



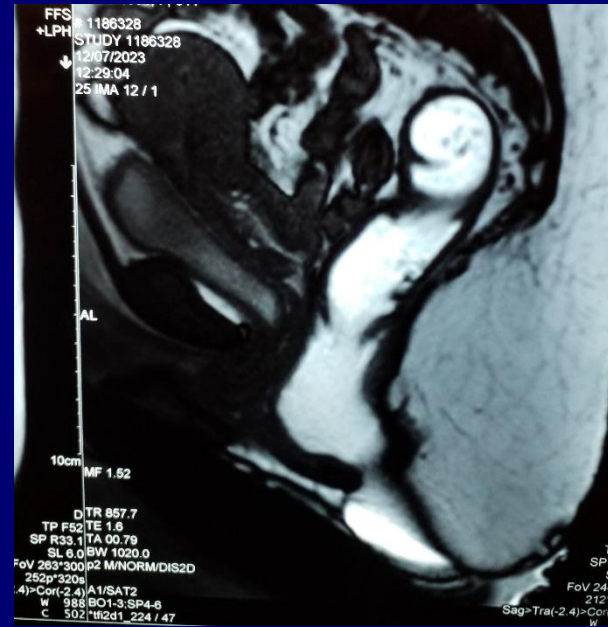
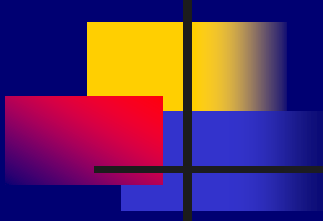
ODS Is it all about Dynamics.

A NEW MATHEMATICAL APPROACH



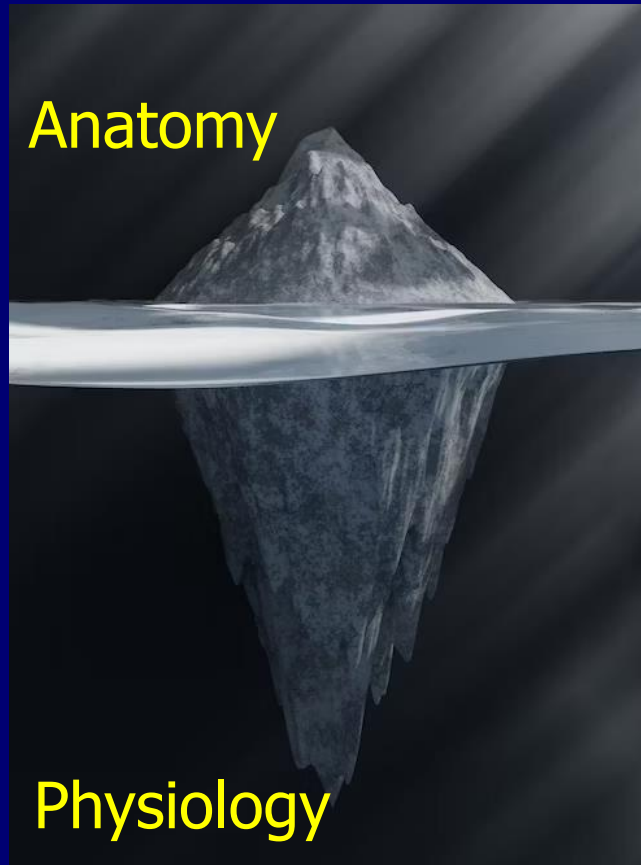
BY

***Prof .Dr. Ahmed Farag.MD.
Faculty of Medicine – Cairo University***



ODS: Is It All about Physiology?

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Società Italiana di Chirurgia Colo Rettale
www.siccr.org 2019; 50: 430-439

The Iceberg diagram for the treatment of obstructed defecation

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neuropathy and irritable bowel syndrome or slow intestinal transit time are the other two functional diseases. Among the **occult organic lesions**, urogenital associated

diseases (prostatism, colpocele, vaginal vault prolapse and cistocele) are the most frequent, followed by enterocele and sigmoidocele, recto-rectal intussusception and solitary rectal ulcer syndrome.



Figure 1

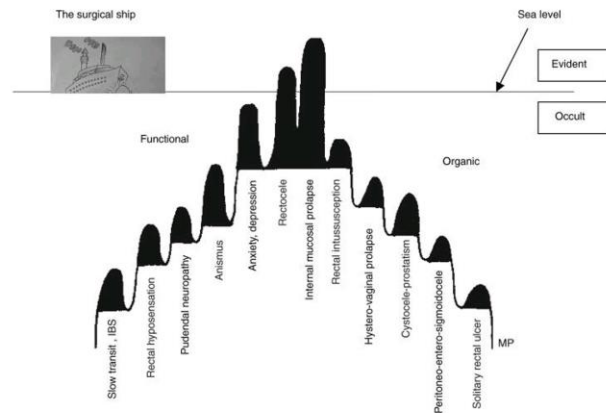


Figure 2

www.siccr.org

431



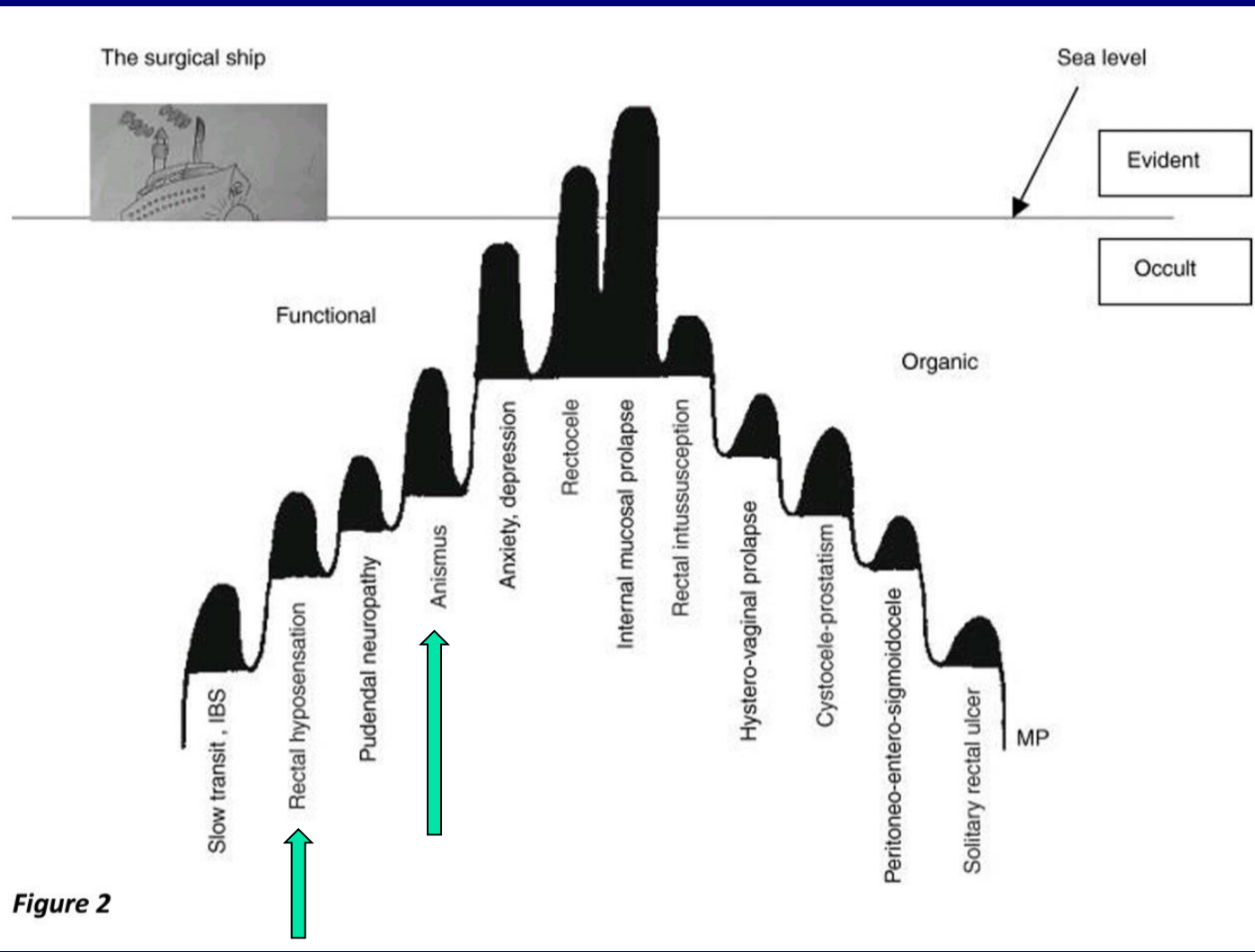
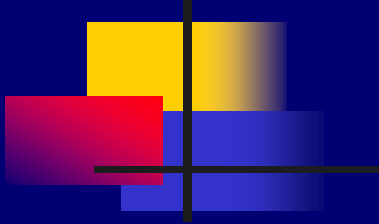
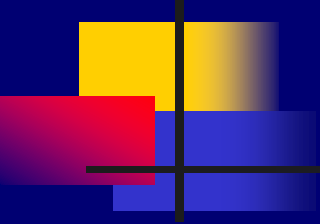
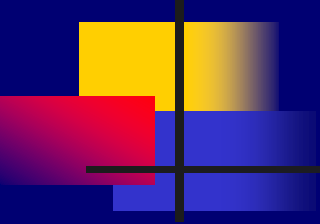


Figure 2

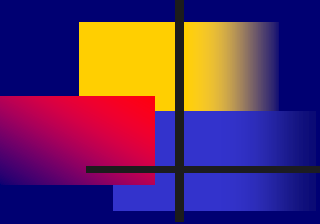


Maintenance of continence and achieving normal defecation, appears to be a complex phenomenon achieved by the combination of Anatomic and physiologic factors, the relative contribution of each being unclear.

