

Digestive System

University of Jordan
Faculty of Medicine
Batch of 2013-2019



Slide Sheet Handout Other

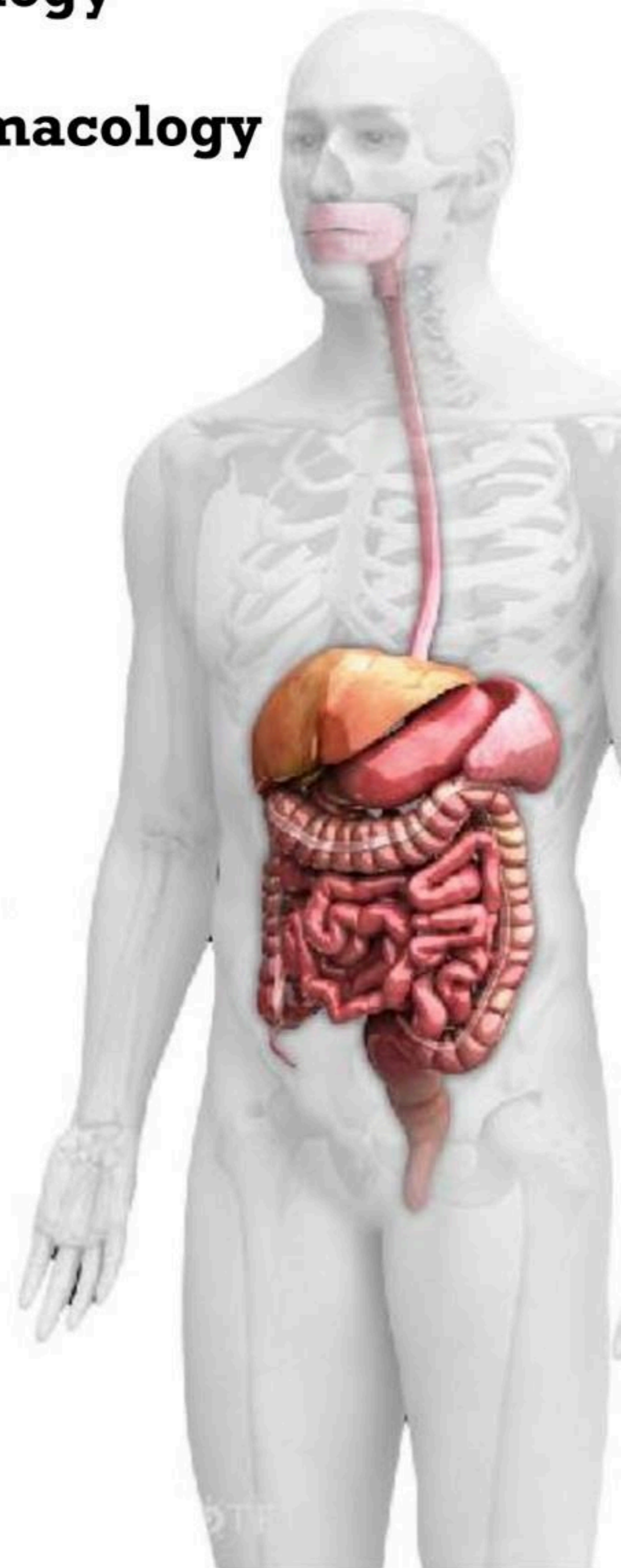
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Sheet #: 3

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Gastro-intestinal Motioities 2

Last time we was talking about GI movements (chewing & swallowing).

In swallowing, we have:

1-Pharyngeal phase: the patterns of pharyngeal phase (a complex pattern at the level of the Pharynx).

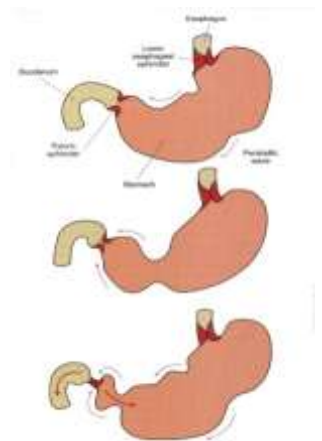
2- Esophageal phase: At this phase,we have primary & secondary peristaltic contractions.

