

Dünndarm- Endoskopie

Fokus: Spiral-Enteroskopie

 **INSEL**SPITAL
UNIVERSITÄTSSPITAL BERN
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BERN UNIVERSITY HOSPITAL

u^b

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**UNIVERSITÄT
BERN**

Reiner Wiest

Enteroskopie- Power-Spiral und mehr

Dünndarm: Besonderheiten (Physiologie)

Push-/Single-/Doppel-Balloon-Enteroskopie

Indikationen für Enteroskopie

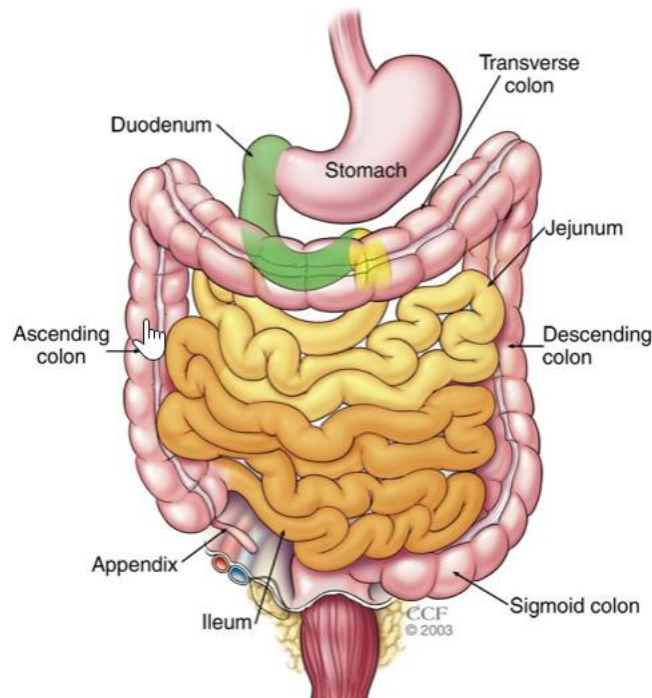
Material, Ablauf, Prinzip der Spiral-Enteroskopie

Datenlage: Effektivität, Komplikationen....

Outlook

PHYSIOLOGIE

Welcher Abschnitt ist für Ueberleben am wichtigsten ?



esophago-
gastro-
duodeno-

intestino-

colo-
rectaler

Verdauungsschlauch

Dünndarm-Besonderheiten-Funktionen

- 500 Quadratmeter Oberfläche, ca. 4 Millionen Zotten, 4-6 meter lang
- Hauptort Verdauung, Absorption Eiweiss, Fett, Kohlenhydrate, Spurenelemente, Medikamente mit intensiver Wechselwirkung:
- Galle/salze, Pankreassaft, Entero-hormone, Microbiota...
- Dünndarm-Mikrobiom: weniger divers und zahl (10^3 – 10^7 /gram) vs. Colon, da schnelle Peristaltik, antimikrobielle Galle/Peptide, pH
- Lokale Nähe zum Epithel was für Verdauung/Absorption am wichtigsten...

Angelakis et al., 2015; Donaldson et al., 2015.

Dünndarm-Besonderheiten-Funktionen

**Niedrigste Inzidenz an Carcinomen im Verdauungstrakt
Kein medizinischer Bedarf/Sinn Screening**

**Entzündlich-inflammatorische relevante Entitäten
eher selten, z.b. CED ca. 10%**

+

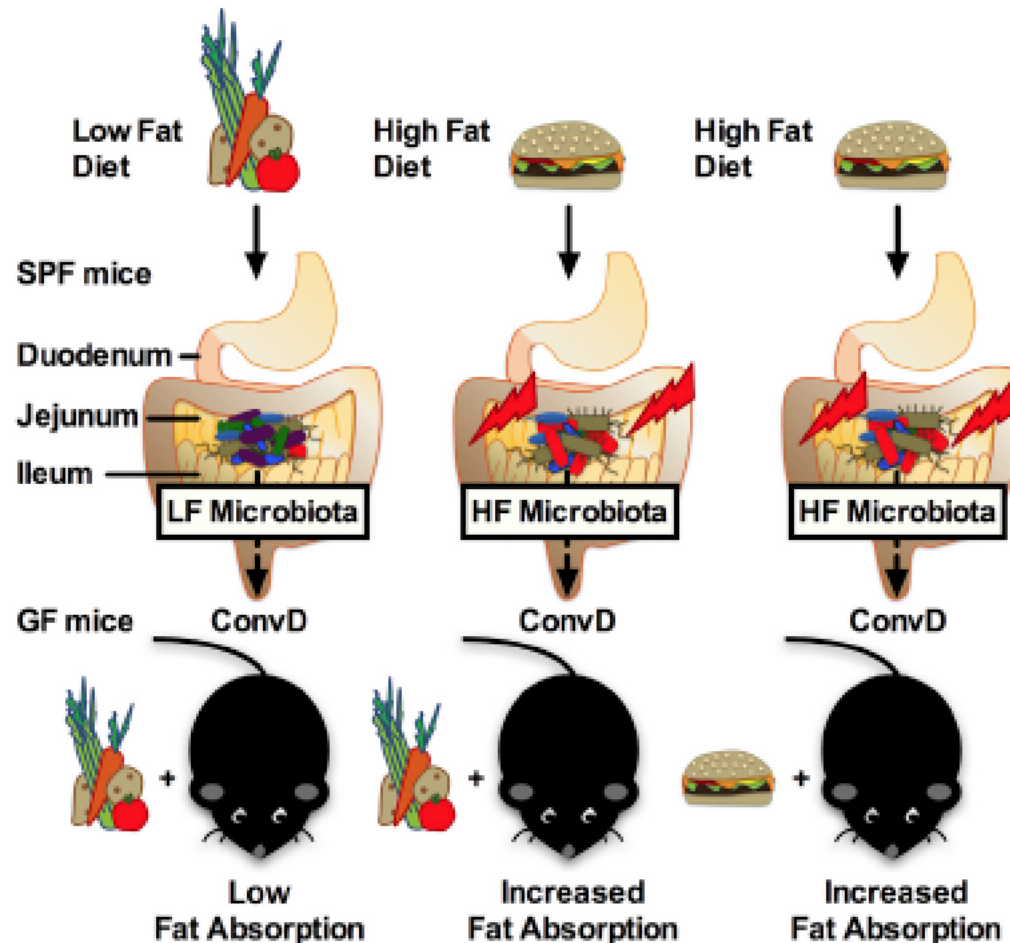
Schlechte, inkomplette, aufwendige Zugänglichkeit

