

Gastrointestinal sonography in children

**Azienda Ospedaliera Pediatrica
“Santobono-Pausilipon”- Napoli**

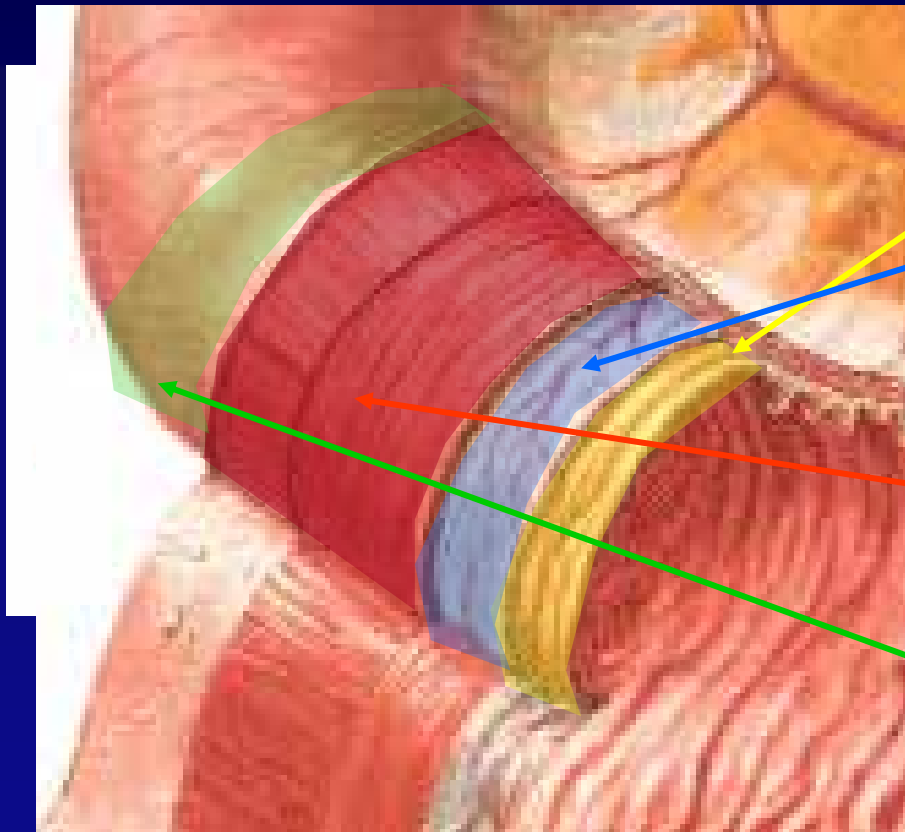
Struttura Complessa di Radiologia



Imaging

Valutazioni anatomiche

- **In particolare:**



mucosa

sottomucosa

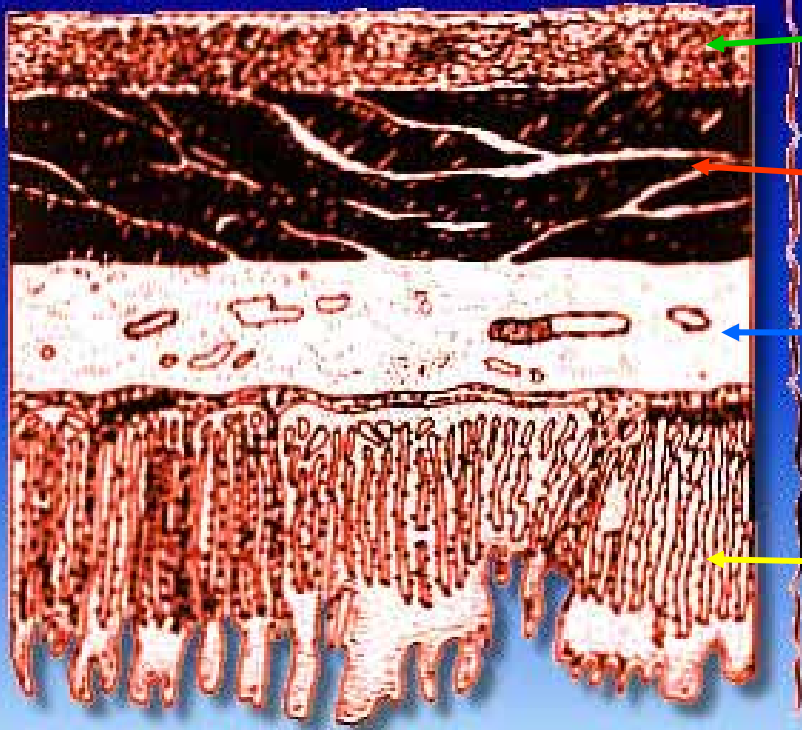
muscolare

sierosa

Imaging

Valutazioni anatomiche

- In particolare:



sierosa

muscolare

sottomucosa

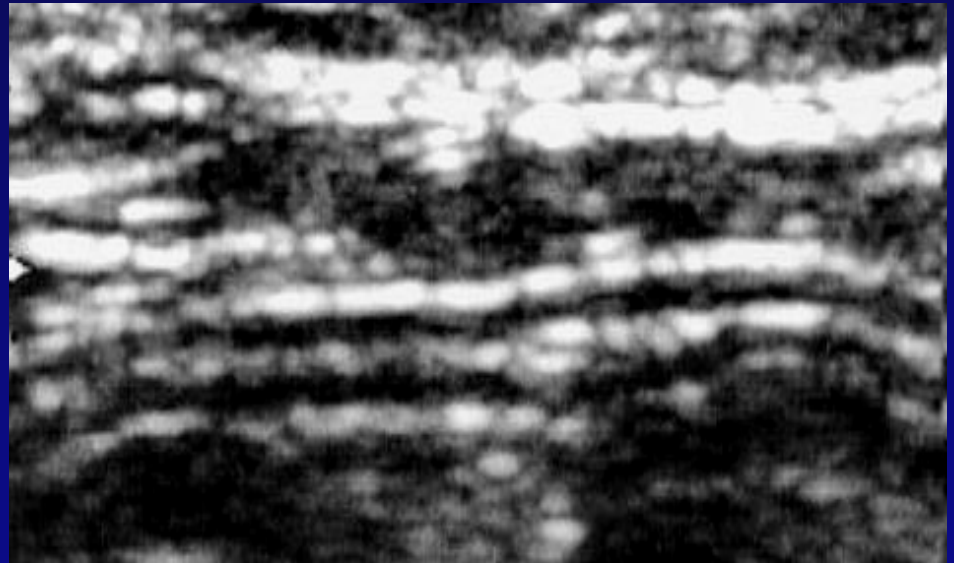
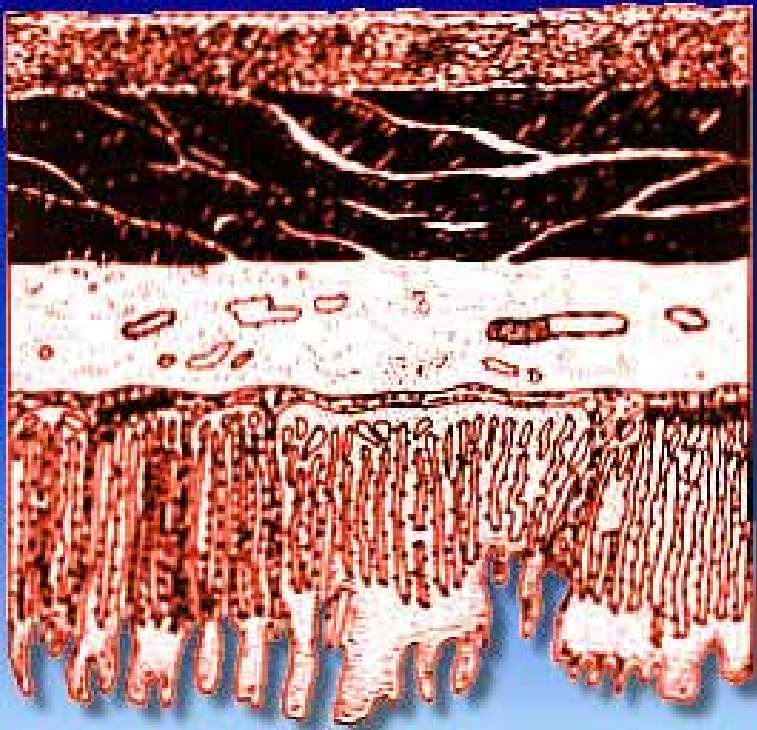
mucosa

