix removed.

Often great thickening of the valve region can be felt and may give rise to the idea that there is a polyp or foreign body present. If such is really present the gut must be opened and the condition rectified.

After reduction the wound is closed in layers with strong silk-worm gut.

This is important seeing the tendency there is for the wound to burst open or subsequently herniate. When, in spite of all efforts, the tumour remains irreducible, the hope of recovery is indeed small. The alternatives left are the following.

1. The establishment of an artificial anus above the site of invagination, while the intussusceptum is either left in situ or removed. Death has been the almost universal result of this procedure. Rydygier (Verband de deutsch. Gesells. f.Chriur. 1895) reported one case which survived. In one of my cases the artificial opening was found post mortem to communicate with the bowel below instead of above the obstruction, Case 7.

2. The formation of a lateral anastomosis between the gut above and that below the intussusception which is left in situ. All such cases as far as I know have proved fatal. It is not a very promising procedure; in none of this series was it performed.

3. Resection of the intussusception with immediate end to end suture of the intestine. In case 64.. where the condition was of long standing this was successful. Kocher (Brit. Med. Journal Oct. 1898) published 5 cases where this procedure was brought to a happy issue. Mr. Clu~~bb~~e (Brit. Med. Journal Nov. 6 1897) reported a success in a child 11 months old, the operation being performed upon the 9th day. No. 64 of my series, a boy aged $9\frac{1}{2}$ operated upon on the 5th day of the disease survived. These are also but rare exceptions. As a rule this operation fails to save life, see Barker's & Wiggins' reports. Cases Nos. 42, 57 and 48 illustrate junction by - simple suture, Maunsell's method, and Murphy's button. Death ensued in each instance.

4. Barker's operation. This consists in suturing the neck of the tumour so as to prevent reduction and then incising the sheath and displaying the intussusceptum. The intussusceptum is cut off and

Plate I.

the free margins of the bowel united together with sutures through the whole thickness of the gut wall. The opening in the sheath is then closed. No. 22 is a success by this method in a chronic case lasting 1½ years. As a rule in acute cases, this operation produces no better results than other methods. Israel (Med. Record, May 10 1905) modifies this method by suturing the opening in the sheath to the abdominal wall so that an artificial anus is formed. Coffey (Annals of Surgery Jan.1907) has described a still more intricate modification of the same principle.

The condition of a young infant brought to such a pass, is hardly a favourable one for the performance of any operation of a complicated or lengthy character.

Combined injection and Laparotomy is not in my opinion a method to be recommended. In the majority of instances it is prompted out of respect to the old treatment of attempted reduction by distension. But I have never seen a case in which partial reduction of the tumour was brought about by injection with the belly already open, that reduction could not have been performed with greater ease and rapidity

by manipulation with the fingers .

If any one needs the proof of this statement let him consider the number of times in these cases injection was tried and failed and yet when the abdomen was opened reduction was performed with the utmost facility.

Mr. Knaggs (Loc. Cit.) reported a case in which rupture of the colon had taken place from injection, and yet when laparotomy was performed, reduction was a very simple matter.

On general principles alone, combined injection and laparotomy ought to be condemned. What is the desired condition of the intestine during any abdominal operation? Empty. In what then does intussusception differ from all other abdominal operations? If in the course of reduction a gangrenous or ruptured area is turned round at the neck the first notice we have of the fact, is that fluid is escaping and flowing into the general peritoneal cavity.

I believe there is absolutely no advantage in having the intestine full of fluid during reduction of a simple case, and in a complicated case where

opening of the bowel is necessary, such a state of matters is a source of very grave danger.

For a comparison between the mortalities of cases treated by injection and those by operation, I must refer absolutely to the collections of others. Unfortunately, as I stated in the introduction, many of the surgical note books of the Hospital are not to be found, and therefore an undue proportion of my cases have been culled from the post mortem records which have been excellently kept, so that while the fatal cases are here included, many of those which ended in a happier manner are not recorded.

Of the 84 cases operated upon, 71 were reduced and of these 34 lived. In 22 cases which could not be reduced, only 2 recovered, one of which was a chronic case, the other was a boy $9\frac{1}{2}$ years old with a history of 5 days duration.

In 17 cases which were not operated upon, recovery took place in 2, injections and manipulations were carried out in the one, and the other got well with no treatment at all - spontaneous recovery. The remaining 15 died.

It must be remembered that some of my cases

date back to the time when sepsis accounted for many victims. The true mortality must be gauged from a review of the recently reported cases.¹

I think we shall be underestimating the per cent of recoveries if ~~you~~^{we} place the figure between 50% and 60% of all cases. In reducible cases the figure is between 70% and 80%.

Wiggins in 39 cases treated by injection found 41% of successes.

Gibson (Anals of Surgery 1900) wrote a most instructive paper showing the relationship between recovery and the duration of the history.

THE AFTER TREATMENT.

Every method in our power must be used to combat the effects of shock. It is usual to give small doses of opium to keep the bowels at rest. Dunbar is much against this as free action of the bowels is required to rid the system of the decomposing intestinal contents which have been stagnating there during the course of the disease. I am

1. Fagge (Brit. Med. Journ. Dec. 17 1904), Clubbe (Ibid. Jan. 1905 and Nov. 1897), Rydyier (Verband. der deutsch, Gessells. fur Chir. 1895), Barker (Clinical Soc. trans. 1898, p.67), Dunbar (Scottish Med. and Surgic. Journ. Aug. 1906) have all made valuable contributions to this subject.

inclined to agree with him to some extent. In cases with acute symptoms it is often found that soon after the operation the temperature rises rapidly. The reason of this is, I believe, that the fluid causing the oedema in the walls of the intussusception is intensely toxic to the system. Before reduction the circulation is very sluggish in the swollen areas - perhaps even at a standstill. After reduction the circulation is re-established and the oedematous fluid is thrown into the circulation. During reduction a considerable amount of squeezing of the mass takes place which brings about the same effect. In these cases I believe that small doses of Calomel should be given to clear out the bowels.