=

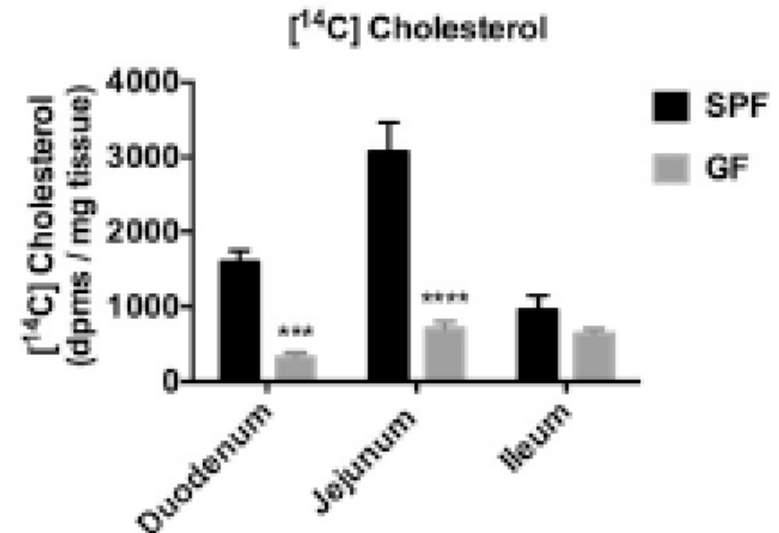
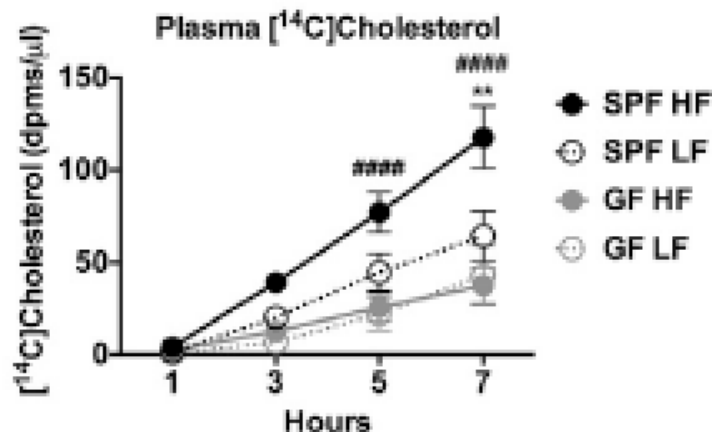
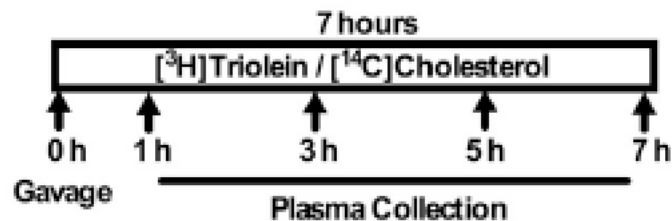
Wenig präsent, relevant im klinischen Alltag

Cell Host & Microbe

Small Intestine Microbiota Regulate Host Digestive and Absorptive Adaptive Responses to Dietary Lipids

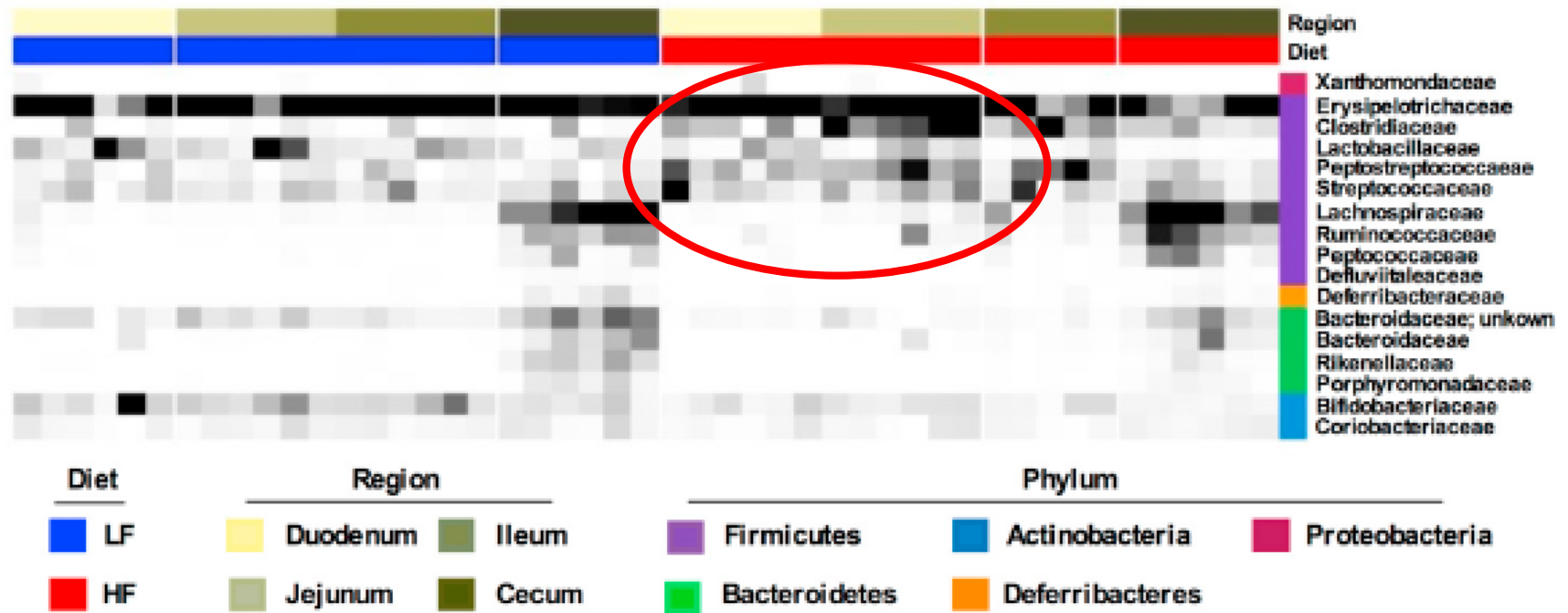


Keim-freie Mäuse: Gesörte Fett-Absorption



Keimfrei vs. Normale Darmflora:
Geringe Lipase Aktivität im Duodenum, Jejunum und
weniger CCK-expression/response auf fett-stimulation

Wo ändert sich auf Hoch-fett-Diät das Mikrobiom am meisten ?