(mucosa+muscularis mucosae)

Imaging

Valutazioni anatomico-ecografiche

- **Aspetto “a 5 strati”**



Causes of acute abdominal pain

Infant	Young child	Teenager
<ul style="list-style-type: none">• Congenital anomaly• Incarcerated hernia• Volvulus• Intussusception• Intestinal perforation• NEC• Appendicitis (rare)	<ul style="list-style-type: none">• Trauma• Meckel's diverticulum• Peritonitis• Appendicitis• Renal calculi• Intussusception (under 4 years)	<ul style="list-style-type: none">• Appendicitis• Mesenterici adenitis• Costipation• Colectitis• Gynecological causes• Litiiasi biliare (rara)• Acute Scrotum

Stringer DA. Acute Abdominal Pain. Emergency Pediatric Radiology – ARRS Categorical Course Syllabus, 1995

“Other” causes of abdominal pain

- Pneumonia
- Hyperthyroidism
- Purpura
- Poisoning

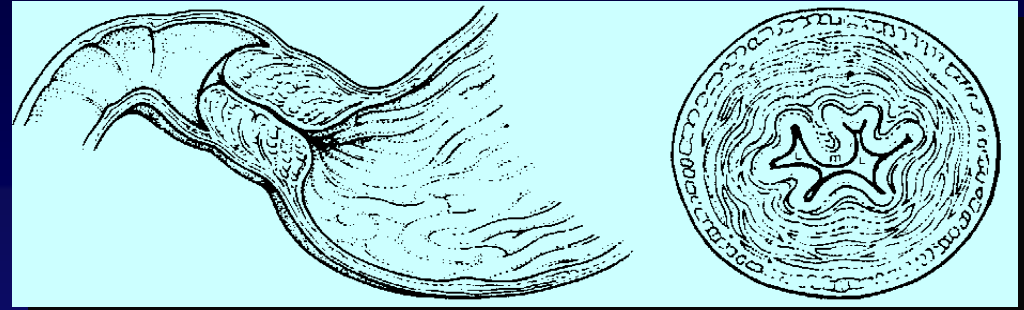
“Abdominal pain is one of the most common presentations in the pediatric emergency department.”

“The most important concern is to decide if the condition requires surgical intervention or can be managed medically.”



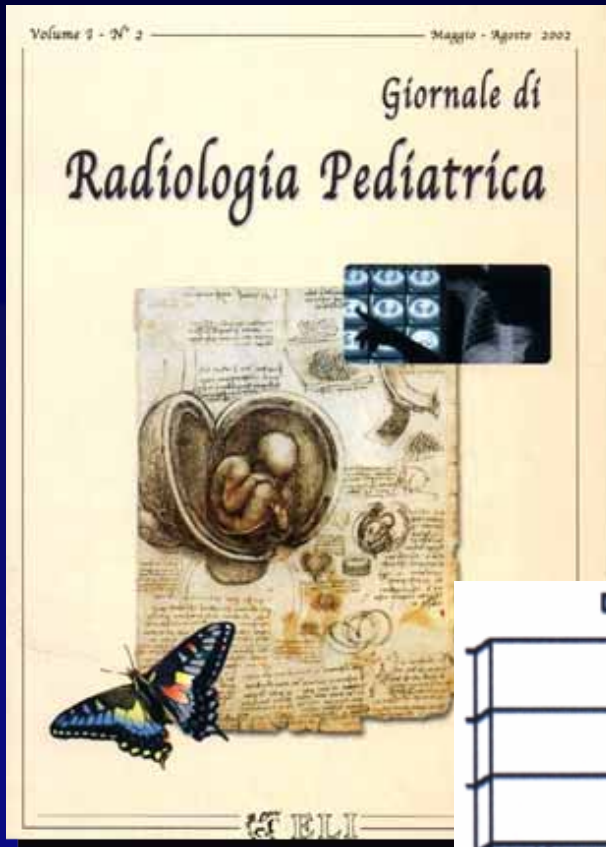
Hypertrophic pyloric stenosis

Sintomi e Segni



- Presentazione più frequente fra le 2 e 8 settimane di vita; Rapporto M:F = 4:1
- Vomito “a getto”, **non biliare**
- Palpazione dell’ “oliva pilorica” (80%)

Hypertrophic Pyloric Stenosis

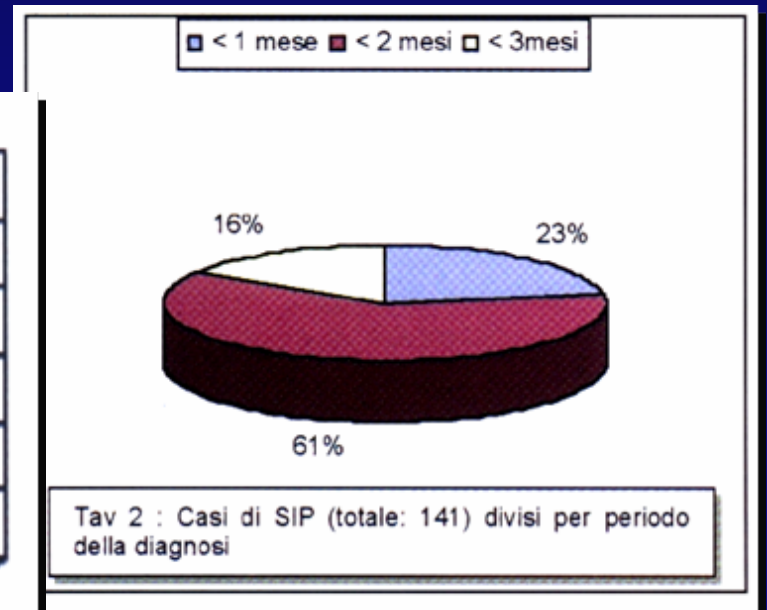
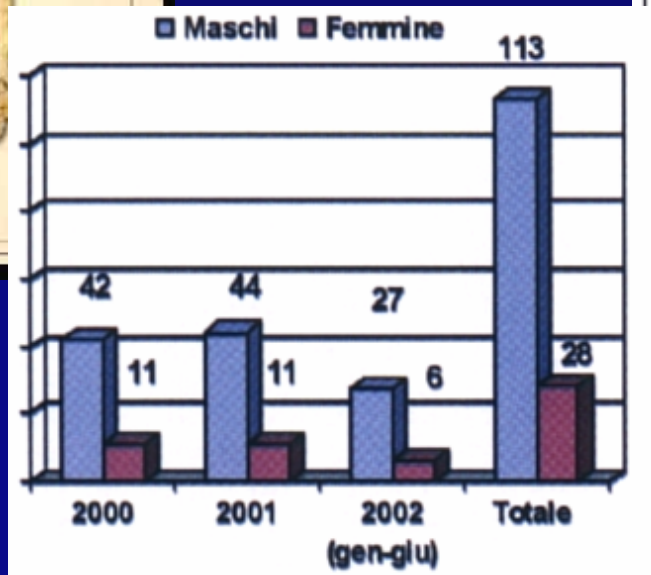