Gastric motilities (to imagine the process

https://youtu.be/hpS5kMn_B0I,<https://youtu.be/o18UycWRsaA>)

We have also started with gastric motilities:

- 1- The first movement that we are having **Receptive relaxation**, When the stomach is empty it has only 50 mL capacity and once bolus come from the esophagus it needs to dilate to store that food .So Receptive relaxation will happen in the gastric smooth muscles decreasing the tone of these muscles and then the stomach will dilate and store food up to 5L
- 2- **peristaltic contraction** : After the stomach is relaxed there are waves of contraction in a form of constrictive ring coming from the mid part of the stomach toward the pyloric sphincter .This contraction helps to mix the bolus with gastric secretions to form Chyme.



Once we have this constrictive ring reaching near the pyloric sphincter ,the pyloric sphincter will constrict and more closure will happen to it we are getting more closure of that sphincter.

Because of that constriction the Chyme (we don't call it food anymore)that is



relatively Solid will be tossed back to the body of the stomach once it reach the pyloric sphincter

• This phenomena is called **retropulsion**, we have the gastric content tossed back toward the body of the stomach.

-the constricted Pyloric sphincter allow passage of chyme with fluid consistency only and this passage is called Pyloric pump activity or gastric emptying But

• Pyloric pump activity: Pumping the content of the pyloric region into the duodenum.

Chyme that is relatively solid will be tossed back from the pylorus toward the body of the stomach by retropulsion and can't pass toward the duodenum

What is the purpose of that retropulsion?

We are actually dissolving and grinding the food by that movement (back and forth over the stomach by retropulsion) resolving the food content with gastric secretion to make the chyme more fluidic in order to pass through the constricted pyloric sphincter

3- In addition to these movements, we having **Hunger contraction**, until now nobody knows how it happens, what it's mechanism and how it is activated. We can say we have some relation between decrease the glucose content of our body fluid and initiation these hunger contractions.

Gastric motilities are very well controlled we have neural and hormonal control for gastric movements.

But don't forget that the hormonal control is not dominant in controlling movement in general ,but dominant in controlling secretions, while the neural

Gastric motilities (from the slide) :

-Receptive relaxation.

-Gastric peristaltic movements:

1-Retropulsion

2-Gastric emptying (pyloric pump activity)

-Hunger contraction.



control is more important in controlling movements in general.

neural control : we have the enteric nervous system So once you are getting the distention (dilation) of the stomach, in this case you are activating the enteric nervous system ,in addition to the ENS we also have the autonomic nervous system fibers that are innervating the stomach and both of them work in increasing gastric activities in general.

Once we have emptying of all the stomach content into the duodenum, now we are getting duodenal distention(dilation), by this distention we are activating reflex which is called entero-gastric reflex, this reflex is Inhibitory and it inhibits gastric activity because they are needed anymore since the stomach is empty , this reflex happens when the Chyme from the stomach reaches the duodenum ,this chyme will decrease the pH in the duodenum causing extrinsic and intrinsic contractions in the duodenum that inhibits gastric motility .

You can think about it logically once we have entry of the gastric content into intestine we are not needing the gastric activities anymore , so we need to reduce these activities and this is achieved by entero-gastric reflex .