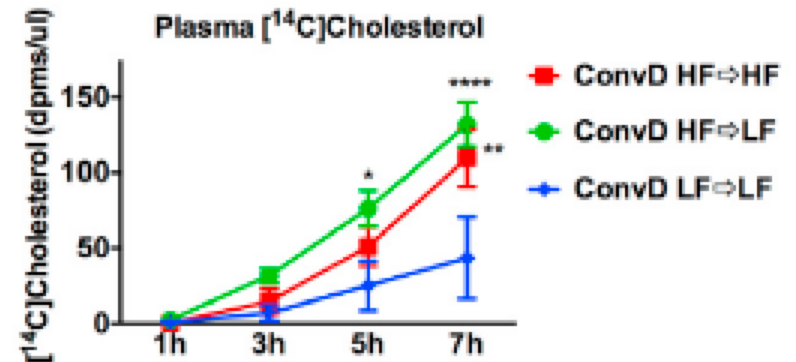
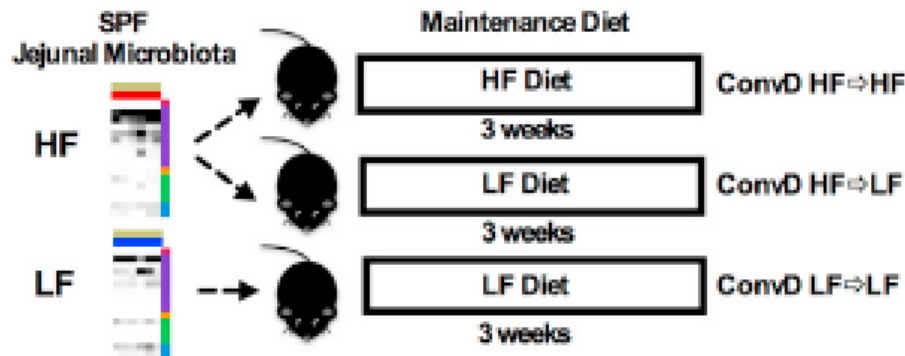


Im Duennndarm

Martinez-Guyrn K et al. Cell Host Microbe 2018

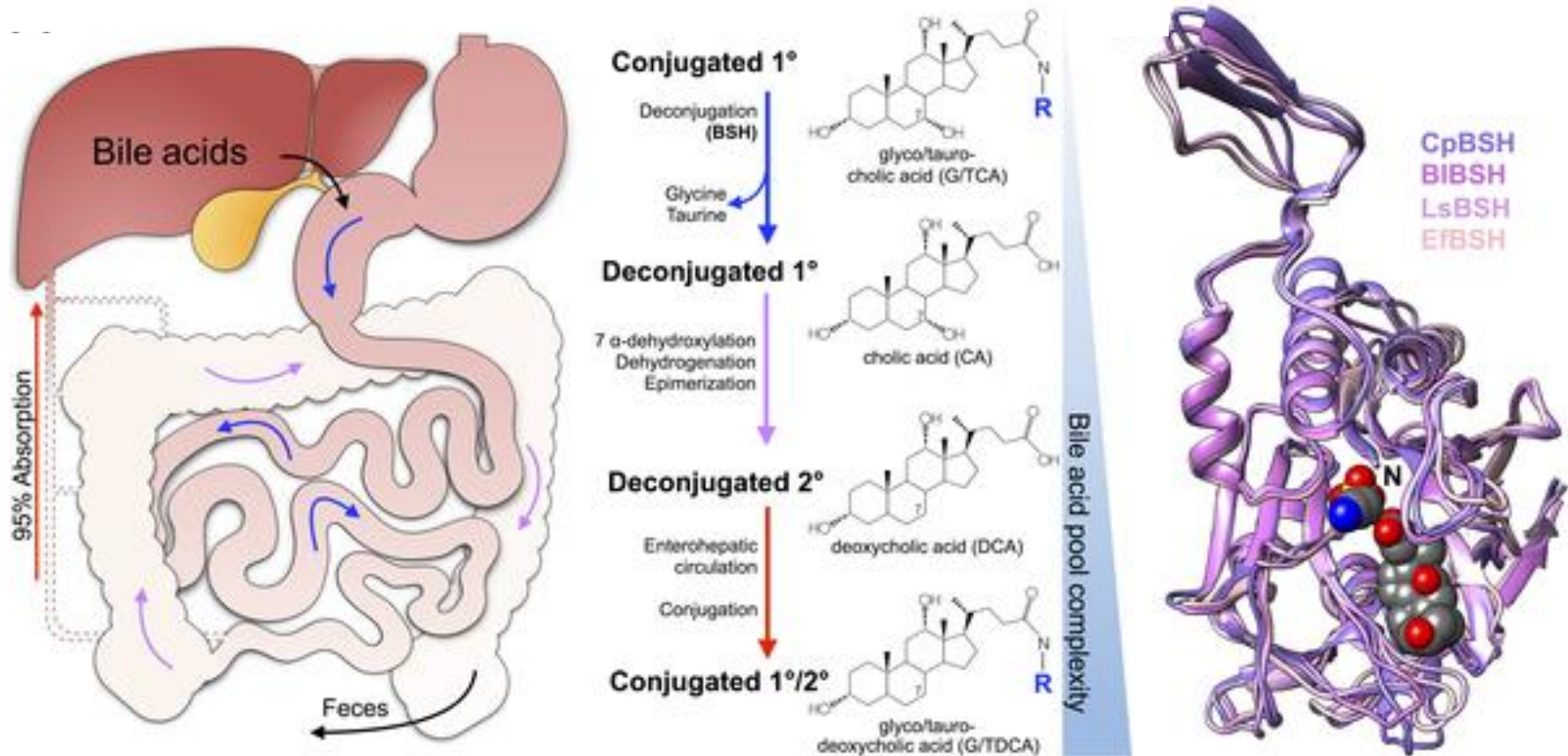
Mikrobiom nach HFD: transfer steigert Lipid-Absorption