TRAINING IN IMAGING

STENOSI IPERTROFICA DEL PILORO

F. Esposito, D. Noviello, M. L. Valentino
A. Tramontano¹, G. Saggiomo²

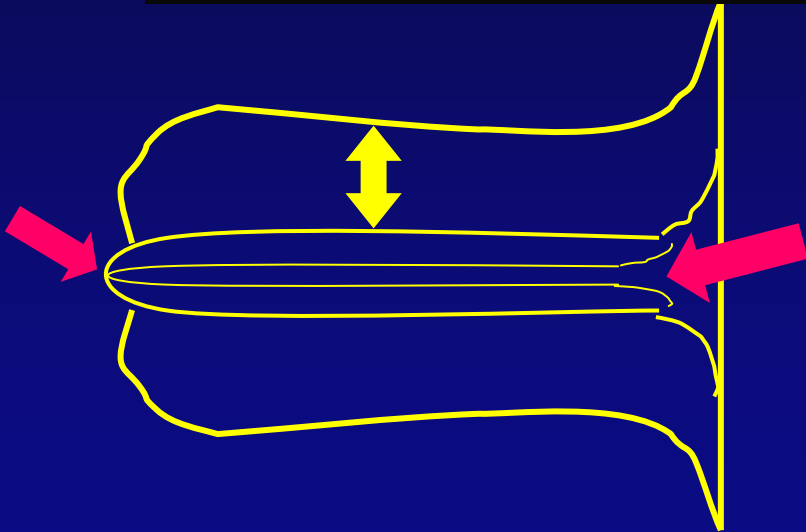
Azienda Ospedaliera Pediatrica "Santobono-Pausilipon" - Napoli
Struttura Complessa di Radiologia
¹ Struttura Complessa di Chirurgia d'Urgenza



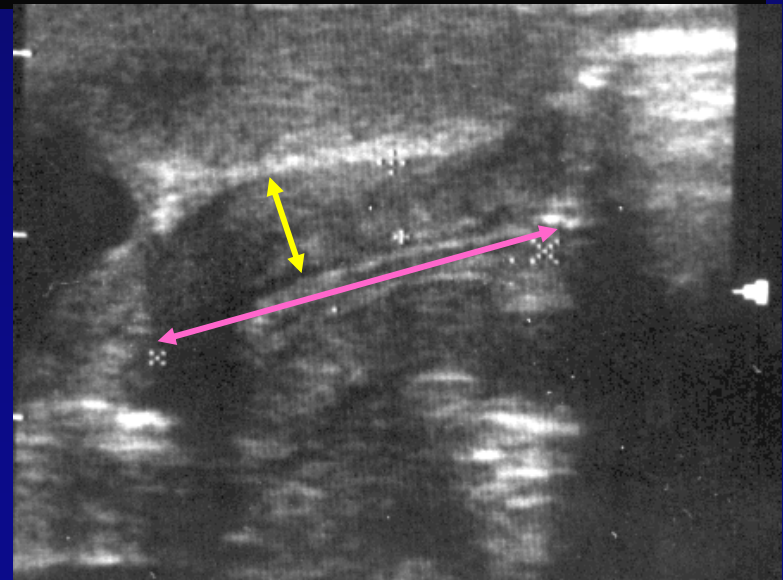
Hypertrophic Pyloric Stenosis

US diagnosis

Muscular thickness ≥ 4 mm



Channel length ≥ 18 mm



MALROTATION



Improper word

**INCOMPLETE
ROTATION**

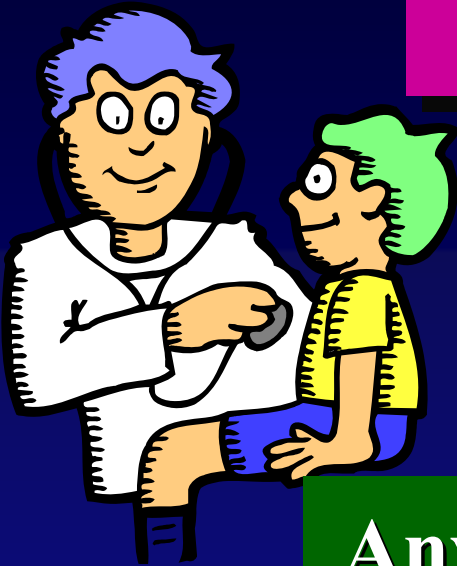
Malrotation

Immediate diagnosis of malrotation with volvulus is an absolute priority to prevent ischemia or intestinal necrosis



Malrotation

Signs and Symptoms

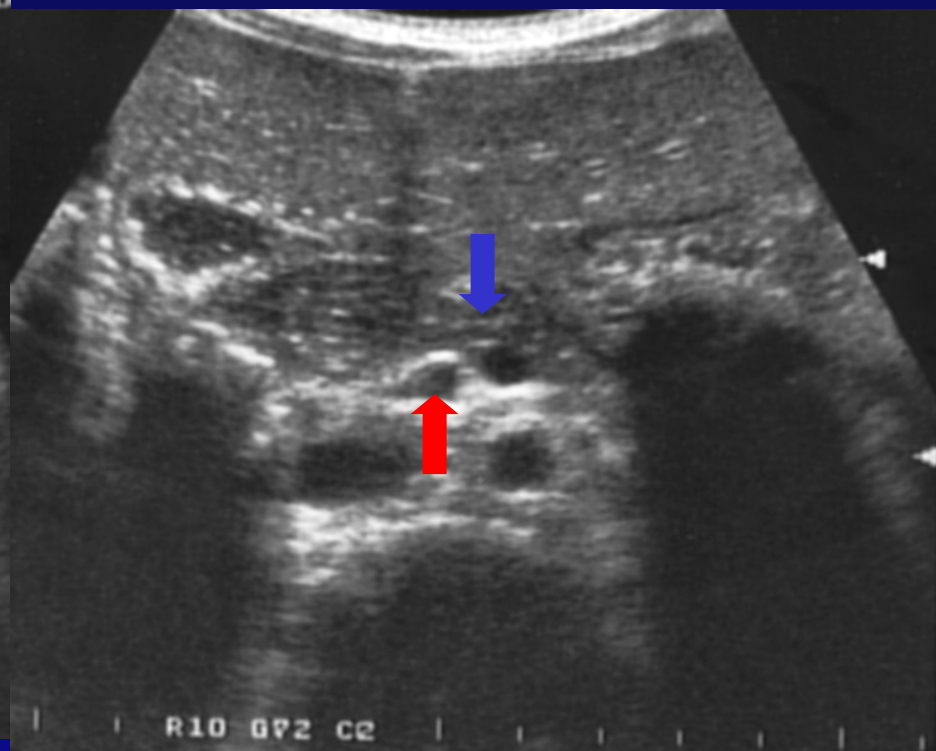
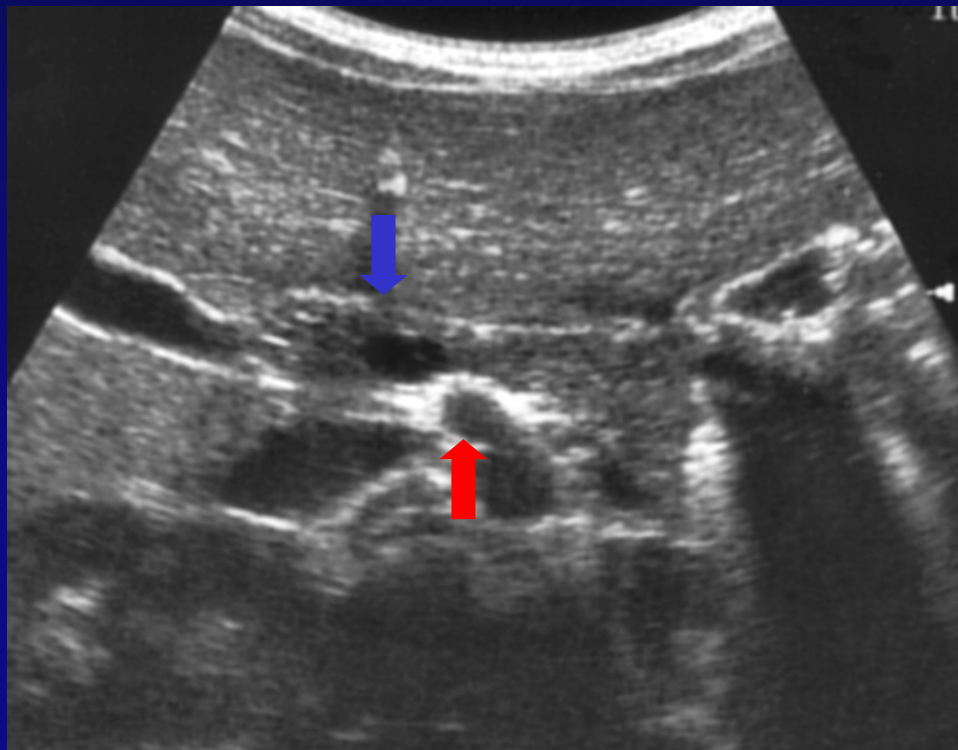