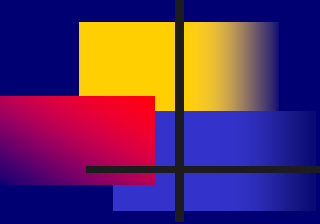
(Sangwan and Collier Surg.Clin North Am 1994)

- 
- The role of Anismus detected on defecation proctography in idiopathic constipation was doubted by some authors due to the high incidence of this condition in their normal controls.

Schouten WR, Briel JW, Auwerda JJ, Van Dam JH, Gosslink MJ, Giani AZ, Hop WC: Anismus: fact or fiction? Dis Colon Rectum 1997 Sep 40:1033-41.

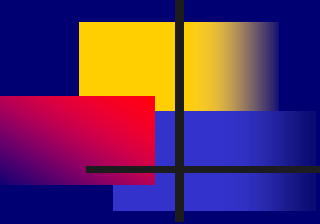
- 
-
- In addition very little is known about what symptoms or defecographic findings should be considered as an indication for surgery in patients suffering from large Rectocele (> 2m) and impaired rectal emptying.

Karlbohm U, Graf W, Nilsson S, Pahlman L: Does Surgical repair of a Rectocele improve rectal emptying? Dis Colo Rectum 1996 Nov 39:1296-1302.



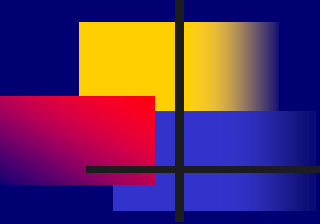
Using traditional research methodology, the reported data had been described as being disseminated research data by some authors and by the others as being adding to the confusion experienced in the world of physiology of the Anorectum.

(Varma et al Dis colon Rectum 1999 – editors comment)



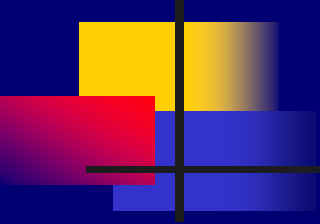
The lack of answers to the question on how the anal sphincter works is mainly due to the fact that, the AR segment is functionally highly integrated and should be studied using an integrated approach.

(Farag A. Dis Colon Rectum 2000 – Letter)



The flow equation had been used successfully previously in medicine in order to understand and study:

- 1. Urodynamics.**
- 2. Hemodynamics.**



Recently the flow equation had been applied for the integration of Anorectal physiology trying to understand how the anal sphincter works, Which should be our information highway for the investigation and treatment of patients suffering from A.I. and other functional A.R. disorders.

Farag A. Eur Surg. Res. 1998

Farag A. Dis Colon Rectum 2000 – Letter.

Integrated Coloproctology: A New Theory in Anal physiology 2009 "Pelviperinealogy.com"

www.integratedcoloproctology.com

A. Farag

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Use of the Hagen-Poiseuille Law: A New Mathematical Approach for the Integration and Evaluation of Anorectal Physiological Testing in Patients with Faecal Incontinence and Pelvic Dyschezia and in Normal Controls

Key Words

Faecal incontinence
Anismus
Constipation
Anorectal physiology

Abstract

This work was done in order to study the possibility of using the Hagen-Poiseuille law for flow of fluids through tubes to integrate and quantitate the anorectal physiological parameters in patients suffering from faecal incontinence and functional pelvic outlet obstruction compared to normal controls. The Hagen-Poiseuille law was intended to be used in the explanation of the role played by different sensory and motor functions of the anorectal segment in maintaining continence and normal rectal evacuation. The intrarectal pressures during rest, coughing, attempted defaecation, rectal sensation, and rectal compliance at the point of first rectal sensation were measured using anorectal manometry. Anal canal length and diameter were measured using lateral defaecographic views during rest, squeeze, and attempted defaecation, and the anal sphincteric reflex contraction in response to coughing or Valsalva's manoeuvre was measured using plug or needle electromyography. These factors were analyzed using the Hagen-Poiseuille law in order to determine anal canal resistance and flow to air, water, and BaSO₄ during rest, coughing, and attempted defaecation in controls, during attempted defaecation in patients with functional pelvic outlet obstruction, and during rest and coughing in patients with faecal incontinence. The Hagen-Poiseuille law could detect anal continence in all controls and could also detect and quantitate functional pelvic dyschezia in all patients. The equation could detect and quantitate faecal incontinence in 8 of 14 patients (57.14%) during rest, in 11 of 14 (78.57%) during coughing, and in all 14 patients after correction for sensory and reflex deficits. Both the Hagen-Poiseuille law and the law of Laplace and their proposed hybrid law were successful in explaining some facts concerning factors affecting normal continence and defaecation. The Hagen-Poiseuille law is a useful new mathematical approach for the integration and quantitation of normal and abnormal continence and defaecation. It can be used to plan for treatment and to determine the outcome of patients suffering from functional anorectal disease.

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Original article

The use of flow equation in functional coloproctology: a new theory in anorectal physiology

AHMED FARAG

General and Colorectal Surgery, Cairo University

Abstract: The flow equation and hybrid law in coloproctology can be used to understand normal anorectal physiology and accordingly explains the controversies experienced due conflicting research data. It can be used equally for incontinence and constipation. According to the flow equation there are four primary mechanical factors maintaining continence and achieving unobstructed defecation, namely intra-rectal pressure (IRP), dynamic viscosity of the bowel contents, anal canal length and diameter. The last 3 factors are responsible for the anal canal resistance (ACR). All other factors are secondary, and working through one or more of the four primary mechanical factors each can be numerically calculated separately. The sensory and reflex components work through the IRP and ACR respectively, and can also be numerically calculated in each individual. This data can be used to plan treatment and predict outcomes. Calculation of the ACR before and after treatment is helpful when making an objective evaluation of different treatment modalities. If different treatments are given to the same patient, e.g. combining constipating agents with sensory biofeedback for the rectum and anal sphincter repair, each modality may affect a different component in the flow equation, such as the dynamic viscosity, IRP, anal canal length or diameter. Calculation of the ACR also gives new insight into the results of modifying existing treatment modalities or creating new ones. Norm-grams and the automated flow calculator were designed to illustrate and avoid tedious calculations and they suggest a final diagnosis for each patient.

Key words: Flow equation; Hybrid law; Intra-rectal pressure; Anal canal resistance; Incontinence; Constipation.

2 **Defecation 1: testing a hypothesis for pelvic striated muscle action**
3 **to open the anorectum**

4 P. Petros · M. Swash · M. Bush · M. Fernandez ·
5 A. Gunnemann · M. Zimmer

*Defecation 2: Internal anorectal resistance
is a critical factor in defecatory disorders*

**M. Bush, P. Petros, M. Swash,
M. Fernandez & A. Gunnemann**

Techniques in Coloproctology
Official Journal of SICCR, MSCP, ISCRS,
ECTA, Colorectal Anal Group of Surgical
Section of Chinese Medical Association,
MSPFD

ISSN 1123-6337
Volume 16
Number 6

Tech Coloproctol (2012) 16:445-450
DOI 10.1007/s10151-012-0860-3



Functional Coloproctology is the last enigma in medicine where the factors maintaining normal continence and defecation are still unclear at the dawn of the new millennium. The use of flow equation suggests new definitions for A.I. and constipation from the flow point of view, determines the primary mechanical factors maintaining continence & defecation. It also suggests how the sensory and reflex factors interact with the mechanical factors in order to maintain continence and initiate normal defecation. All these factors can be measured numerically in health and disease. This knowledge can be our information highway in explaining the literature, suggest anatomical-function correlation, explains controversies, planning treatment for each individual patient, predicting outcome, objectively evaluating the outcome after treatment, anticipating and minimizing Postoperative complications. The use of flow Equations and the Hybrid law which suggests a new etiology for simple A.R. disorders may declare the start of a new Era which I call "Digital Coloproctology". This book is addressing the C.R. Surgeons, Gastroenterologists and those specialized in A.R. physiology.



Ahmed Farag

Integrated Coloproctology.