C

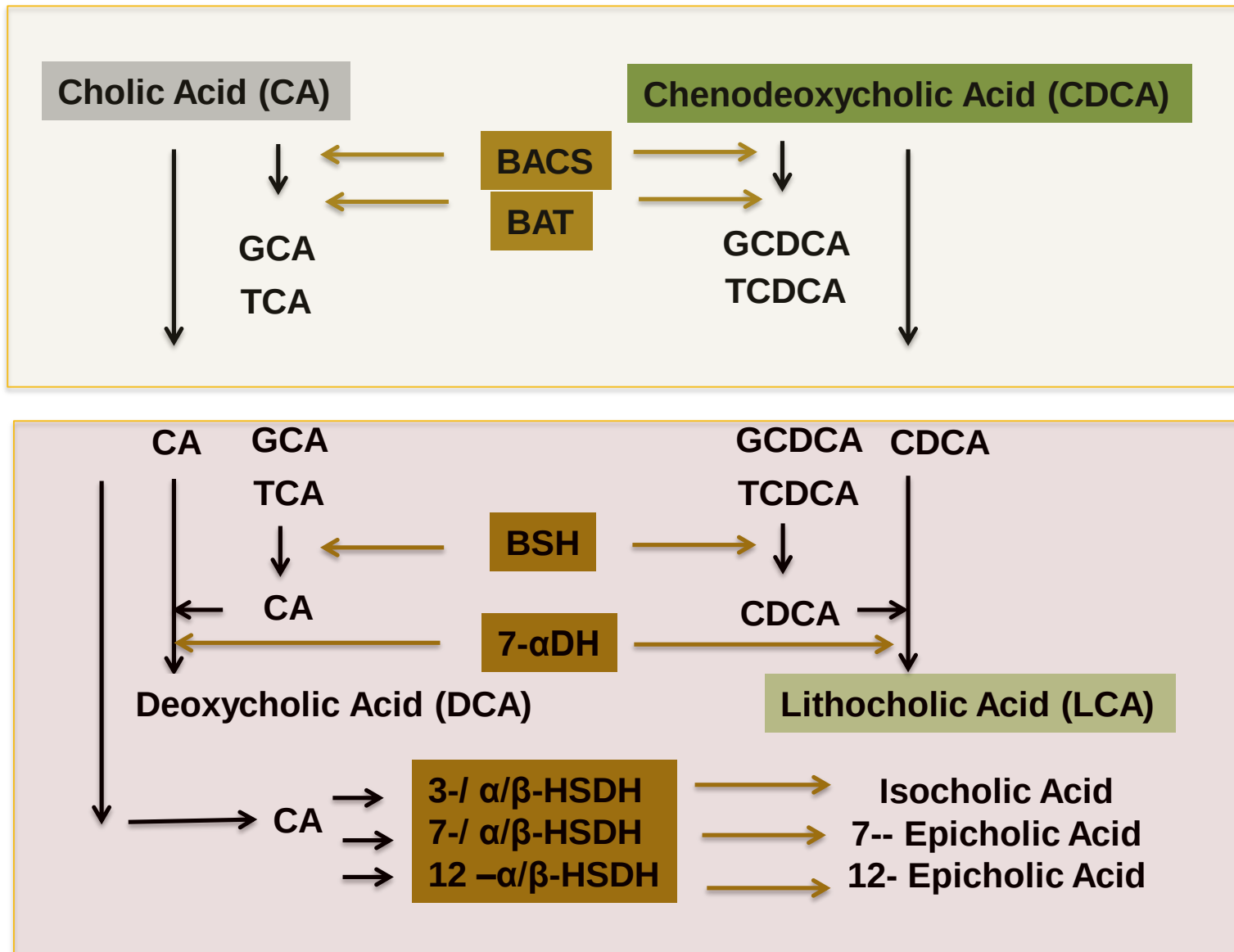


**Bakterienzusammensetzung im Dünndarm entscheidend für Fett-Aufnahme
z.b. nach HFD DD-Mikrobiom verbessert Fett-Absorption unabhängig von der post-conventionalizations Diät**

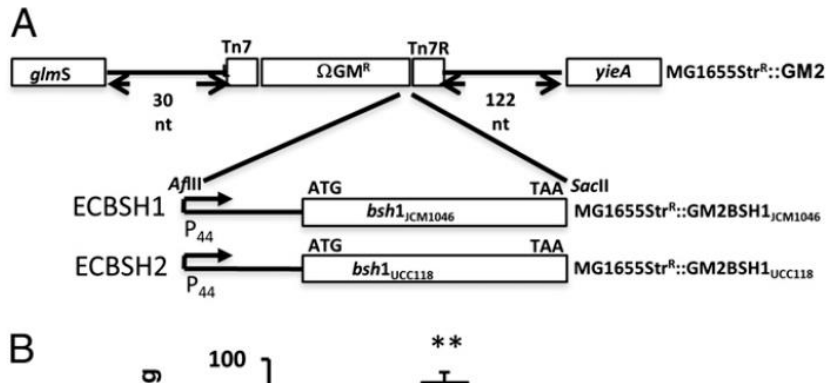
Galle und Mikrobiom im Dünndarm: Bile-Salt-Hydrolase



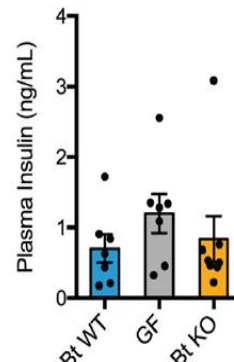
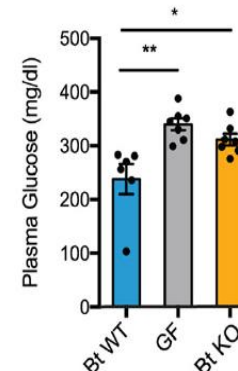
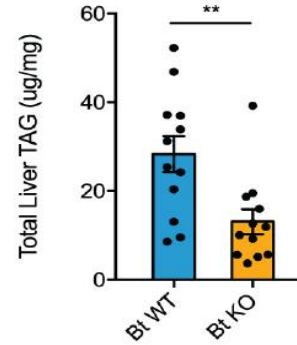
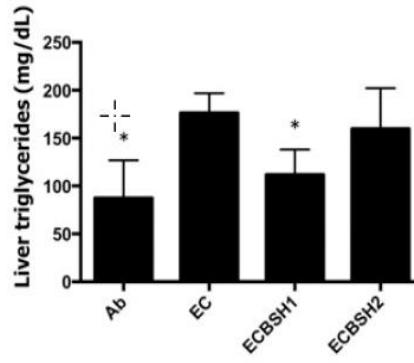
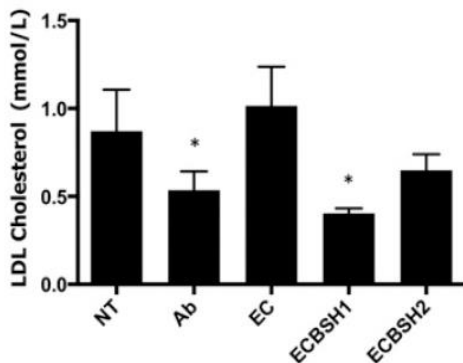
Foley MH et al. <https://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1007581>



Galle und Mikrobiom im Dünndarm: Bile-Salt-Hydrolase



**Überexpression oder Knock-out eines Enzyms
In einer Bakterien—Spezies im Dünndarm
genügt um systemisch und hepatisch Fett/Glukose-Metabolismus
signifikant zu modulieren**



Joyce et al. PNAS 2014

Yao et al. Elife 2018

ENDOSKOPIE

Indikationen für Enteroskopie

- **Diagnostisch**

- Obskure gastrointestinale Blutung
- V.a. Dünndarm Crohn
- Screening/surveillance auf Polypen bei familial polyposis syndromes
- Abklärung für/bei coeliac disease
- Malabsorption und unklarer Diarrhoea

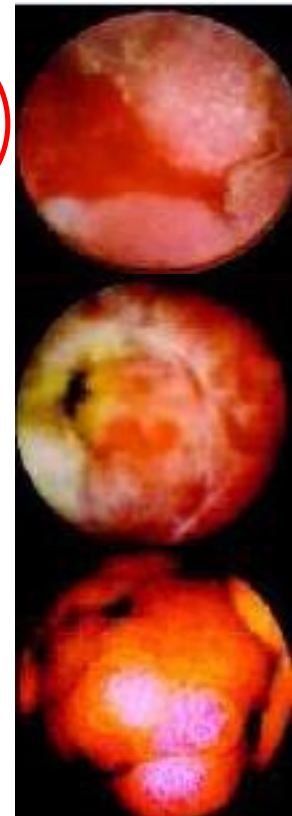
- **Therapeutisch**

- Thermokoagulation blutender Läsionen
- Polypektomie
- Anlage Jejunostomie Tubes
- Fremdkörper-Entfernungen
- Balloon dilatationen
- ERC bei Hepatico-Jejunostomie.....