Any newborn with green vomiting must be considered to be suffering from a malrotation with volvulus until proven otherwise

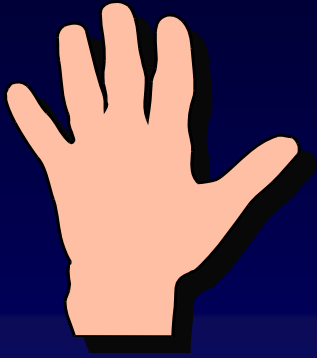
Malrotation

ultrasound findings

Inversion of the mesenteric vessels



Malrotation



Caution!

Approximately 1/3 of patients with documented malrotation surgically show normal vascular relationships

VOLVULUS

Twisting

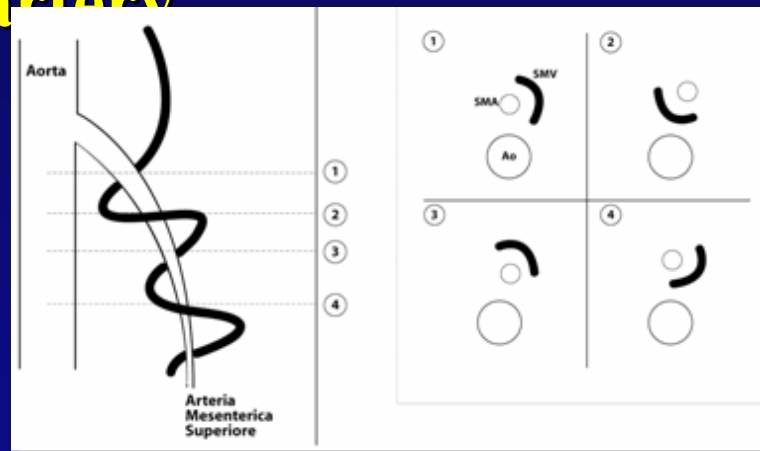
Any loop can make a twist if sufficiently dilated and/or solidarity with a mass

In this case: **twisting on the short mesentery around the superior mesenteric artery**
(Condition frequent in patients with malrotation)

Volvulus

ultrasound findings

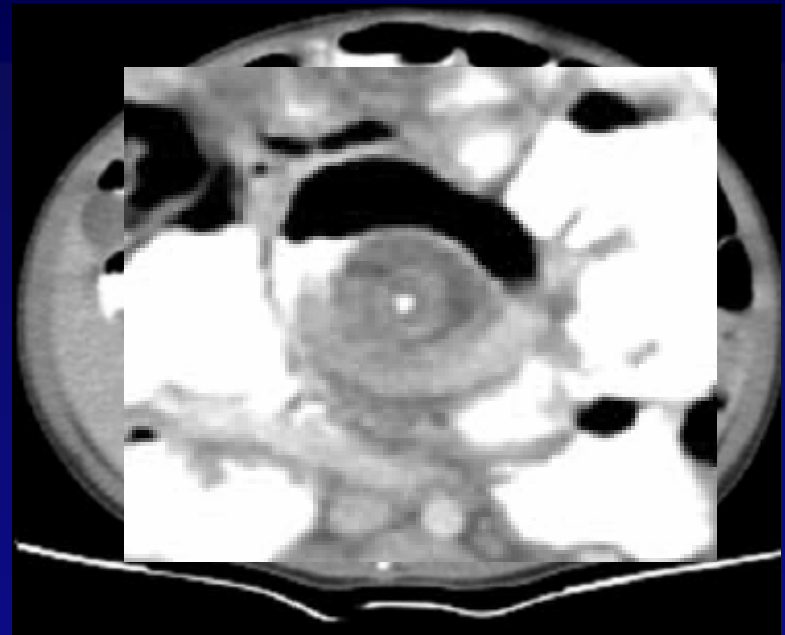
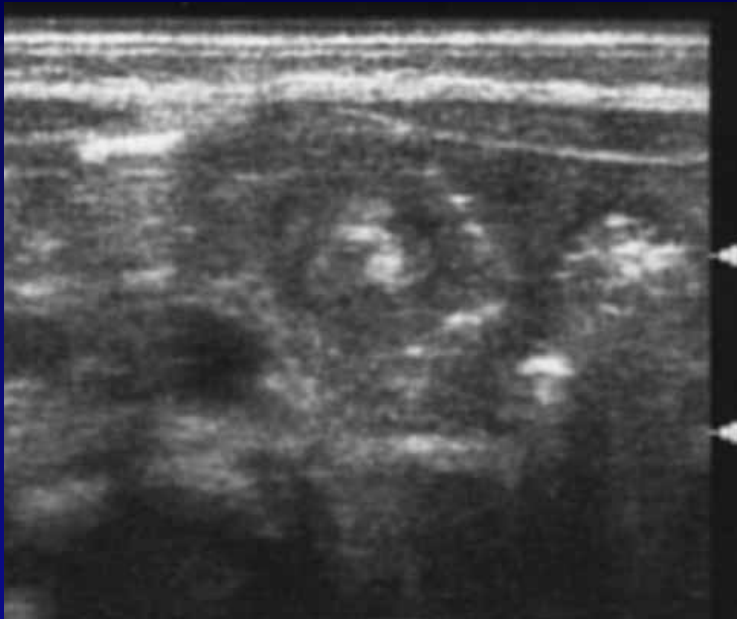
- Twisting on superior mesenteric vein
- twisting on mesentery around the superior mesenteric artery



Whirlpool sign

Volvulus

Integrated imaging



Whirlpool sign

Volvulus



Is effective the “whirpool sign”?