A New Theory of Anorectal Physiology.



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Surgeons (EGCRS). Member of the ASCRS.



978-3-659-18614-1



Flow simulations of rectal evacuation: towards a quantitative evaluation from video defecography

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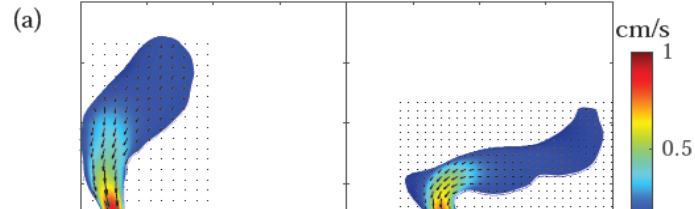
²Univ. Grenoble Alpes, CNRS, CHU Grenoble Alpes, Grenoble INP, TIMC, Grenoble, France

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(Dated: August 22, 2022)

Mechanistic understanding of anorectal (patho)physiology is missing to improve the medical care of patients suffering from defecation disorders. Our objective is to show that complex fluid dynamics modeling of video defecography may open new perspectives in the diagnosis of defecation disorders. Based on standard X-ray video defecographies, we developed a bi-dimensional patient-specific simulation of the expulsion of soft materials, the feces, by the rectum. The model quantified velocity, pressure and stress fields during the defecation of a neostool with soft stool-like rheology for patients showing normal and pathological defecatory function. In normal defecation, the proximal-distal pressure gradient resulted from both the anorectal junction which formed a converging channel and the anal canal. The flow of the neostool through these anatomical parts was dominated by its shear-thinning viscous properties, rather than its yield stress. **Consequently, the evacuation flow rate was significantly affected by variations in pressure applied by the rectum, and much less by the geometry of the anorectal junction.** Lastly, we simulated impaired defecations in absence of obvious obstructive phenomena. Comparison with normal defecation allowed us to discuss critical elements which should lead to effective medical management.



IV. DISCUSSION

The first attempts to model the fluid mechanics of human defecation were made by Farag [29, 30], who used the Hagen-Poiseuille law for modeling the Newtonian flow



Anal sphincter dysfunction in patients treated with primary radiotherapy for anal cancer: a study with the functional lumen imaging probe

Susanne Haas, Pia Faaborg, Donghua Liao, Søren Laurberg, Hans Gregersen, Lilly Lundby, Peter Christensen & Klaus Krogh

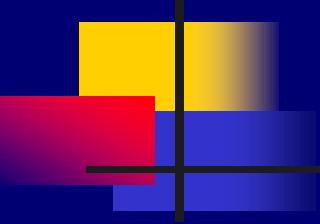
Flow resistance of the anal canal

During the FLIP distension, the flow resistance of the anal canal (ACR) was defined from the anal canal length (ACL), the middle part diameter of the anal canal (ACMD) and the dynamic viscosity of the inflated bag (DV), as [35]:

$$ACR = \frac{128 \times DV \times ACL}{3.14 \times ACMD^4}$$

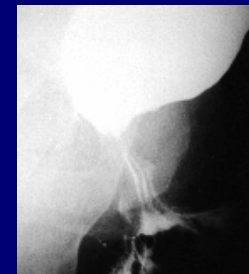
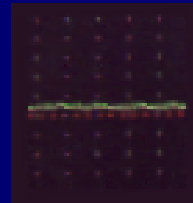
ACL was calculated as the distance between the proximal and distal anal canal location. Subjects were only included in this part of the analysis if we could clearly identify the two locations. The DV was assumed to be constant for all tests and hence the ACR/DV ratio (ACRR) was calculated as the measure of flow resistance of the anal canal as an expression of the anal sphincter resting tone when exposed to increasing volumes (10-50 mL).

- 73-133.
- [35] Farag A. The use of flow equation in functional coloproctology: a new theory in anorectal physiology. *Pelviproctology*. 2009;28: 17-23.

- 
-
- **Constipation** can be defined as:
A low flow rate of the stools or gases during defecation per unit time.

The Flow Equation

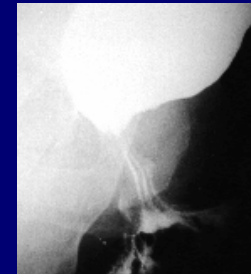
$$\text{Flow (A.I.)} = \frac{\text{intrarectal Pressure}}{\text{Anal canal Resistance}}$$

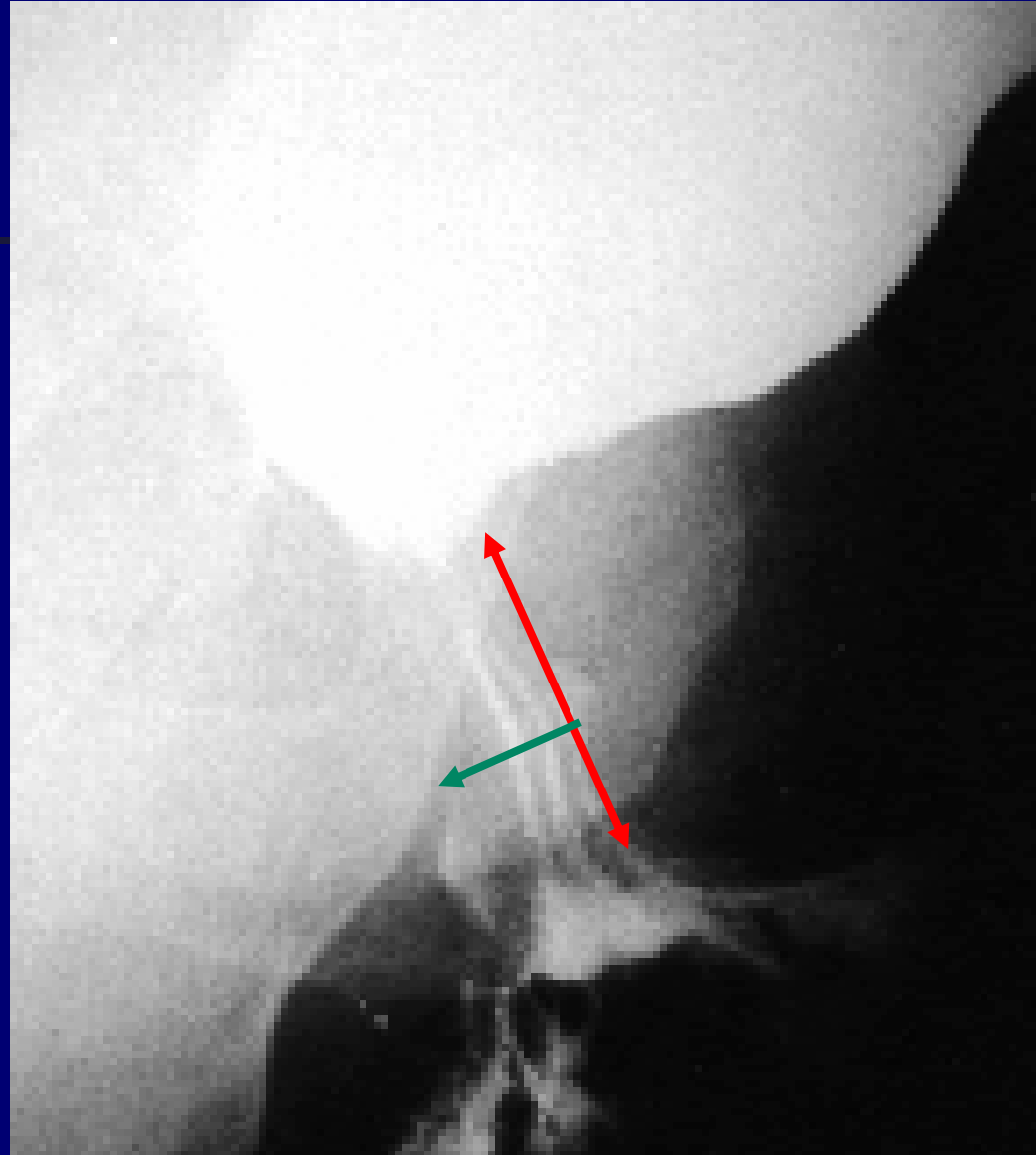
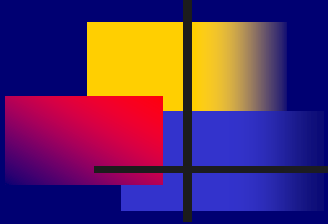




The Resistance Equation

$$\text{A.C. Resistance} = \frac{128 \times \text{Dynamic Viscosity} \times \text{A.C. Length}}{3.14 \times (\text{A.C. Diameter})^4}$$