70%

20%

10%



Dünndarm-Endoskopie: Uebersicht – Tool-Box

Methoden bei V.a. oder dokumentierte Erkrankung im Dünndarm



**Push-
Enteroskopie**



Push-and-pull Enteroskopie



**Video Kapsel
Endoskopie**

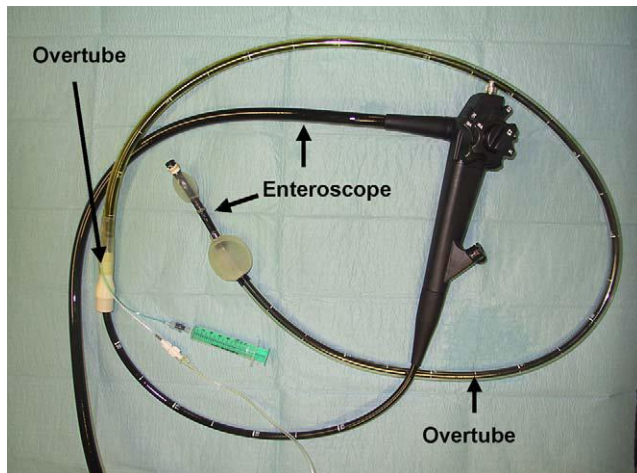


Motorisierte Spiral-Enteroskopie

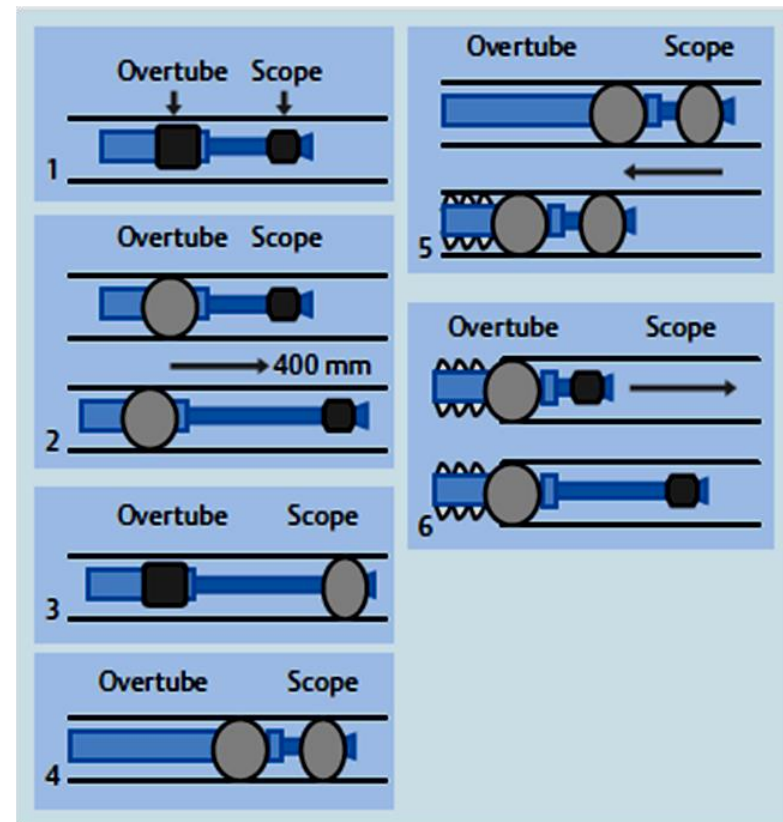
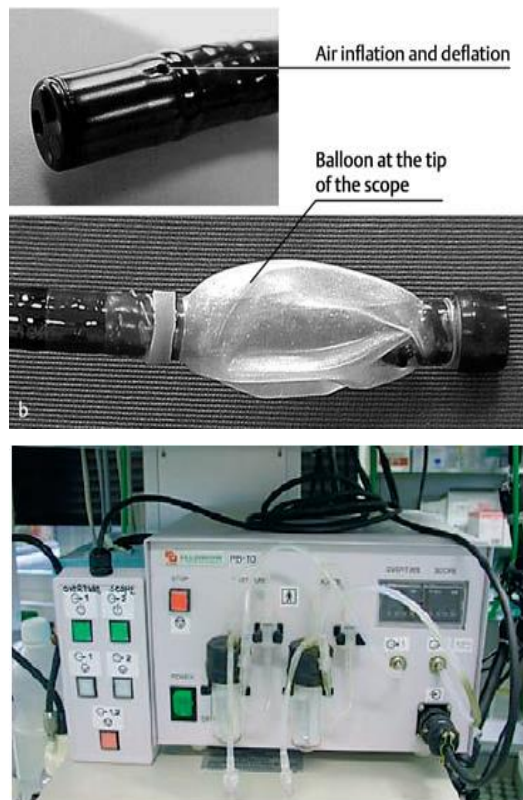


Doppel-Balloon Enteroscopie-system

- Eingeführt 2001 (Yamamoto et al.; Gastrointest Endosc 2001;53:216-220)
- Arbeitslänge 200 cm (diameter: 8.5 mm)
- Flexibler Overtube mit Länge 145 cm (diameter: 12 mm)
- Latex Balloone am Ende des Overtube und des Enteroskops
- Möglichkeit Biopsien, therapeutische Interventionen



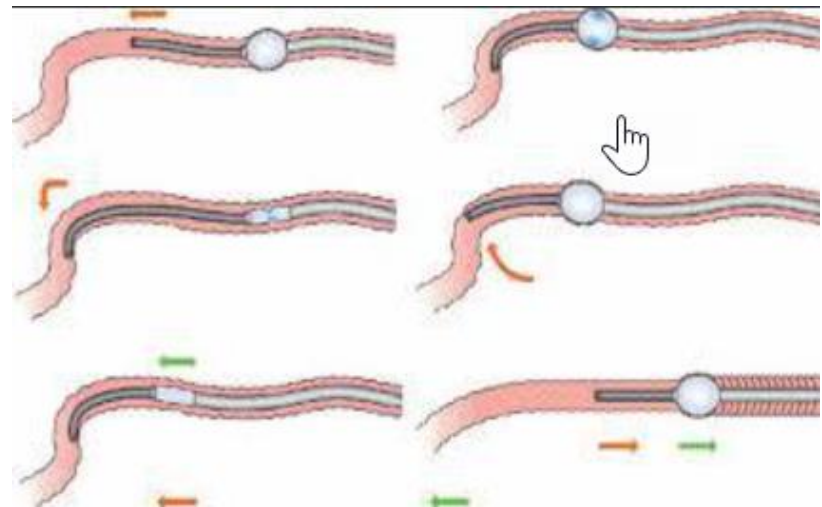
Doppel-Balloon Enteroscopie-system



Yamamoto et al.; GIE 2001

May et al., Endo heute 2004

Single-Balloon-Enteroskopie



Eingeführt 2007, Arbeitslänge 200 cm (diameter: 9.2 mm, A-kanal 2.8 mm)

Flexibler Overtube mit Länge 140 cm (diameter: 13.2 mm)

**Randomisiert kontrollierter Vergleich zu DBE: ähnliche
diagnostisches Ausbeute, therapeutische Effizienz, geringere Rate
Gesamt-Enteroskopie, AE-rate nicht unterschiedlich, rascher Aufbau....**