	N. Pts	Sens.	Spec.
Shimanuki Radiology 1996	160	92%	100%
Chao JUM 2000	31	89%	92%

Personal series (abbiamo i nomi e cognomi!)	31 (gen. 2000-dic. 2003)	79%	100%
---	------------------------------------	------------	-------------

Volvulus

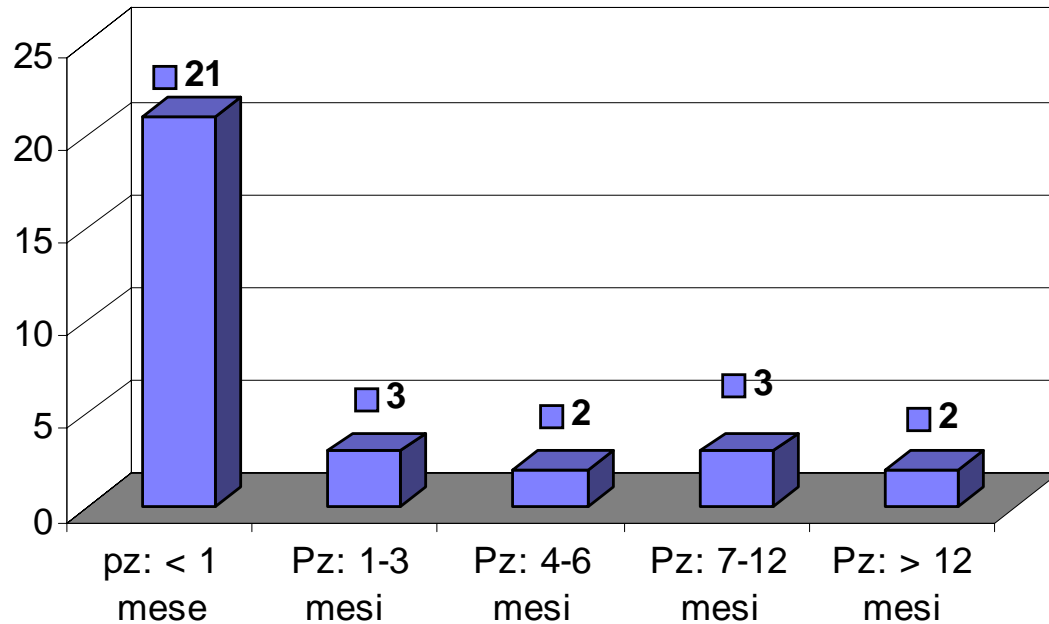
Perbacco!!

Table 1. Patient Age and Presenting Symptoms

Age	Signs/Symptoms
1 d	Distended abdomen/pulmonary hypoplasia, palpable mass
1 mo	Projectile nonbilious emesis
9 mo	Palpable abdominal mass, chronic diarrhea
2 y	Abdominal pain
2¼ y	Colicky abdominal pain, suspicion of intussusception
3⅙ y	Bilious emesis and suspicion of intussusception
5½ y	Vomiting and suspicion for appendicitis



Intestinal malrotation



SANTOBONO PAUSILIPON
AZIENDA OSPEDALIERA PEDIATRICA

Personal series: Gen 2000 – Dic 2003

Volvolus

Volvolus

Perbacco!!

Table 1. Patient Age and Presenting Symptoms

Age	Signs/Symptoms
1 d	Prolonged abdominal tenesmy, hypotonia, palpable mass
1 mo	Projectile nonbilious emesis
9 mo	Palpable abdominal mass, chronic diarrhea
2 y	Abdominal pain
2 1/2 y	Colicky abdominal pain, suspicion of intussusception
1 1/2 y	Intermittent vomiting and suspicion of intussusception
4 1/2 y	Vomiting and suspicion for appendicitis



Utility of the Sonographic Whirlpool Sign in Diagnosing Midgut Volvulus in Patients With Atypical Clinical Presentations

J Ultrasound Med 23:397-401, 2004

Maria Olga Patino, MD, Martha M. Murden, MD

Objective. To illustrate cases of midgut volvulus in 7 children, of whom 6 were diagnosed initially by sonography using the whirlpool sign, and to emphasize the importance of including malrotation and midgut volvulus in the differential diagnosis of acute or chronic abdominal pain in those beyond the neonatal period, the usual time of presentation for midgut volvulus. **Methods.** A sonography computer database of a large pediatric hospital was reviewed over a 26-month period for sonographic reports that contained the key words *midgut volvulus* and *whirlpool sign*. From November 1999 until January 2002, 7 patients had a sonographic diagnosis of midgut volvulus on the basis of the whirlpool sign. Sonographic and surgical records of these patients were reviewed retrospectively. In addition, the department computer database of all contrast-enhanced upper gastrointestinal examinations performed over the same period was searched using the key words *midgut volvulus*, and an additional 2 cases of midgut volvulus were found, neither of which had undergone a prior or subsequent sonographic study. **Results.** Seven patients, ranging in age from 1 day to 5 1/2 years, were found to have the whirlpool sign on sonography performed for acute abdominal symptoms, including projectile nonbilious emesis, colicky abdominal pain with suspicion of intussusception, palpable abdominal masses, right lower quadrant abdominal pain with suspected appendicitis, and chronic diarrhea. Six of the 7 cases of midgut volvulus were confirmed with upper gastrointestinal examinations. One patient was

confirmed as midgut volvulus at surgery. **Conclusions.** The sonographic whirlpool sign is a valid and highly sensitive sign for the diagnosis of midgut volvulus secondary to malrotation, and sonographers should be aware that it frequently occurs beyond the neonatal period with symptoms other than bilious emesis. **Key words:** malrotation; midgut volvulus; whirlpool sign

Caution!



Take home message!



- **When US cannot exclude a diagnosis of malrotation, upper GI examination is still the best choice**
- **Abdominal US examination **must routinely** include the study of mesenteric vessels**

Appendicitis

Diagnosis!

“Appendicitis is the most common cause of acute abdominal pain that necessitates surgical intervention in the Western world”

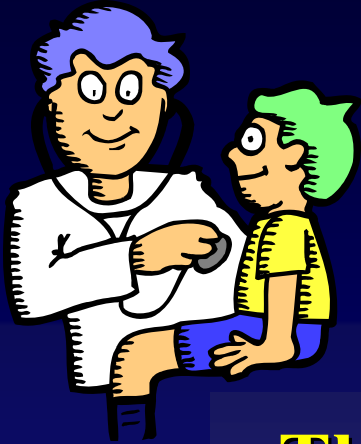
Kessler N - Radiology 2003

“After gastroenteritis, appendicitis is the most common acute abdominal inflammatory problem in childhood, and its accurate diagnosis remains as challenging as ever”

Swischuk L E - 2000



Appendicitis



Signs and symptoms

- **The clinical signs of appendicitis are well known...**
- **...but, OF COURSE, are not always necessarily present!**

Mimics of Appendicitis



Acute Mesenteric Adenitis
Acute gastroenteritis
Meckel's Diverticulitis
Intussusception
Crohn's disease
Perforated peptic ulcer
Diverticulitis
Epiploic appendagitis
Urinary tract infection
Ureteric stone
Primary peritonitis
Henoch-Schonlein purpura
Yersiniosis
Diseases of the Male: Testicular torsion
Epididymitis
Seminal vesiculitis
Gynecologic disorders: Pelvic inflammatory disease (PID)
Ovarian cyst or torsion
Endometriosis
Ruptured ectopic pregnancy
Rectus sheath hematoma
Cholecystitis



Appendicitis

Diagnosis

Role of the imaging

- ◆ Facilitating an early correct diagnosis
- ◆ Formulate any differential diagnosis
- ◆ Reduce the percentage of negative laparotomie
- ◆ Limiting the bowel perforations and other complications
- ◆ Reduce the intensity and the cost of care

Appendicitis

Diagnosis

Ultrasound



“Although there are those who still claim that the diagnosis of the appendicitis is clinical, with experience, one comes to the conclusion that ultrasound is much more sensitive”

Swischuk L E - 2000

“Who carried out the investigation must be an expert in paediatric gastrointestinal ultrasound and must make use of equipment last generation. If these conditions are missing is preferable the clinical diagnosis because it threatens to worsen the outcome with false positives or dangerous delays in diagnosis”