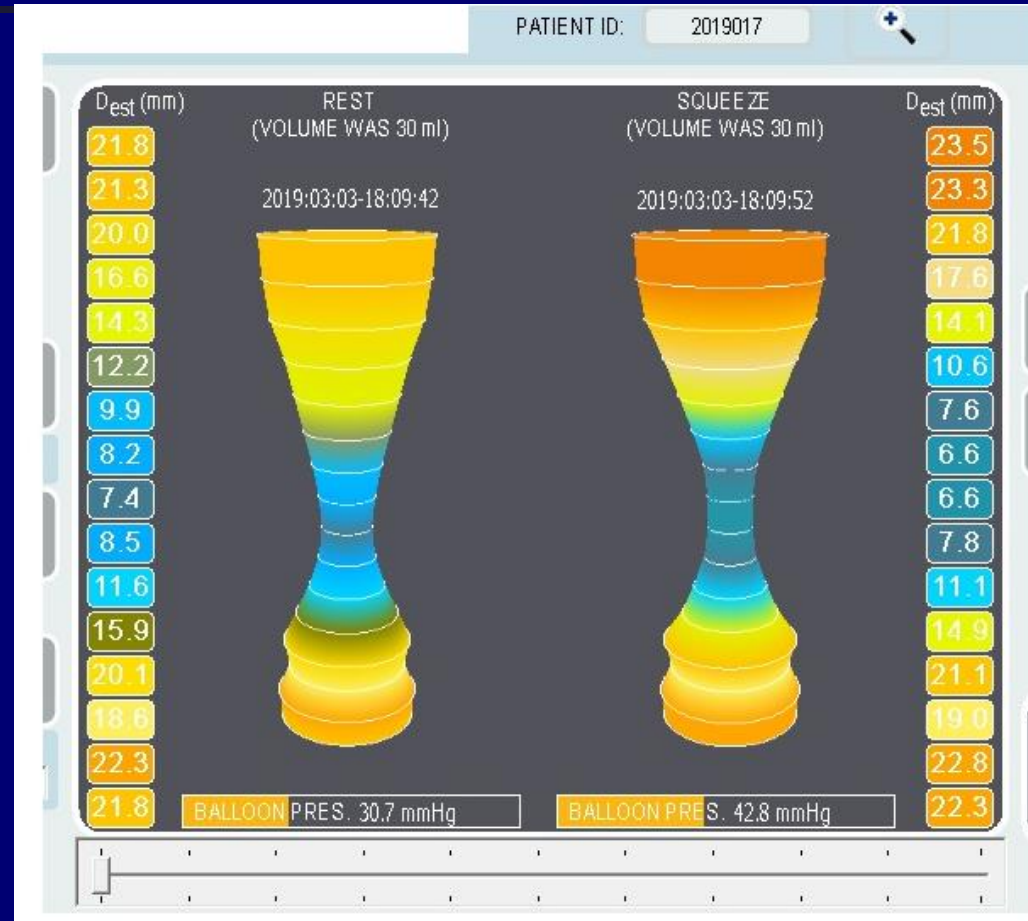




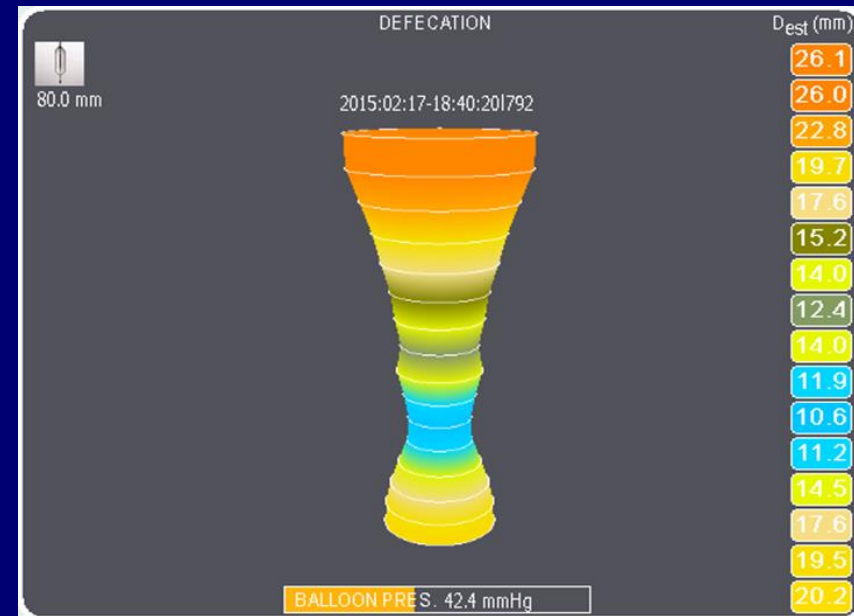
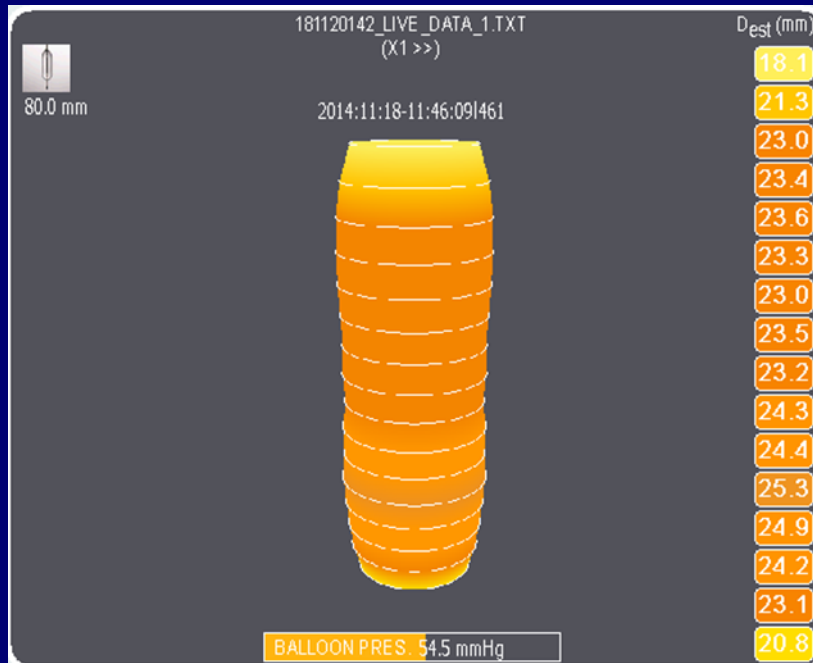
A.C.L.

A.C.D.

Functional Luminal Imaging Probe FLIP



Comparison using Flip between Control (right side) and ODS (left side) Using Flip

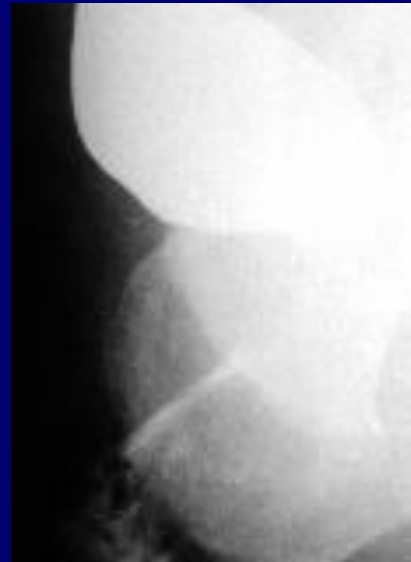




Structure – Function relationship



Rest



Sq. (X8)