Hormonal control

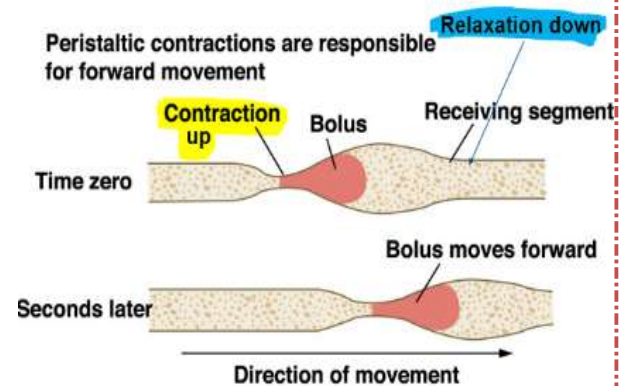
- 1- Gastrin is released by antral gastric mucosa have a stimulatory effect over the stomach peristaltic contractions .
- 2- we have more hormones released by duodenal mucosa like (cholecystinin(CCK) ,secretin and GIP-refers to gastric inhibitory peptide) these hormones inhibit gastric activity, but again these are not the main control of motilities in general they control secretions .

Motilities of the small intestine (<https://youtu.be/1yMTmoZhemQ>)

So what is the motilities that we have along the small intestine? We have many types of movement.

1-Peristaltic contraction :

-once we have the chyme in a segment of the GI tract tube it will cause distention (dilation) of that segment, This will initiate a local reflex in the circular layer of smooth muscles making them contract above the dilated segment in a form of a constricted ring and relax below the dilated segment, so basically we are having contraction up relaxation down. This process is repeated along the GI tube in an anal ward direction pushing the food toward the anal so it is a propulsive movement.



What about the longitudinal layer of smooth muscles? it will contract and relax rhythmically at a certain rate leading to shortening followed by elongation in the GI tube

Both the activity of circular layer (contraction up, relaxation down) and longitudinal layer (shortening and elongation) create a propulsive movement pushing the food in anal ward direction

Control of peristaltic contraction

- 1- at the circular layer of smooth muscles : it is controlled by the enteric nervous system. We have excitatory neurons of ENS above the dilated segment causing contraction which will lead to the formation of

constrictive ring And inhibitory neurons of ENS below the dilated segment causing relaxation (contraction up , relaxation down)

- 2- at the level of the longitudinal layer : it is controlled Electrically by the activity of Interstitial cells of cajal initiating action potential rhythmically causing shortening then elongation

Note : don't forget that the initial stimulation of this peristaltic contraction is achieved by Distension of the area in the middle between constricted ring above and relaxed tube below .

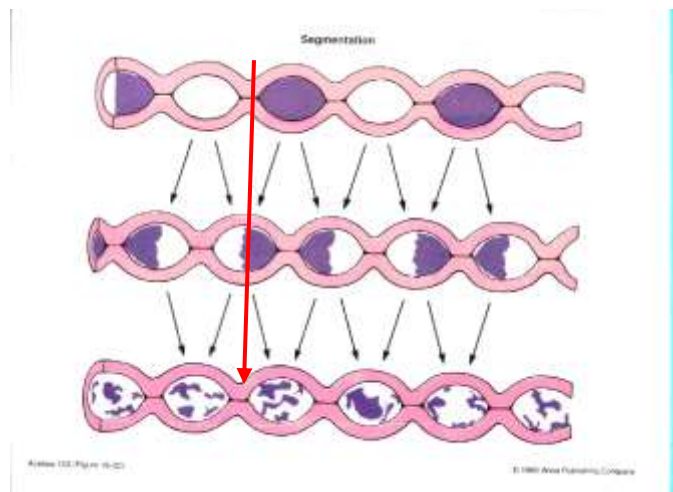
In the lab, you will not see the activity of the Circular layer (contraction up - relaxation down) because the intestines is empty .You will see the activity of the longitudinal layer only

Note : don't forget that the main effect of this peristaltic contraction is propulsive effect in anal ward direction in addition to some mixing effect

2-Segmentation contraction

Unlike peristaltic contraction which moves chyme in one direction , Segementation contractions moves chyme in both direction to achieve greater mixing of chyme of the GI tract secretions

? What we mean by segmentation contraction? If we are viewing the motor activities at the level of the small intestine. As you see the circular layer here it is in contraction, after a while it is converted to relaxation then contraction then relaxation ... and so on.





so, we have like rhythmic contractions of the circular layer, which is giving this segmented appearance Of the small intestinal because of that we are calling it as segmentation contraction.