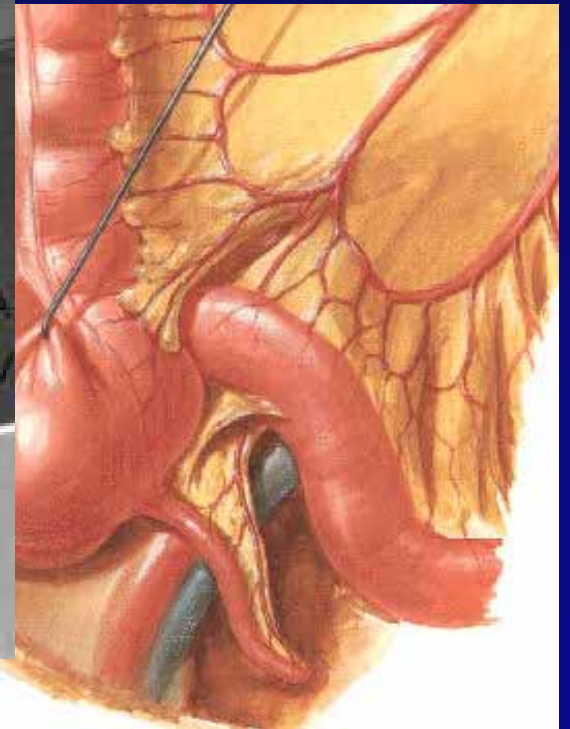
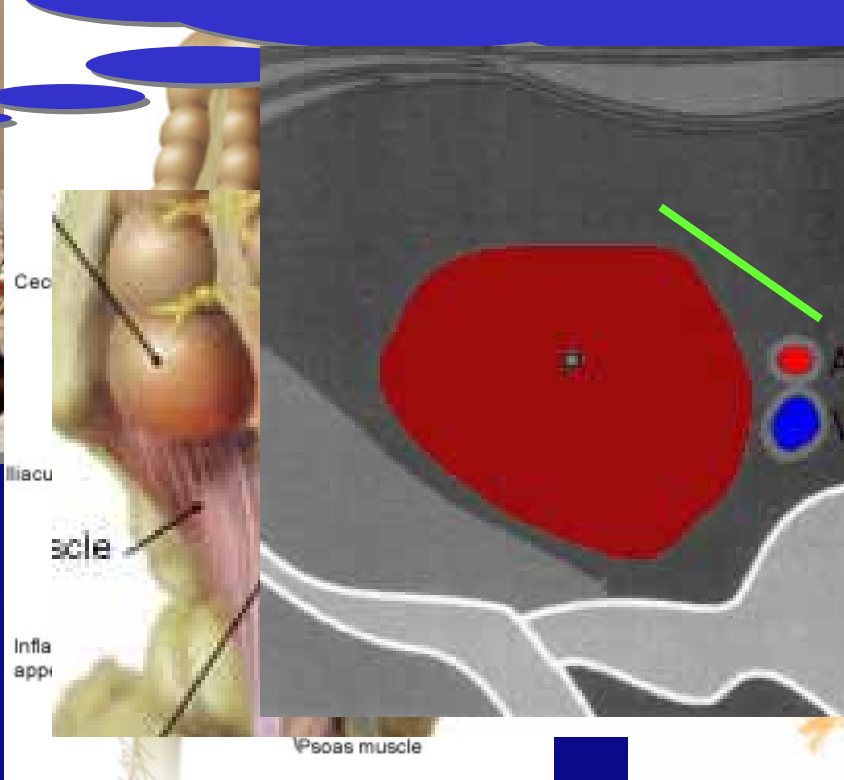
Tomà et al - 2002

Appendicitis

Diagnosis

Ultrasound

But look where for the appendix?



Appendicitis

Pathological findings

- presents of hypervascular, aperistaltic, sausage-like, blind-ending, concentric layered structure
- not or only moderately compressible
- ≥ 6 mm diameter
- inflamed, hyperechoic, not compressible mesenteric or omental fat hyperemia parietale
- wall thickening of the contiguous intestinal loops



Appendicitis

Appendicite



Ma l'Ecografista è di aiuto?

Julien R. C. M. Puytaert, MD, PhD

When in Doubt, Sound It Out¹

Radiology -1994

Ultrasound can help?

	1991	1994	1997	2000
Appendicectomie	406	334	407	397
Appendicectomie negative	23%	8.7%	8.0%	4.0%
Pazienti sottoposti a US	1.0%	41%	91%	98%

Kaiser S et al.: Eur J Pediatr Surg 2004

When you make ultrasound?

Every time there is
a doubt!

Julien B. C. M. Puylaert, MD, PhD

When in Doubt, Sound It Out¹

Radiology -1994

I agree, dear
colleague!

I am sure: the
diagnosis is
appendicitis!



Julien B. C. M. Puyf

When in Doubt, Sound It Out¹

Radiology -1994

Appendicite



Ma l'Ecografista è di aiuto?

Julien B. C. M. Puylaert, MD, PhD

When in Doubt, Sound It Out!

Radiology -1994

Negative predictive value of an appendix < 6 mm

Nicolas Kessler, et al. Appendicitis: Evaluation of Sensitivity, Specificity, and Predictive Values of US, Doppler US, and Laboratory Findings. Radiology 2004;230:472-478

98%

Rettenbacher T. Outer Diameter of the Vermiform Appendix as a Sign of Acute Appendicitis: Evaluation at US Radiology. 2001;218:757-762

100%

Rioux M. Sonographic detection of the normal and abnormal appendix. AJR 1992; 158:773-778

98%

Ultrasound allows to exclude with high accuracy the diagnosis of acute appendicitis.

Appendicite



Ma l'Ecografista è di aiuto?

Julien B. C. M. Puylaert, MD, PhD

When in Doubt, Sound It Out¹

Radiology -1994

**Non visualization of the appendix :
VPN = 90%-100%**

“... non visualization of the appendix can only be valid as an accurate finding to exclude appendicitis for...

...sonographers who can usually identify a normal appendix.”

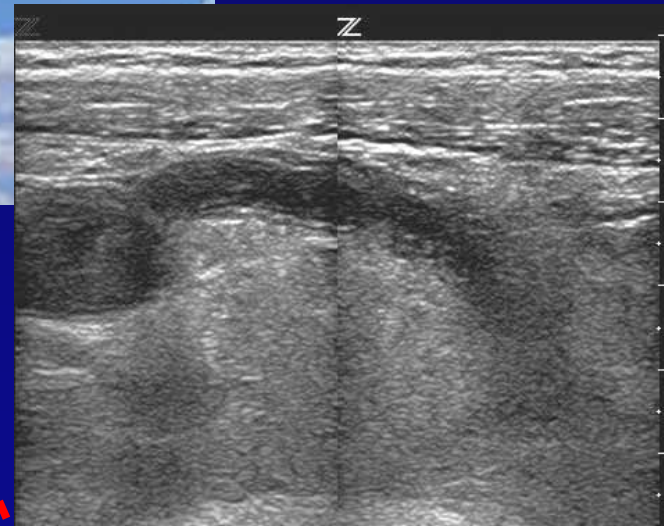
Nicolas Kessler, et al. Appendicitis: Evaluation of Sensitivity, Specificity, and Predictive Values of US, Doppler US, and Laboratory Findings. Radiology 2004;230:472-478

Make diagnosis of appendicitis is possible...

... if ...