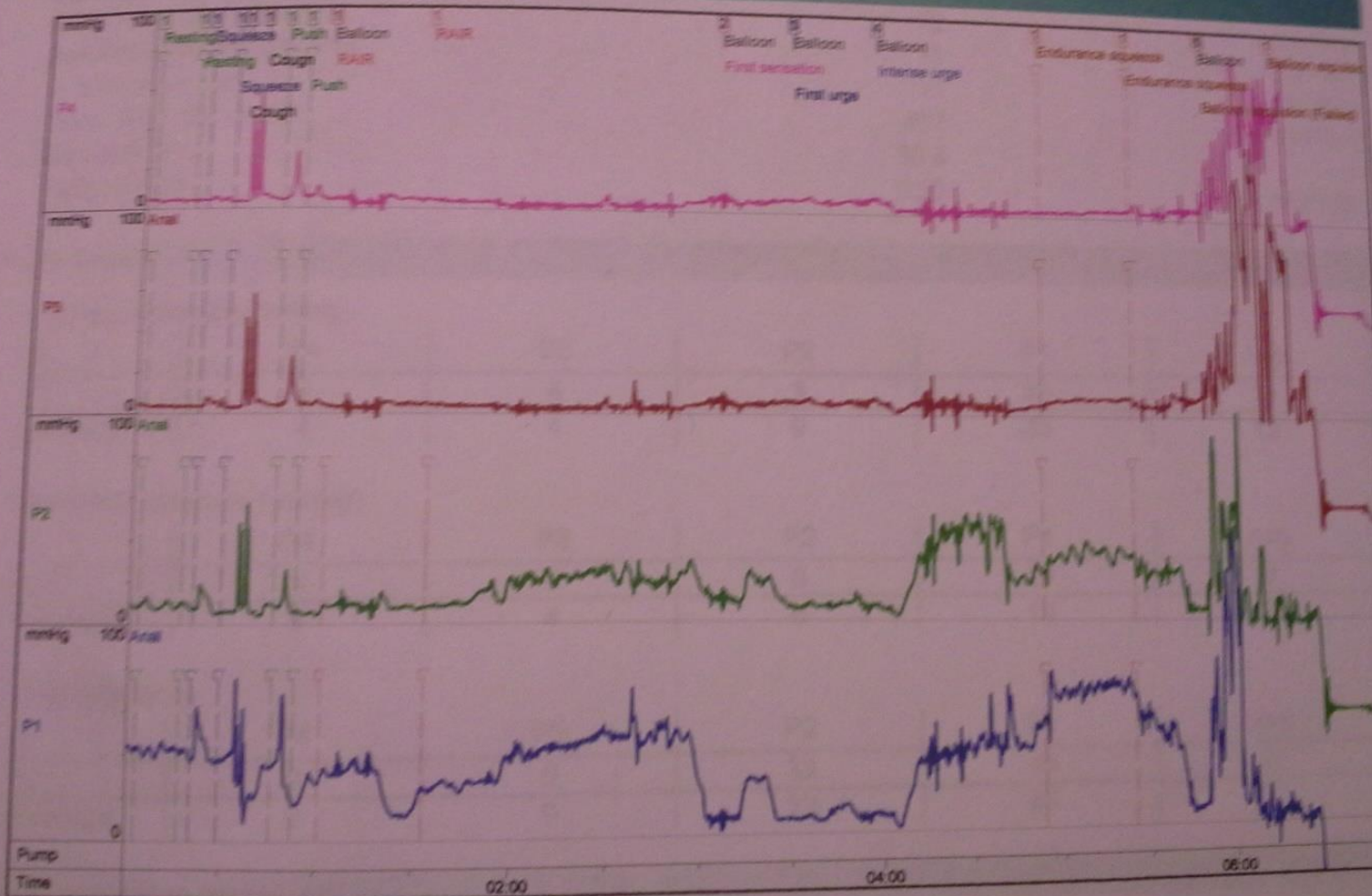
Strain (/88)

Patient number: 2015026

Investigator: -

Referred by: -

Graph



Resting results

Normal = 59-74



Primary Mechanical Factors

$$\text{Flow (A.I.)} = \text{intrarectal Pressure} \times \frac{3.14 \times (\text{A.C. Diameter})^4}{128 \times \text{D.V.} \times \text{A.C. Length}}$$

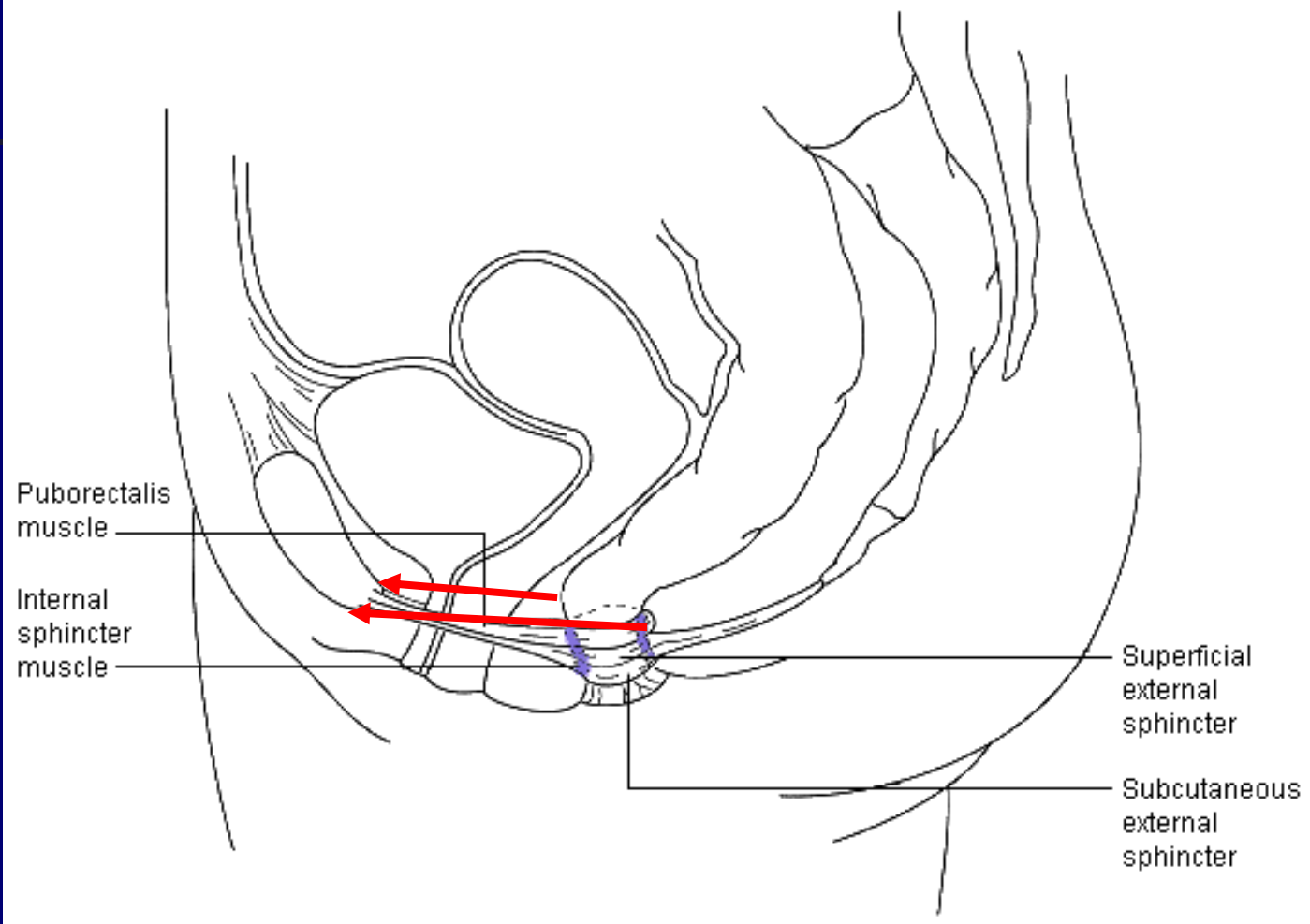
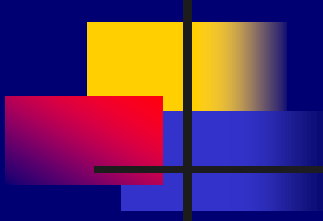
Dynamic Viscosity of Air:Water:Barium sulphate paste =
1 : 38 : 68

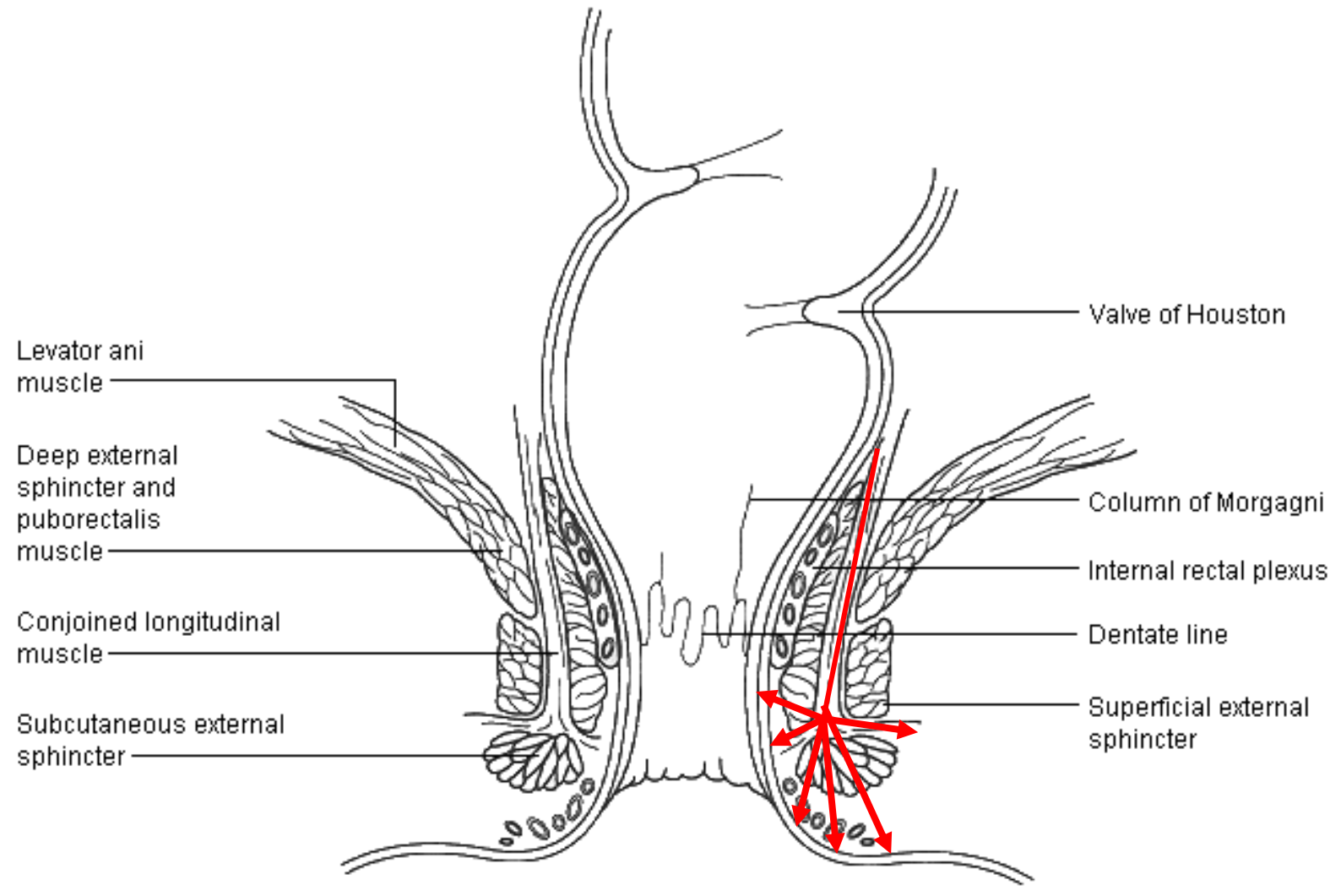
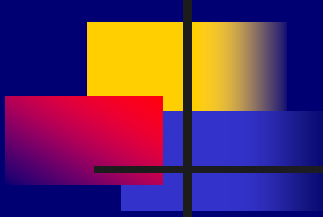