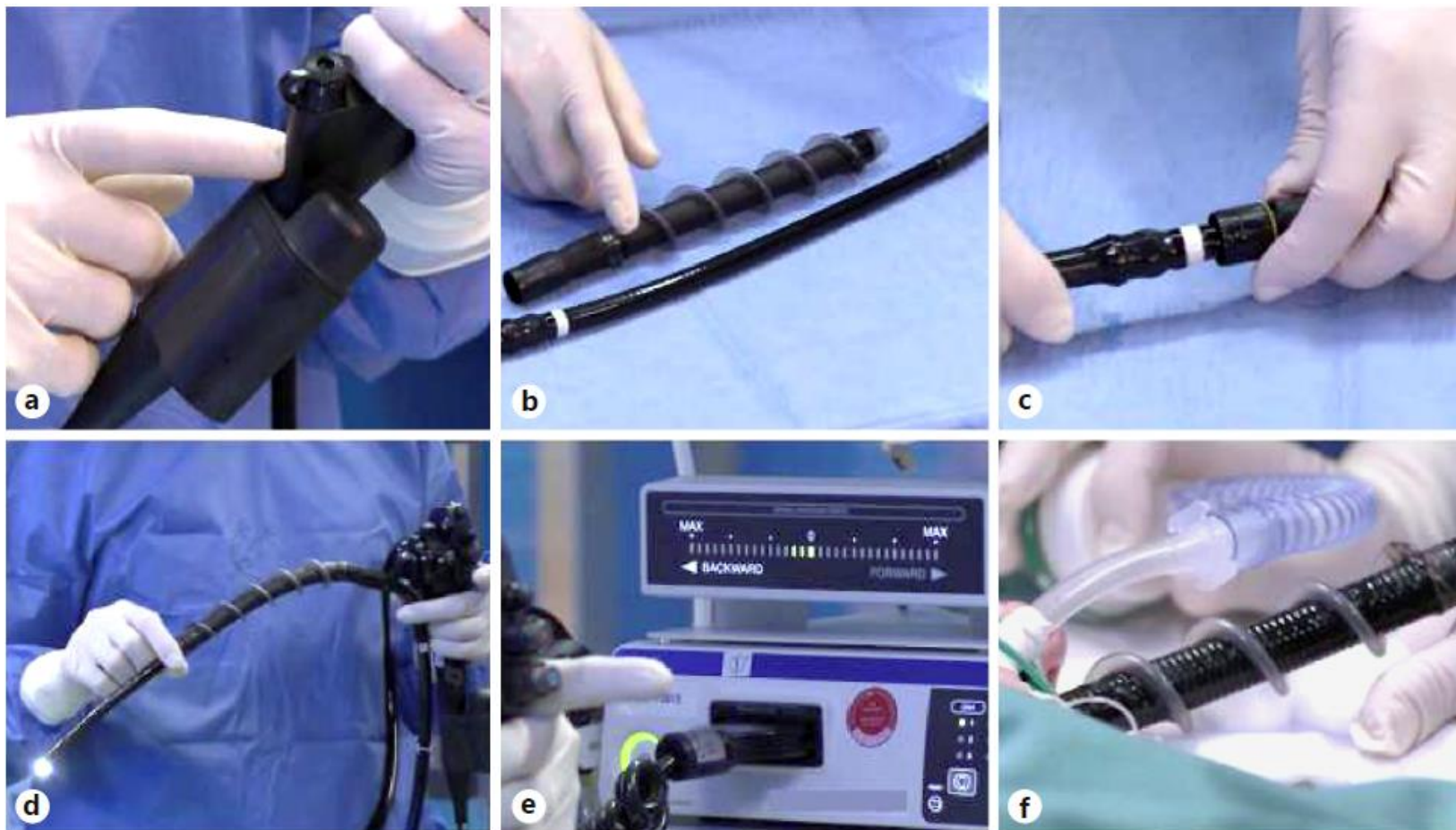
Manno et al. WJG 2012; Takano et al. GIE 2011

Material der Spiral-Enteroskopie

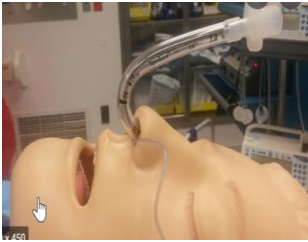
- **Gesamtlänge Endoskop 168 cm**
- **Länge spitze bis zur Spirale 20 cm**
- **Länge der Spirale 24 cm**
- **Aussendurchmesser Endoskop 12.8 mm**
- **Flanchen/ Spiralen Durchmesser 31 mm**
- **Arbeitskanal 3.2 mm**
fits gängiges Zubehör!



Material der Spiral-Enteroskopie



Ablauf der Spiral-Enteroskopie



Vollnarkose mit nasalem (dünnem Tubus)
Gastroskopie zur Statuserhebung (Ausschluss KI)
Balloondilatation oberer Esophagus-Sphinkter 20mm

Proximaler Esophagus nach Spiral-Enteroskopie



Material der Spiral-Enteroskopie



Drehrichtung:
Vorwärts: uhrzeiger
Rückwärts: gegen-uhreiger
Sinn...max 30 rpm



Ablauf der Spiral-Enteroskopie

- Einführen Enteroskop mit maximalem Esmarch-Griff
- Spiral-Motor-Vorschub esophageal bei entblocktem Tubus
- Pyloruspassage so gut gestreckt wie möglich
- Wasser-Immersion grosszügig (spült Luft nach oral)
- Saugen, Saugen, Saugen (entfernt Luft, schafft platz)
- Rütteln, Schütteln, Lagern....
- Rückzug: gegen-uhreigersinn «mit» drehen
- 80 cm Markierung: kein weiterer Rückzug eh Magen erreicht
- sonst möglicherweise fixierung Pyloro-esophageal

Kontraindikationen: Spiral-Enteroskopie

- **Esophageale Pathologie:**
Risiko für Blutung/Perforation bei
EoE, Strikturen, Varizen
- **Koagulopathie, OAK, etc.**
- **V.a. vorliegende Perforation**
- **Fehlende Hals-Reklination (z.B.**
Bandscheibenvorfall)
Zu geringe Mundöffnung
- **Kinder/pädiatrische Klientel**
- **Schwangerschaft**

Pitfalls/ Komplikationen bei Spiral-Enteroskopie

Motorschaden ? Was tun ?