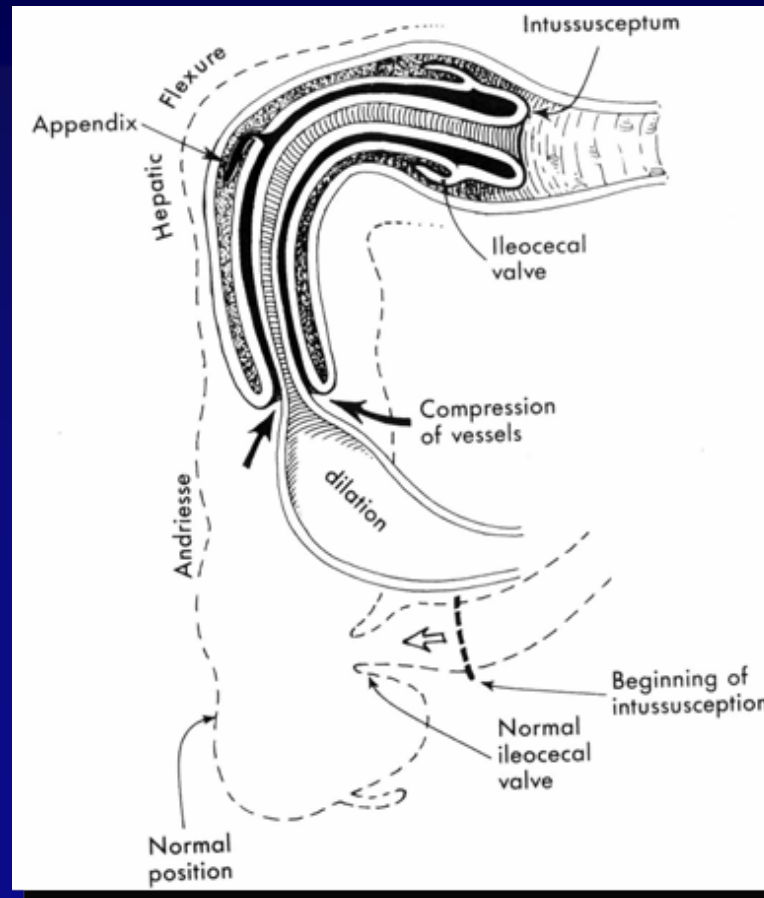


... you have an operator with a view "pointing"!

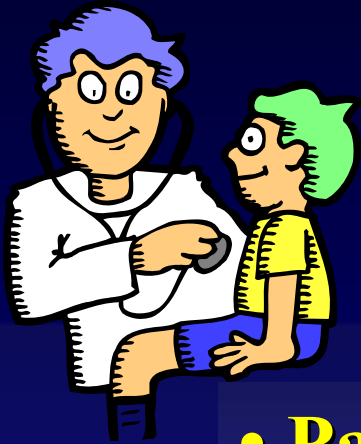


Intussusception

Intussusception is the invagination or telescoping of one portion of intestine into the contiguous distal segment



Intussusception



Signs and Symptoms

“Classical” clinical triad

- Paroxysmal abdominal pain (80-90%)
- Ematic stool (60-65%)
- Abdominal palpable massa (90%)

Present at the same time in less than 50% of cases!



Ma l'Ecografia è di aiuto?

Julien B. C. M. Feytaert, MD, PhD

When in Doubt, Sound It Out!

Radiology -1994

US Diagnostic Accuracy: 100%

Pacros et al . *Acute intestinal intussusception in children: contribution of ultrasonography (145 cases). Ann Radiol. 30:525-530; 1987*

Verschelden P et al . *Intussusception in children:relyability off US diagnosis – a prospective study. Radiology.184:741-744; 1992*

del Pozo et al . *Intussusception in children:currente concepts in diagnosis and enema reduction. Radiographics.19:299-319; 1999*



Ma l'Ecografia è di aiuto?

Julien B. C. M. Frylaet, MD, PhD

When in Doubt, Sound It Out!

Radiology -1994

Negative predictive value 100%

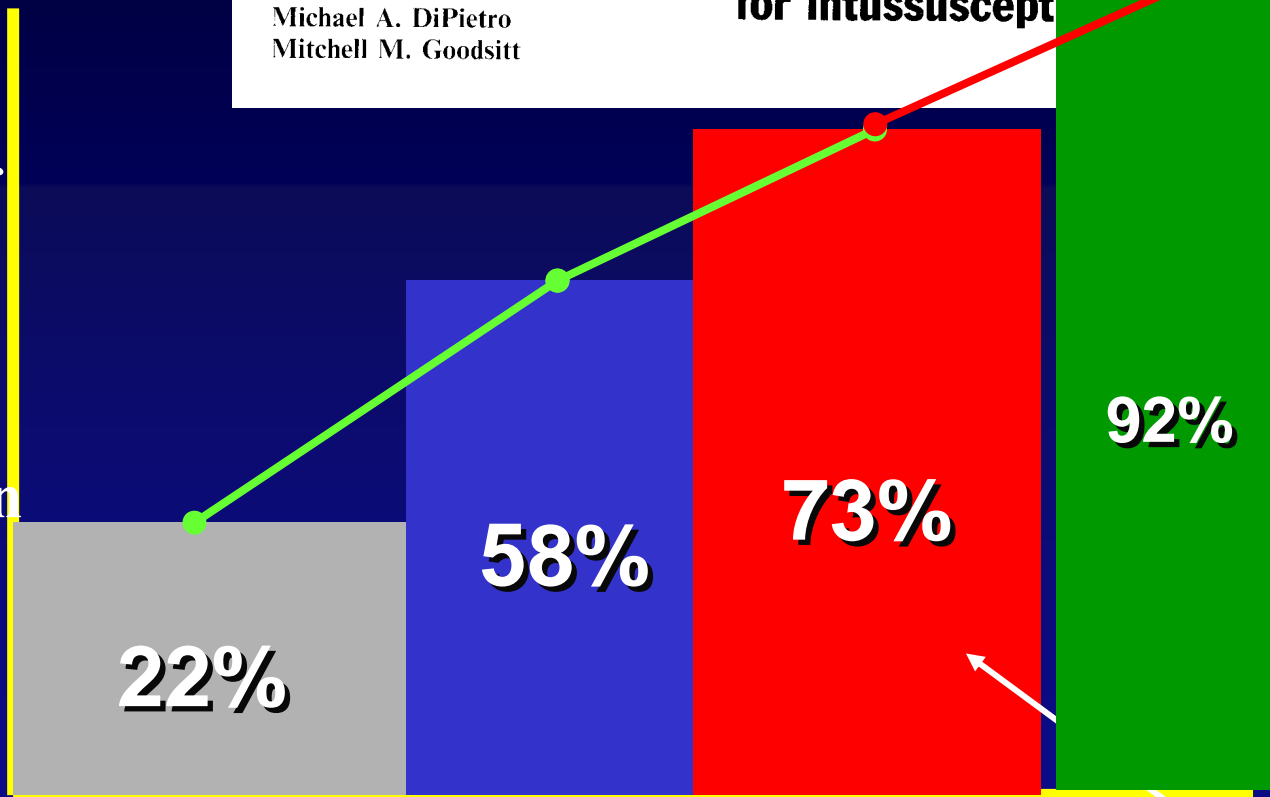
**Verschelden P et al . *Intussusception in children: reliability off US diagnosis – a prospective study*
*Radiology.184:741-744; 1992***

Ultrasound allows to exclude with high accuracy diagnosis of Invaginazione

Susan Henrikson
Caroline E. Blane
Khalidoun Koujok
Peter J. Strouse
Michael A. DiPietro
Mitchell M. Goodsitt

The effect of screening sonography on the positive rate of enemas for intussusception