The effect of these segmentation contractions over time is mixing , we are mixing the chyme with the enzymes that are released from the pancreas, you will see them with other fluid also ,as pancreatic juice, bile , and all other secretions .

So this(mixing) is the main effect; but we have also another effects.

What control this type of contraction (rhythmic, phasic)? electrical control by interstitial cells of cajal .

Usually, the rhythm of slow waves(the electrical activities) at the upper part of the small intestine is about 12 slow waves/ minutes.

Also the rhythm of these contractions (segmentation contraction) per minutes in the upper part of the small intestine; about 12/minutes.

If you are going to the lower part of the small intestine, you are finding the rhythm of slow waves is about 8/minutes.

Also the rhythm of these segmentation contractions is about 8/minutes.

So they are following the same rhythm as the slow waves. So the slow waves are the main controllers of this type of movement.(segmentation contraction)

✂The segmentation contractions the main effect is mixing but we cannot also exclude some propulsive effects.



3- Migrating motor complex contractions:

it is a contraction that starts from the stomach and ends at the ileocecal bulk as a one wave starting from the stomach and continuing along the small intestine .this can't take place only when if the small intestine is empty ,so after emptying the chyme from the small intestine into the colon we are initiation this type of movements.

There function is to sweep (to clean) the content of the small intestine after meals, after finishing everything, we are cleaning the small intestinal content by having this type of contraction. It is believed that they are activated by a hormone called motulin, which is the main initiator of this type of movements.

4-Peristaltic rush

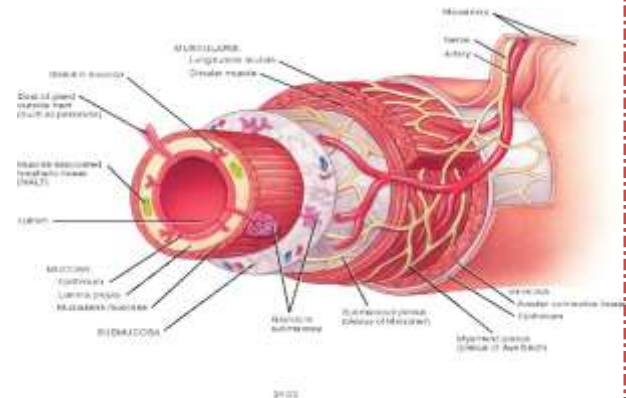
Pathologic movement that is characterized by rapid peristalses that occur along the small intestines and it is caused from mucosal irritation due to ingestion of any harmful agent and this movement will be demonstrated as Diarrhea .

Actually, activation of these peristaltic movements is for protection; we are trying to remove these harmful agents, as fast as possible from the body.

5-movements caused by the activity of muscularis mucosa

This activity is responsible for shortening and elongation of the mucosal folds to get striding of chyme over the mucosa to create more absorption by the intestinal mucosa

the mucosa of the small intestine usually is folded and we have at the base of the mucosa the muscularis mucosa



After absorbing from this part, we are getting shortening for example then elongation then shortening....and we are moving that mucosa to get much better spreading of the chyme over mucosa.

So, these are the types movement that we are having along the small intestine.

Again the main control of phasic contraction (rhythmic contraction) is the electrical control in addition to the electrical control we also have enteric and autonomic nervous system can interfere in increase or decrease some type of movements.

Also some hormones can affect movements (but again they are not the main controllers of gastrointestinal movement) like gastrin, cholecystokinin (CCK) and serotonin.

✧ Serotonin for example as an inflammatory factor could enhance intestinal motilities in general.

✧ Secretin & glucagon can inhibit intestinal movement.