Rückzug nicht mehr möglich Was tun ?

z.b. esophageale Schwellung (induziert durch Scherkräfte)

 **alles dekonnectieren, von hand raus-rotieren....**

- **Mukosa-schaden, -blutung, hämatom esophageal**
 - **Schluckbeschwerden > 25% Patienten**
 - **Eine Pankreatitis berichtet in Literatur**
- Perforation ?..... Overall AE-rate: ca. 14-16%**

Parasad et al. GIE 2020; Beyna T et al. GIE 2021

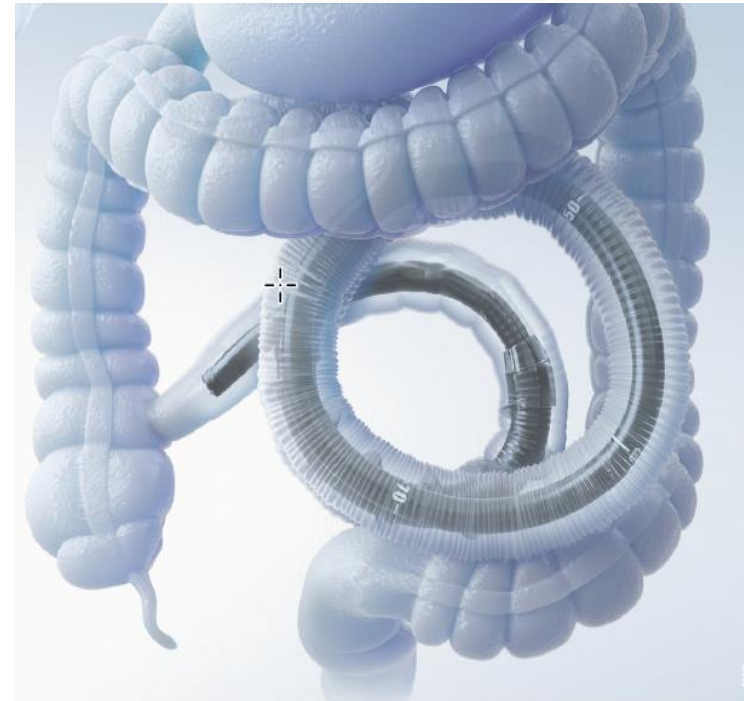
Loop-Bildung bei Enteroskopie: unvermeidbar

Doppel-Balloon



Geringer Halt, rutscht...

Spiral-Enteroskop



Besserer Halt, Adhärenz...

Vorteile der Spiral-Enteroskopie



Relativ unkomplizierte Anwendung
rasch erlernbar (Vgl. Doppel-Balloon), kein Röntgen!
leichter, tiefere Intubation (Vgl. Balloon-entero)



Stabilität für therapeutische Eingriffe:
Flanchen halten/adhärenz langstreckig...
APC, Polypektomie, Biopsie, Clipping..



Kürzere Untersuchungszeiten:
Inkl./v.a. wenn therapeutisch....
Durchschnittlich antegrad: 25-40 min (ab Treitz!)
Retrograd: 17-40 min (Eindringtiefe ab IC: ca. 120 cm)

Beyna T et al. GIE 2021; ...



Video Case Report

Motorized Spiral Enteroscope assisted retrieval of
video capsule in a patient with Crohn's disease

Diagnostic yield and therapeutic impact of novel motorized spiral enteroscopy in small-bowel disorders: a single-center, real-world experience from a tertiary care hospital (with video)

Mohan Ramchandani, MD, DM,¹ Hardik Rughwani, MD, DM,¹ Pradev Inavolu, MD, DM,¹
Aniruddha Pratap Singh, MD, DM,¹ Harsh Vardhan Tevethia, MD, DM,¹ Nitin Jagtap, MD, DNB,¹
Anuradha Sekaran, MD,² Haranath Kanakagiri, MD,³ Santosh Darishetty, DA,³
D. Nageshwar Reddy, MD, DM, DSc¹

Hyderabad, India

- Gastroenterology, July 2020
 - Journal Club 20.01.2021
 - Bénédicte Giriens

Literatur Spiral-Enteroskopie

Autor	Fallzahl	Antegrad Coecum	Gesamt-Enteroskopie	Diagnostisch Ausbeute
Ramchandani et al. (1)	57	31%	60.6%	70.2%
Prasad J et al. (2)	14	-	-*	92.8%
Beyna T et al. (3)	30	16.6%	70%	80%
Beyna T et al. (4)	132 ⁺	10.6%	75%	74.2%

*: full enteroscopy not attempted in all cases +; 90/132 therapeutisch (>70% APC)

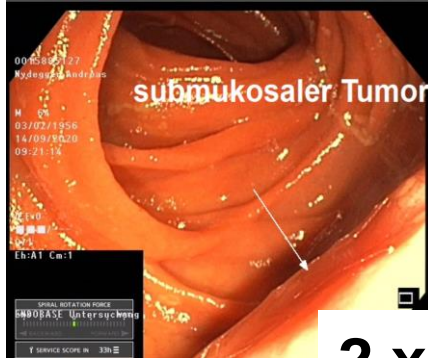
(1): GIE 2020; (2): Video GIE 2020; (3): GIE 2021; (4): Gut 2021;

Eigene Erfahrungen: Spiral-Enteroskopie



Angiodysplasia

0007661053
Staub, Kala
M 72
19/10/1948
14/05/2021
09:32:14
D.F:0
0/1
Eh:A3 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 220 cm



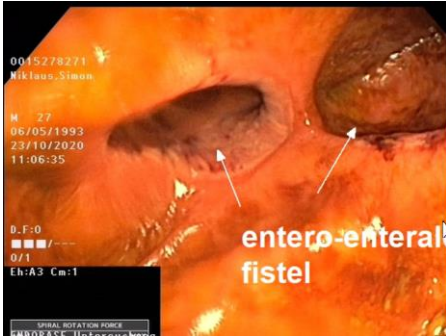
submukosaler Tumor

0015885127
Nydegger, Andreas
M 64
03/02/1956
14/09/2020
09:21:14
D.F:0
0/1
Eh:A1 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 330 cm



2 x GIST

M 73
24/10/1947
22/04/2021
13:28:30
D.F:0
0/1
Eh:A3 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 220 cm



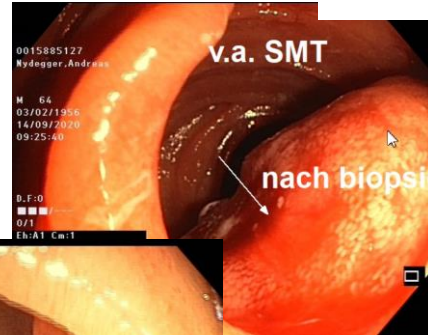
entero-enteral
fistel

0015278271
Niklaus, Simon
M 27
06/05/1993
23/10/2020
11:06:35
D.F:0
0/1
Eh:A3 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 220 cm



Meckel-divertikel ?