Percentage of positivity to clisma in suspected intussusception



Pre-eco

training

Post-training

US some negative cases

1995-2000

2001-2002

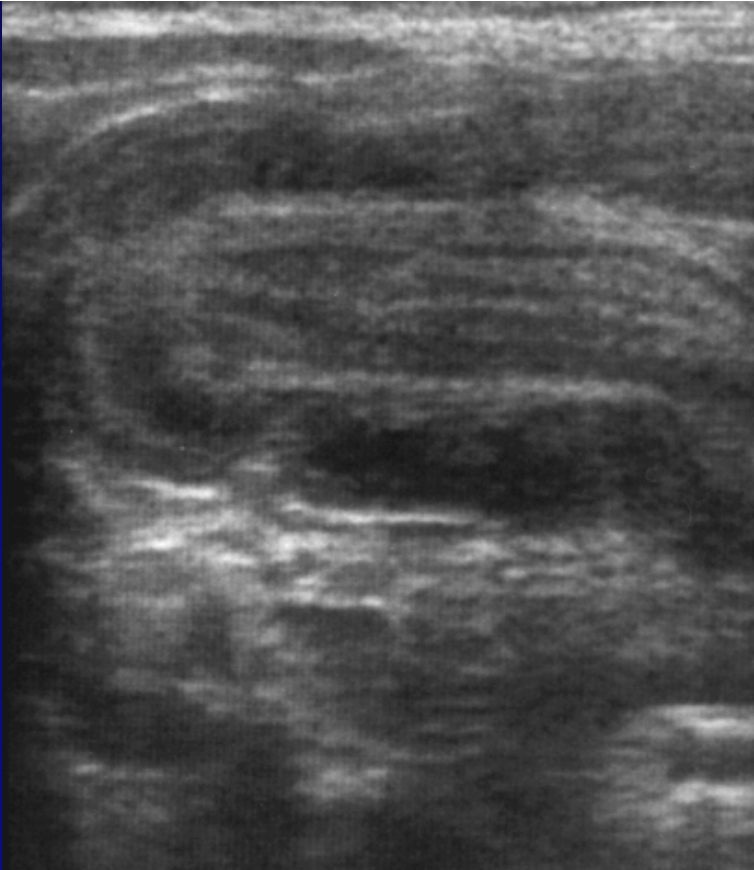
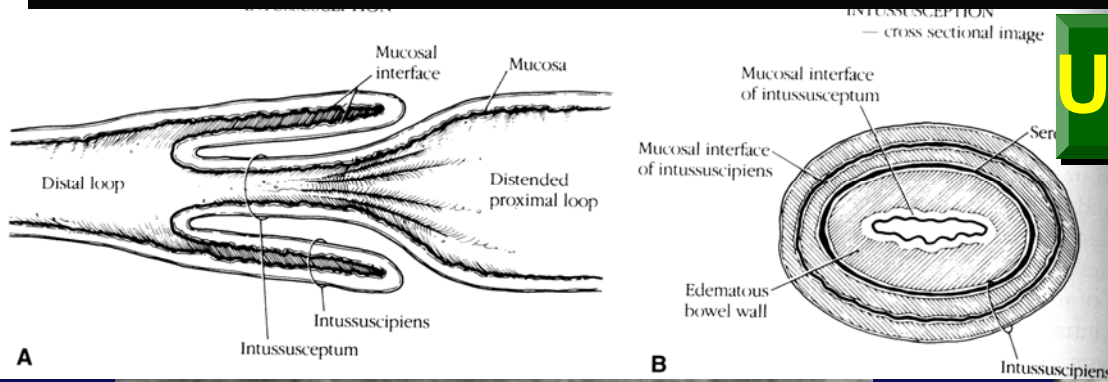
Susan Henrikson
Caroline E. Blane
Khalidoun Koujok
Peter J. Strouse
Michael A. DiPietro
Mitchell M. Goodsitt

**The effect of screening sonography
on the positive rate of enemas
for intussusception**

***“We know of no case of
intussusception missed at US”***

Intussusception

Ultrasound findings



Ultrasound signs indicative of irreducibility dell'invaginazione: myth or reality?

Segni ecografici indicativi di irriducibilità dell'invaginazione in età pediatrica. Nostra esperienza e review della letteratura

F. Esposito¹, M. Quarantelli², D. Noviglio¹, M.L. Valentino¹, S. Russo¹, V. Giorgio¹, G. de Stefano¹, G. Ferricelli⁴, A. Giorgio¹

¹ Azienda Ospedaliera Pediatrica "Sanctobono-Pasquipoti" - Struttura Complessa di Radiologia - Napoli

² Università degli Studi di Napoli "Federico II" - DAS Diagnostica per Immagini e Radioterapia

³ Azienda Ospedaliera Pediatrica "Sanctobono-Pasquipoti" - Struttura Complessa di Chirurgia d'Urgenza - Napoli

⁴ Azienda Ospedaliera "D. Cotugno" - Servizio di Ecografia ed Ecointerventistica - Napoli

Poster presentato al XVI Congresso Nazionale SIUMB 2004

Parole chiave: Invaginazione;
Clisma opaco; Ecografia

Scopo. Valutare se vi sia relazione fra diversi pattern ecografici dell'invaginazione e la presenza o meno di linfonodi, rispetto alla percentuale di riduzione con clisma opaco.

Materiale e Metodi. Sono stati esaminati 254 bambini (145 M, 109 F; età 1- 48 mesi) con diagnosi ecografica di invaginazione intestinale, confermata al clisma opaco.

Si sono valutati i seguenti segni:

- aspetto ecografico dell'invaginazione in sezione trasversale: "target-sign" (multipli anelli concentrici, con un centro più o meno ecogeno), "doughnut-sign" (ampia rima ipoeogena periferica circondante area centrale francamente ipereogena),
- presenza di linfonodi nel contesto dell'invaginazione.

Nello studio sono stati inclusi solo casi in cui erano individuabili due o più linfonodi con asse maggiore uguale o superiore a 12 mm. Tutti i bambini sono stati sottoposti a clisma opaco entro 45 minuti dall'esame ecografico.

Risultati. 165 pazienti presentavano pattern ecografico cosiddetto "doughnut-like"; 89 mostravano un pattern tipo "target-like".

206 pazienti non presentavano linfonodi nel contesto dell'invaginazione, 48 casi mostravano presenza di due o più linfonodi con asse maggiore >12 mm.

Il clisma opaco baritato, eseguito entro 45 min dall'esame ecografico, otteneva la riduzione dell'invaginazione in 106 (64%) pazienti con "doughnut-like" pattern e in 59 (66%) con "target-like" pattern. Inoltre si otteneva la disinvaginazione in 29 (60%) pazienti con presenza di linfonodi e in 136 (66%) in cui non si visualizzavano ecograficamente linfonodi nel contesto dell'invaginazione.

Conclusioni. Sebbene si sia ottenuta una riduzione dell'invaginazione in percentuale leggermente inferiore nei ricorrenti con "doughnut-like pattern" questa differenza non è apparsa statisticamente

Giornale Italiano di Ecografia, 2006

successi nella riduzione nei pazienti senza linfonodi non negativa qualora siano presenti linfonodi omogenee coinvolte. Valutare l'ispessimento della porzione esterna dell'invaginazione e la presenza di linfonodi come controindicazioni al tentativo di riduzione.

Ultrasound signs indicative of irreducibility dell'invaginazione: myth or reality?

	N. pazienti	N. riduzioni	(%)
Pattern intussusception			
Target-like	89	59	66
Doughnut-like	165	106	64

	N. pazienti	N. riduzioni	(%)
Presence of lymphnodes			
Con Linfonodi	48	29	60
Senza Linfonodi	206	136	66

Ultrasound signs indicative of irreducibility dell'invaginazione: myth or reality?

“It is extremely difficult to predict whether intussusception may have necrosis or will be irreducible based on sonographic features alone”

Conclusion...

*“Note of any of the above-mentioned features may alert one to the possibilities of necrosis or irreducibility but does **not preclude** an attempted reduction by enema”*

Intestinal sonography in children

Conclusion

However, it has been shown that transabdominal sonography achieves good to **excellent results** as a directed tool for evaluating potential bowel disorders: appendicitis can be diagnosed with a sensitivity ranging from 80% to 93% and a specificity between 94% and 100%.

Bowel Wall Thickening on Transabdominal Sonography

Hans Peter Ledermann¹, Norbert Börner², Holger Strunk³, Georg Bongartz¹, Christoph Zollikofer⁴, Gerd Stuckmann⁴

AJR:174, January 2000

The information provided by sonography allows a more complete understanding of the state of the bowel and may thus make management decisions easier and potentially change outcome.