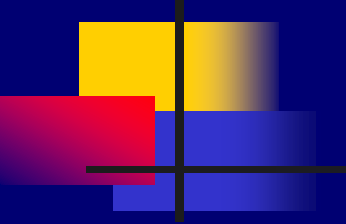
Controversies in A.I.

$$\text{Flow (A.I.)} = \text{intrarectal Pressure} \times \frac{3.14 \times (\text{A.C. Diameter})^4}{128 \times \text{D.V.} \times \text{A.C. Length}}$$

1. Anal Canal Pressure?
2. Anorectal Angle?
3. Perineal Descent?
4. Frequency of A.I.?







	<i>Longitudinal muscle</i>	<i>Internal A. sphincter</i>	<i>External A. sphincter</i>	<i>Puborectalis muscle</i>
A.C. Length	<ul style="list-style-type: none"> •It forms a supportive framework for the IAS and EAS during rest and squeeze. • It decreases the A.C length during defecation 	Maintains A.C.L. during rest (++)	Maintains ACL during rest (+) and during Squeeze (+)	Maintains ACL during rest (++) and during squeeze (++) and relaxes to decrease ACL during defecation (++)
A.C. Diameter	<ul style="list-style-type: none"> •Forms a supportive framework for the IAS and EAS during rest and squeeze. •Opens the A.C. during defecation 	Maintains A.C.D. during rest (++) and relaxes to increase ACD during defecation (++)	Maintains ACD during rest (+), decreases ACD during squeeze (++) and relaxes to increase ACD during defecation (++)	Maintains ACD during rest (+) and during squeeze (+) and relaxes to increase ACD during defecation (+)



Sensory & Reflex Factors

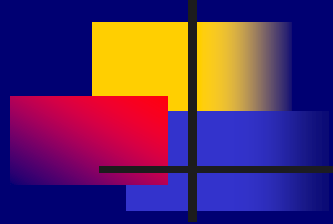
Flow (A.I.) = *intrarectal* Pressure / *Anal canal* Resistance



Sensory



Reflexes



- The Flow Calculator.

Flow Index *(Anal Incontinence)*

< 0.1 - 1 cc/Sec. <

Normal

Soiling

Incontinent

Fluid Stools
Soft Stools

Gas
Fluid stools
Soft Stools

- A flow index of 1cc/s. was taken as well as a cutoff point between obstructed defecation (flow < 1cc/s. of Soft stools i.e. Ba Sulphate)



Constipation

Step 1

Add ACL

Add ACD

Calculate Resistance

Resistance Result=

Step 2

Add Pressure mm/Hg

Calculate The Flow Index

Flow Index Result=

Results

Step 1

Add ACL

Add ACD

Calculate Resistance

Resistance Result=

Step 2

Add Pressure mm/Hg

Calculate The Flow Index

Flow Index Result=

Constipation

Results

These results indicate no anismus

[Back to Main](#)

Step 1

Add ACL Add ACD

Calculate Resistance

Resistance Result=

Step 2

Add Pressure mm/Hg

Calculate The Flow Index

Flow Index Result=

[Back to Main](#)

Constipation

Results

These results indicate Anismus

Step 1 Constipation

Add ACL Add ACD

Calculate Resistance

Resistance Result=

Step 2

Add Pressure mm/Hg

Calculate The Flow Index

Flow Index Result=

Results

Obstructed defecation to watery stools.

[Back to Main](#)

Step 1 Constipation

Add ACL Add ACD

Calculate Resistance

Resistance Result=

Step 2

Add Pressure mm/Hg

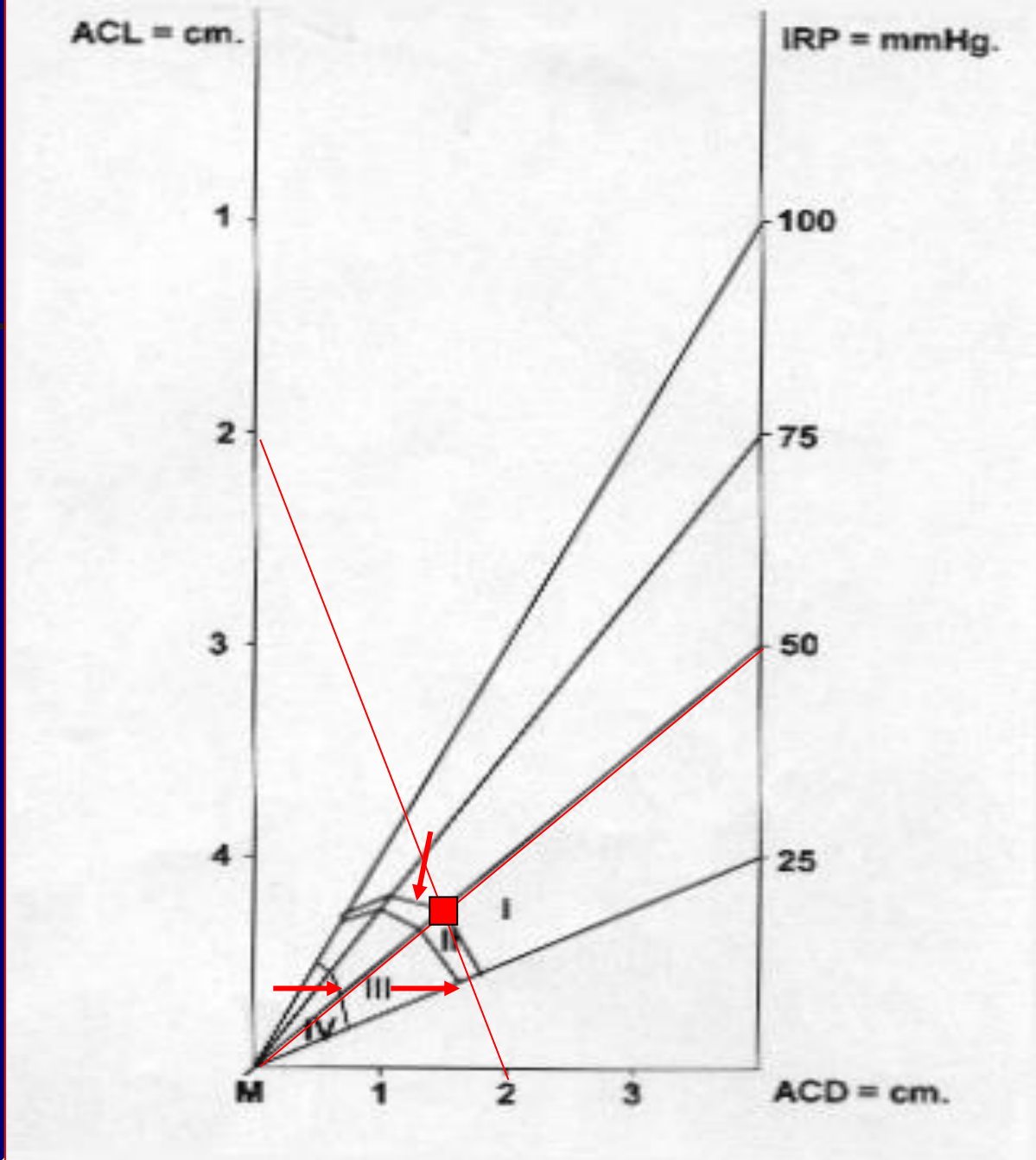
Calculate The Flow Index

Flow Index Result=

Results

Normal or Normal after correctoin of his/her Recocele, intussusception, colonic Inertia, mechanical obstruction or hard stool

[Back to Main](#)



Zone 1: Normal defecation

Zone II, III&IV: Obstructed Def.