So we can summarize movement among small intestine as

- 1- Segmentation contraction (with main effect to get mixing of chyme).
- 2- Peristaltic contraction (with main effect propulsive)
- 3- Migrating motor complex (the main effect is to clean actually, after finishing digestion and absorption process)
- 4- Sometimes we can have peristaltic rush (trying to remove the harmful agents from the intestine)

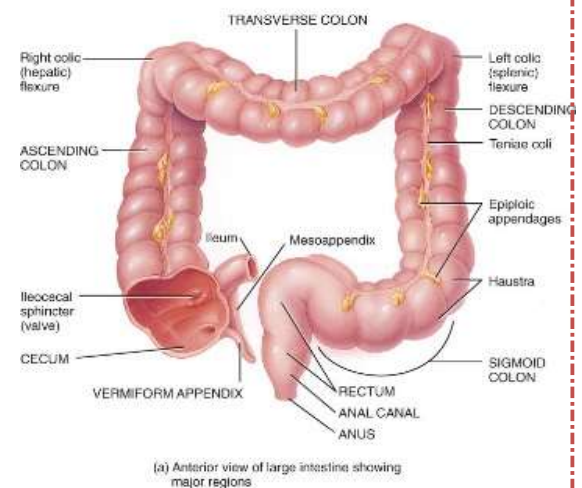
Motilities of the Colon(<https://youtu.be/6CoIDScAzog>)

We have two main types of movements (do not forget that these types present all the time) :

- 1- Haustral contractions.
- 2- Mass contractions.

We have to know the difference in the structure of the colon from the small intestine:

If you remember, we said we have a longitudinal layer along the small intestine, which is covering the whole wall of the small intestine, but in the colon, the smooth muscle cells fibers of longitudinal layer are more presented (grouped) three locations; one as you see it in front, upper part and one behind. These locations forming what we are calling strips of smooth muscle cells, so the layer of smooth muscle cells (longitudinal layer), the fibers are grouped to form these three stripes. (Called teniae coli). So the longitudinal layer of smooth muscles in the colon are called teniae coli .





Now, if you have activity of smooth muscle cells in that teniae coli, in addition, adding to that activity is the activity of the circular layer, like segmentation contraction in the small intestines. you will see more bulging at the level of the colon unlike the small intestine, these are more evident bulges.

But these bulges are called haustra, we will take that in anatomy, because of the presence of these bulges we call this motor activity: as haustral contraction.

1-Haustral Contraction

similar to segmentation contraction that takes place in the small intestines, it happens by the rhythmic contraction of the smooth muscles of the circular layer in the colon. In addition to it, there is also the contraction of the longitudinal layer (teniae coli) and that's what makes the difference between segmentation contraction (Only circular layer) and haustral contraction (both layer) that's why the Large intestines are more bulgy in structure and we have more evident segments called Haustra (that's why the contraction is named haustral). Main function of this type of contraction is to move the feces from the cecum and ascending colon toward the transverse colon. then Mass contraction in addition to haustral contraction will move feces toward the sigmoid colon.

? Now, what is the effect of these haustration contractions over the content? Do you need to mix things there? NO

There are 2 main effects of this contraction :

- 1- Spreading of the colonic content over the mucosa to achieve absorption of electrolytes and water



2- Propulsive effect : mainly for moving the feces from the cecum and ascending colon toward the transverse colon .This effect is very weak that's why the movement toward the transverse will take about 9 hours and this prolonged time will be used to achieve as much absorption of water and electrolytes as possible .When the feces reach the transverse colon it will be semisolid .

These motor activities (haustration) are not enough to move the content from the transverse colon toward the anal direction, so we are needing more powerful contractile activities.

2-Mass Contractions

Series of contraction that moves the fecal material from the transverse colon toward the sigmoid colon . they are actually similar to peristaltic contractions in the small intestines , we have contraction up, relaxation down .But more powerful contraction up relaxation down and shortening and elongation in the middle.

these contractions are not found all the day over the colon; they are initiated 1-3 times/ day As a series of contractions, not only one contraction and dying, this series of contraction last for 20 minutes-30 minutes then die, After 8 hours we have another series of contraction for 20-30 minutes then die and so on.

They are initiated by reflex, which is called gastro-colic reflex and duodenocolic reflex .