Some of the cases actually die of toxaemia (Case 86). Mr. Barker has drawn special attention to this point. Opium is moreover liable to increase any tendency to paralysis in the damaged gut. It is said that there is a tendency for recurrence to occur unless the bowels are kept at rest. In only one of my cases was recurrence met with at an early date - within 24 hours - and in this case I know opium had been given. The risk of recurrence is I believe very small indeed. As a rule the child is so exhausted that it readily falls to sleep, if

such be not the case, I would rather give small doses of potassium bromide than opium. The child must of necessity be kept warm and its general wants attended to.

Feeding may be commenced within two hours of the operation, if sickness is not caused by the anaesthetic. My experience has been that small children stand the operation well, if their general condition has not already been too much lowered and the operation is not unduly prolonged.

If sickness is still present immediate relief often follows washing out the stomach by means of a No. 9 Catheter.

If great shock is met with, nothing is better than the administration of saline, either by the rectum, subcutaneously, or into a vein. Once a child has recovered from the shock of the operation little remains but to keep it quiet and allow it to accumulate its strength. The use of stimulants will vary with the individual ideas but in the majority of cases very little is needed. At the end of 24 hours the bowels should be opened if they have not been opened before.

As to the treatment of the wound, ordinary surgical principles must be followed but in view

of an accident I have often seen happen, I would add a word of warning. Owing to the straining, kicking, and crying, in which small babes so often indulge, it is never wise to remove the deep, or tension sutures, before the 10th day. They should be left in longer if no irritation is produced, thereby. If removed sooner there is a great risk of the wound bursting open and the bowels escaping into the dressings. Or the deeper planes of the wound may separate and the intestines appear as a large hernia under the skin. I have known such an accident happen on 6 occasions. In one local peritonitis and death ensued, in another a swab was left in the abdominal cavity at the second operation, in a third infarct of the lung followed. When the stitches are all removed it is well to cover the scar and a large area of the abdomen round about with adhesive plaster to prevent any bulging taking place, otherwise a hernia is liable to follow.

Of other complications severe diarrhoea is perhaps the commonest. It is probably caused by the damaged and often ulcerated portion of the gut which becomes infected and inflamed. Small doses (min.5) of castor oil should be given three times a day to remove any irritating material from the

region of the sensitive portion of gut, strict attention must of course be given to diet. If the motions are very foul, it is sometimes a good plan to wash out the large bowel with ordinary normal saline.

THE CAUSE OF DEATH.

Many cases are hopeless from the start, gangrene or rupture of the bowel has taken place, and peritonitis of a general character ends the scene. Shock however, probably claims a majority of the victims. The results of strangulation are of much greater severity in infants than adults. Babes have been known to die in 12 to 18 hours from this cause alone. No. 24 of my series died in 48 hours, without operation.

The pain and the strong afferent stimuli engendered by the disease are probably as great in the adult as in the infant, but in the latter they are, as it were, concentrated on a far smaller surface, and their effect is proportionately severe. If the shock is survived reaction ensues with a high temperature due, I believe, to toxic absorption from the incarcerated piece of gut, and possible to absorption from the intestinal mucous membrane.

This, I believe, is the cause of death in those who die on the 3rd or 4th day after the operation. Various septic influences have been noted, gangrene has appeared in the limbs on two occasions, in another instance septic meningitis followed. One of Mr. Barber's series died from thrombosis of the mesenteric veins, an infarct of the lung was seen in a case in this Hospital.

The bursting open of the partially healed wound accounted indirectly for 3 deaths in this series.

In chronic cases the patient is gradually worn out by pain, sleeplessness, and anxiety.

The ever recurring attacks of colic, accompanied by fruitless straining, and the occasional passage of mucus and blood, gave no respite to the sufferer. The appetite fails or if food is taken the stomach frequently ejects it. Emmaciation is slow or rapid according to the severity and constancy of the symptoms. Its progress is steady. With the emmaciation, weakness appears, and worn out with the misery of his condition, the end may come with unexpected suddenness.

One can not close an account of this disease without again alluding to its most disastrous feature, namely the delay in giving efficient treatment from the want of an early diagnosis. And yet there are few diseases which have a more attractive array of signs and symptoms than ordinary cases of intussusception. What then is the reason of this anomaly? The answer is want of care and attention.

Babes of 4 to 8 months old receive scant notice in too many cases when brought to the Dr. with a

history of pain and perhaps a little diarrhoea. Mere colic, flatulence, slight diarrhoea, or constipation, are all so common, that a glance is given at the well fed appearance of the face, and the mother is sent off with the cheery assurance that all will be well if a little castor oil is given. The presence of blood in the motion is only elicited on enquiry.

That enquiry should always be made.

The amount of attention which has of late years been ~~not~~ directed to this disease has impressed upon the profession ^{the importance} of not overlooking the early symptoms. If this essay ~~is~~ at any time helps to flash a suspicion of intussusception through the mind of any one about to send away such a case without careful examination, it will have amply repaid ~~for~~ the labour of its compilation.