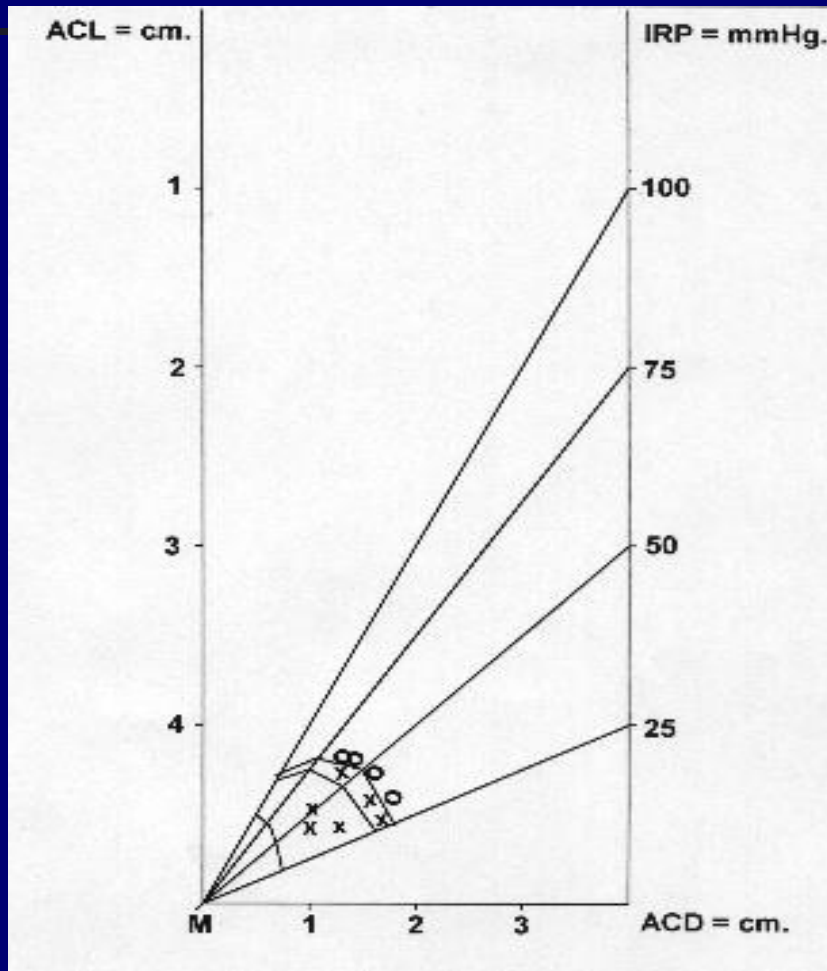
II: for soft well formed stools.

III: for fluid stools.

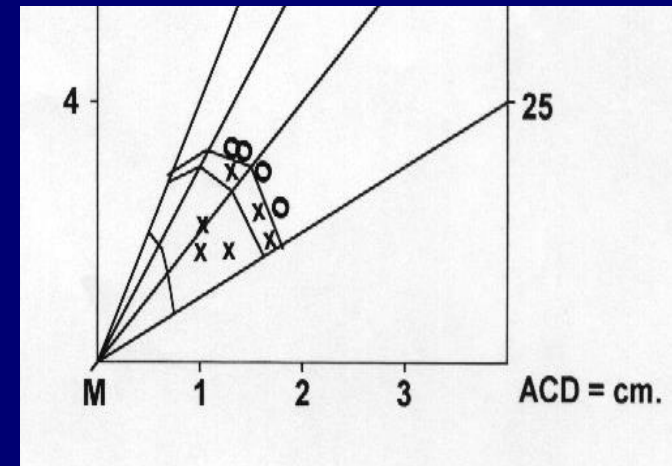
IV: For Gas.

Defecation norm gram

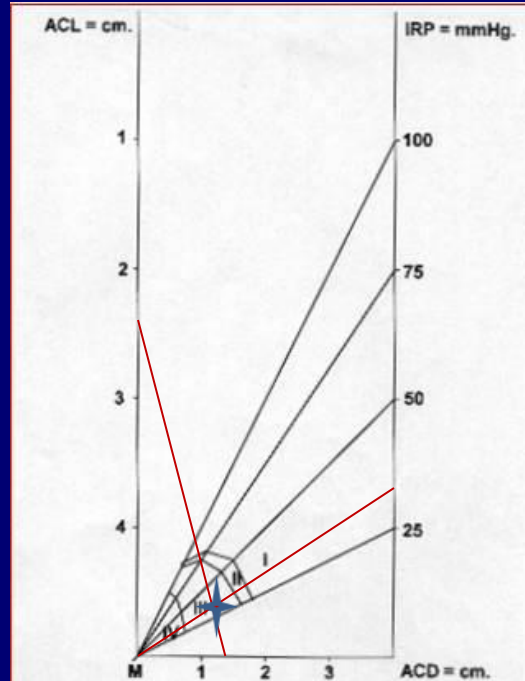
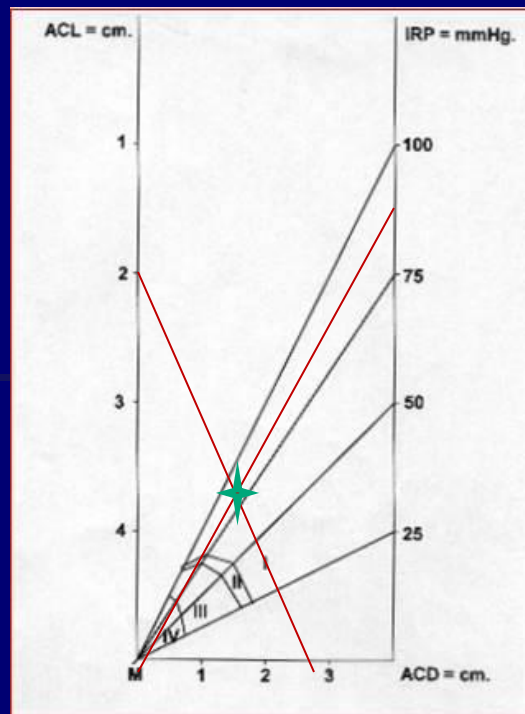
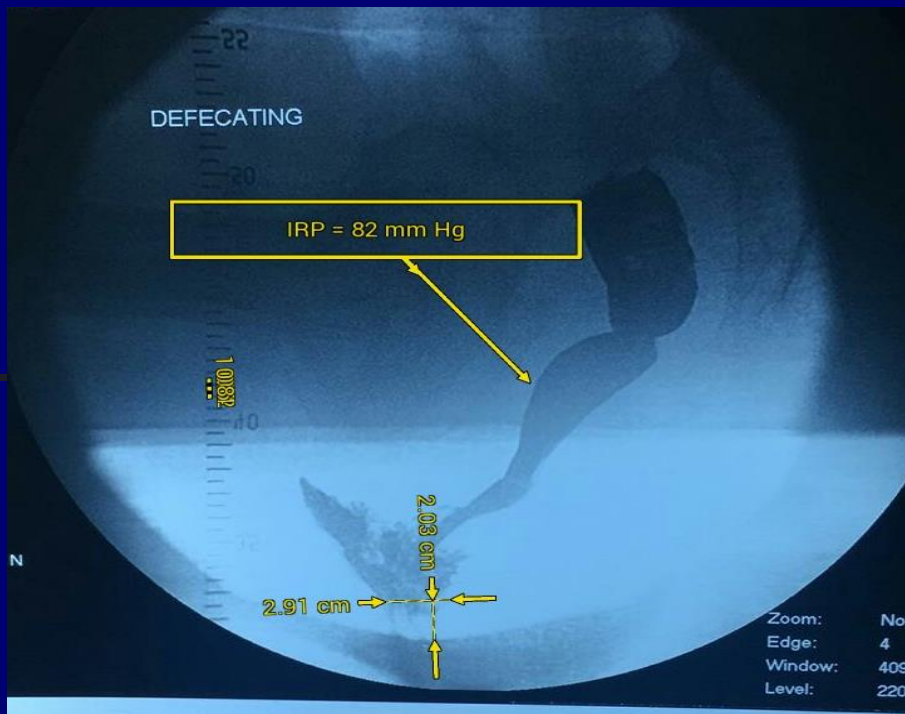
Patient selection for treatment.



O = successful cases.
x = Failures.