Gastro-colic reflex: it involves increasing the motility of the colon as a response to stretch of the stomach

Duodenocolic reflex : increasing the motility of the colon in response to segmented dilation of the intestines

Through what nervous system these reflexes are initiated ? Autonomic, through vagus nerve to get activation of these colonic movements (the activation of mass contraction).

Now, mass contractions moving the content in the anal ward direction toward the sigmoid colon, and the sigmoid become more dilated .

Defecation

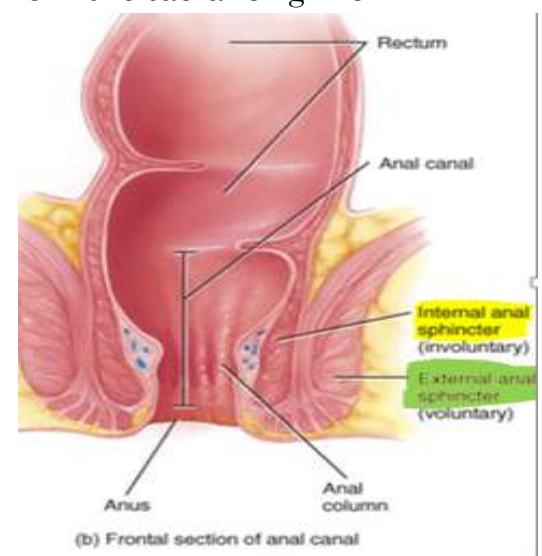
That distention in the lower colonic part results in activation of what we are calling intrinsic defecation reflexes.

Intrinsic defecation reflex happen through the myenteric nervous system (enteric) and cause increase in the contraction of the descending colon , sigmoid colon and rectum pushing the fecal material toward the anus .

So we are activating the enteric nervous system, we are getting more powerful contraction.

Now by activation of intrinsic defecation reflex, we are moving the content even down toward the rectum, the rectum will become dilated resulting in activation of extrinsic defecation of reflexes ,in this case, we have involvement of autonomic nervous system, mainly fibers coming from the sacral origin of the parasympathetic fibers, which are controlling these contractions .This extrinsic reflex further increase contractions in the lower part of the colon and relax the internal anal sphincter .

But I think you know that the anus is graded by sphincters; there are internal and external anal sphincters.





Defecation will take place only if the internal and external sphincters are relaxed.

The internal anal sphincter can be relaxed during extrinsic defecation reflex, but that is not enough to get defecation, you need to open the external anal sphincter as well.

? What type of muscle in the external anal sphincter? Striated muscles. So under the voluntary control for normal adults, when he is at the right time at the right place, they can go to the bathroom and defecate. But even sometimes you can have relaxation of external anal sphincter, but still there is no defecation in this case you need to increase the intrabdominal pressure, by holding respiration (take deep inspiration) and contraction of the abdominal muscle to get defecation. Even sometimes with all these events there is no defecation will take place; because the fecal materials are harder in this case, there may be a need of medical intervention some times.

You will be a doctor in the future -إن شاء الله- you will see that we can have some patients coming having high constipations and they will only defecate by medical intervention.

So we have these types of movement that are taking place at the level of the small intestine and colon.

I think you know we can have a lot of pathological problems related to movements at the level of the small intestine; like peristaltic rush.

Also at the level of colon, irritation of the colonic mucosa by any mean can result in increasing of activities in the colon. In this case, if the colon is empty having no fecal materials these person may develop cramps, pain and they will defecate but the type of defecation is mucus rather than fecal materials.



Also we have a condition which is similar to achalasia , that we have talked about at the level of esophagus, when there is no migration of neurons in the enteric nervous system toward the colon that means the movement of the colon is much reduced (the activity of it is reduced).

With time the colon will enlarge which results in a condition which is called Mega colon (also called Haustral disease).

The colon is in the form of mega colon, increased size of the colon because of no motilities that are taking place in the colon and these patients are suffering from constipations and so on.

So we can have a lot of pathological conditions related to colon.

"هل فكرت يوماً أن تترك هذه الأرض وهي مكان أفضل مما دخلته ؟"