Rectocele Group



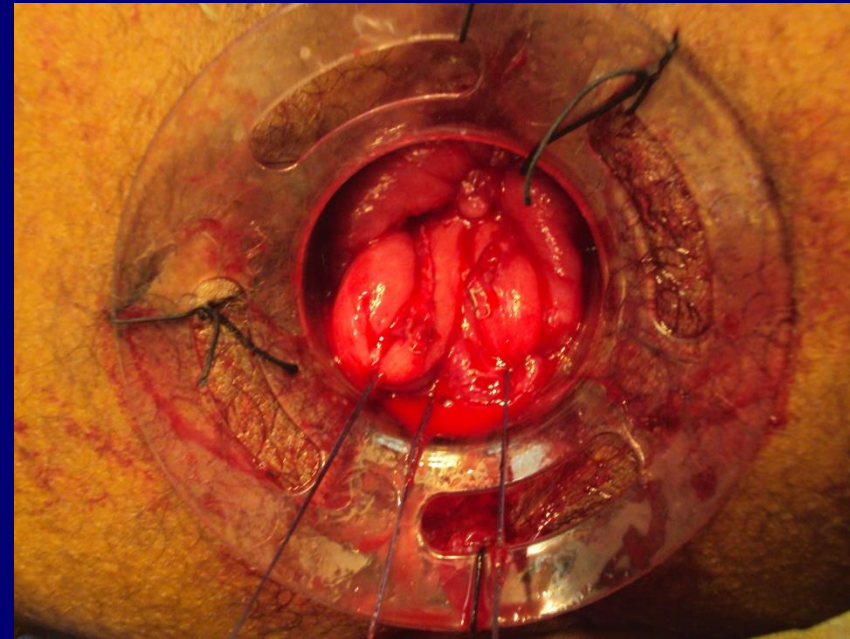
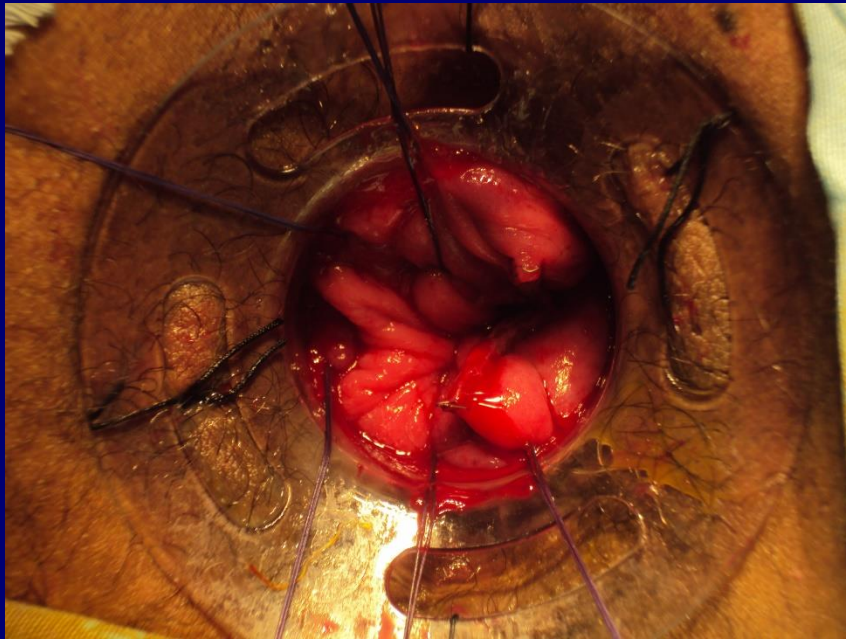


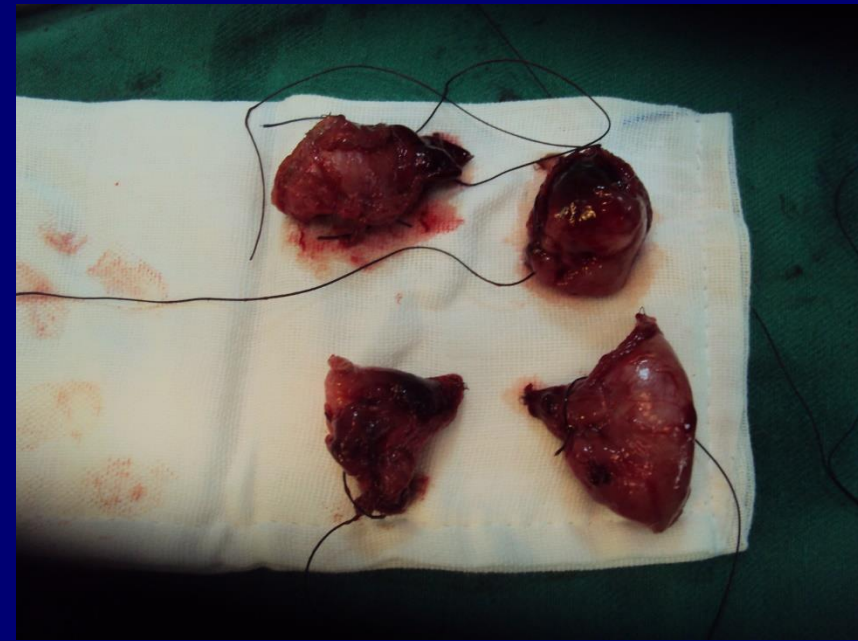
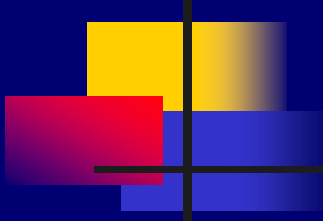
Rectal Inertia (RI)

- Normal = \geq 50 mmHg.
- Mild RI = 40 - 50 mmHg.
- Moderate RI = 30 - 40 mmHg.
- Severe RI = 20 - 30 mmHg.
- Rectal Atony = $<$ 20 mmHg.

All pressures measured as mean IRP during defecation in 3 occasions with abdominal straining, without abdominal straining and during first and extreme.

Trans-STARR + reinjection with Botox.

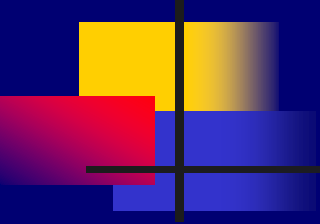






How the A. Sphincter Works
Can also Help in:

- ❑ **Predicting outcome.**
- ❑ **Operator independent assessment of treatment.**
- ❑ **Assessment of different treatment modalities if used simultaneously.**
- ❑ **Planning for New treatment modalities.**

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- Could It be the Flow equation and the Hybrid Law in Coloproctology the answer?

IntegratedColoproctology.com

A new approach for the new millennium. Profile The Theory The Equation Crystal Ball International Group

International Work Group for Integrated Coloproctology and Research Methodology.

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- The final aim of this web site is to create such group which is expected to conduct multi-center trials comparing different approaches using integrated anorectal physiology against each other and against traditional research methodology aiming at suggesting the appropriate research methodology which should be used by most of the centers all over the world for management of cases with functional anorectal disorders.
- Criteria for selection of the ideal approach in functional Coloproctology:
 - It should suggest and quantitate the mechanical factors responsible for normal continence and normal defecation.
 - It should suggest and quantitate the role played by sensory and reflex factors and how they interact with mechanical factors in normal individuals.
 - Explain and confirm the non controversial database reported previously in the literature using the traditional research methodology.
 - Clearly explain and justify the controversies reported in the data base using traditional research methodology.
 - It can diagnose and accurately quantitate the severity of Anal incontinence and constipation without overlap between normal and abnormal.
 - It should be able to quantitate the role played by each individual factor if the cause of A.I. or constipation is multifactorial in any individual patient.
 - Help in accurate planning of treatment in any particular patient.
 - Helps for predicting outcome of treatment in any individual patient.
 - Follow up of patients after treatment with accurate Quantitation of the role played individually by each treatment modality if different modalities are combined in any particular patient.
 - Helps to create new more accurate diagnostic or novel treatment modalities for functional anorectal disorders.

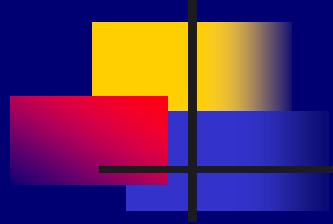
Each of the above 10 points assessment is scored from 0-10 according to its overall accuracy in achieving the suggested goals. With an overall accuracy score made of 100 points.

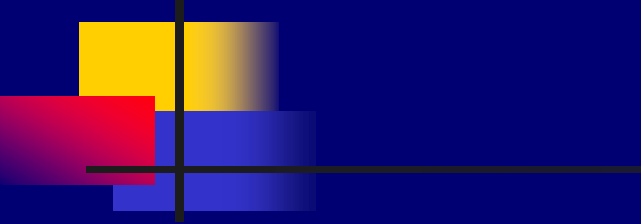
Are you interested to join us?

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Nobel Prize in Physiology or Medicine





Knowledge Is Power



Thank You

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