0015278271
Niklaus, Simon
M 27
06/05/1993
23/10/2020
11:11:16
D.F:0
0/1
Eh:A3 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 220 cm



v.a. SMT
nach biopsie

0015885127
Nydegger, Andreas
M 64
03/02/1956
14/09/2020
09:25:40
D.F:0
0/1
Eh:A1 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 220 cm

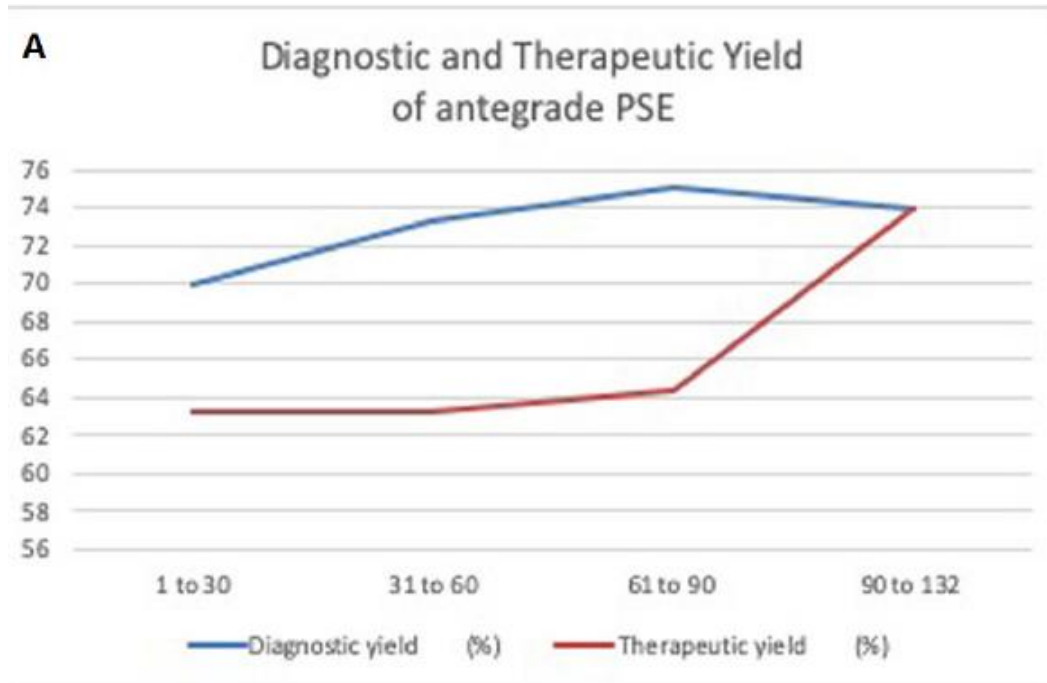


NET

0005057213
Rothen, Barbara
F 52
13/09/1968
07/06/2021
15:13:20
D.F:0
0/1
Eh:A3 Cm:1
SPINAL ROTATION FORCE
ENDOBASE Unterforschung
T SERVICE SCOPE in 200 cm

auch für ERC-
Hepatico-Jejunostomie

Erfahrung/Lernkurve Spiral-Enteroskopie ?



**Kein klarer Unterschied
In Subgruppen/Erfahrung
für:**

- Rate Total-Enteroskopie
- Gesamt-Untersuch.zeit
- Komplikationsrate
- Technische Erfolgsrate
- Maximale Eindringtiefe

.....

Beyna et al. Gut 2021

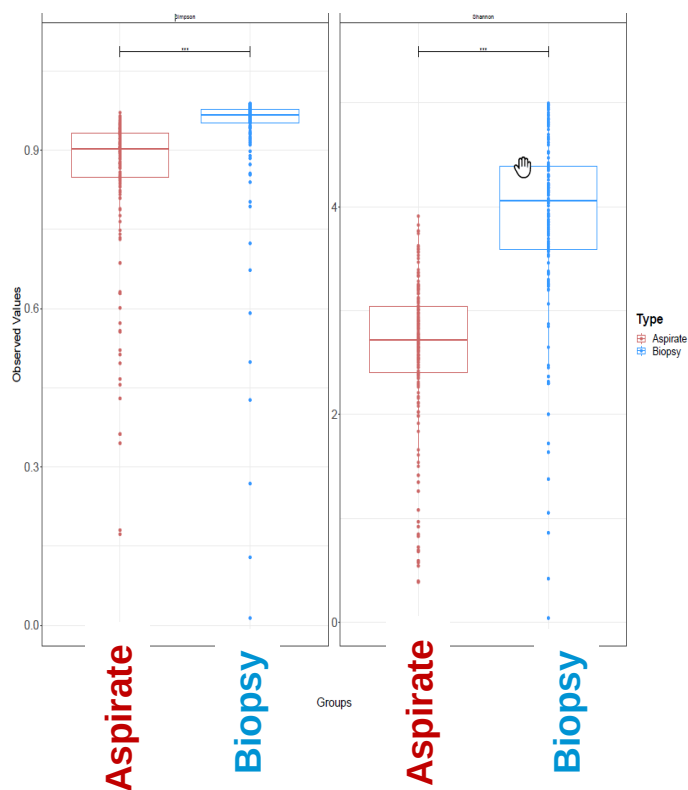
5-10 Fälle ausreichend um Expertise zu erlangen



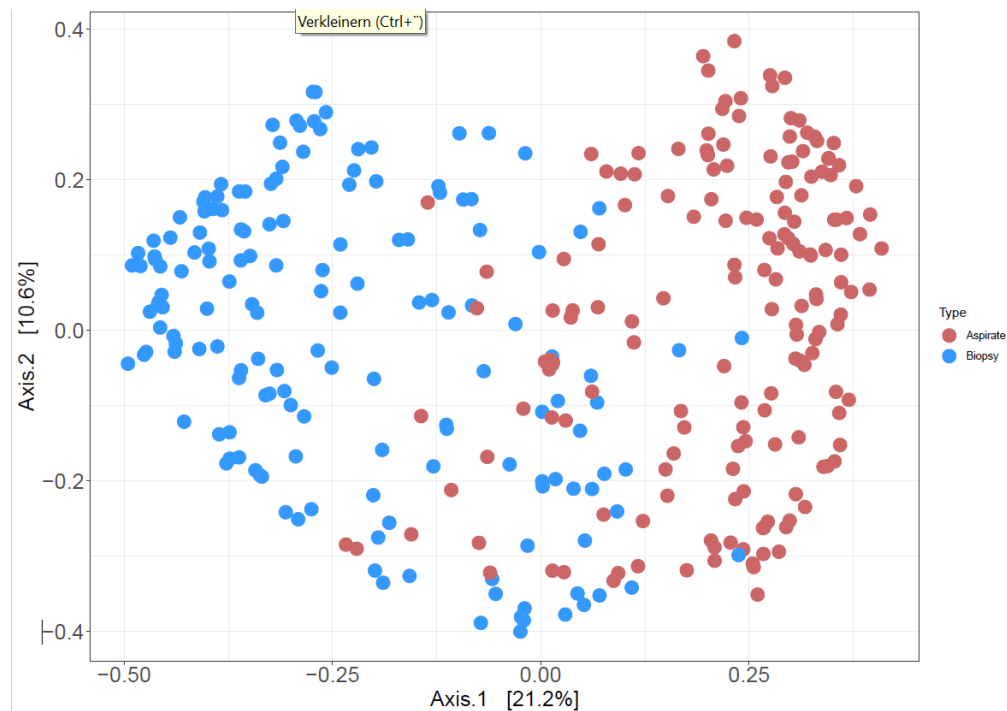
OUTLOOK

Duodenal Horizontal Compartmentalization: biopsy vs. lumen

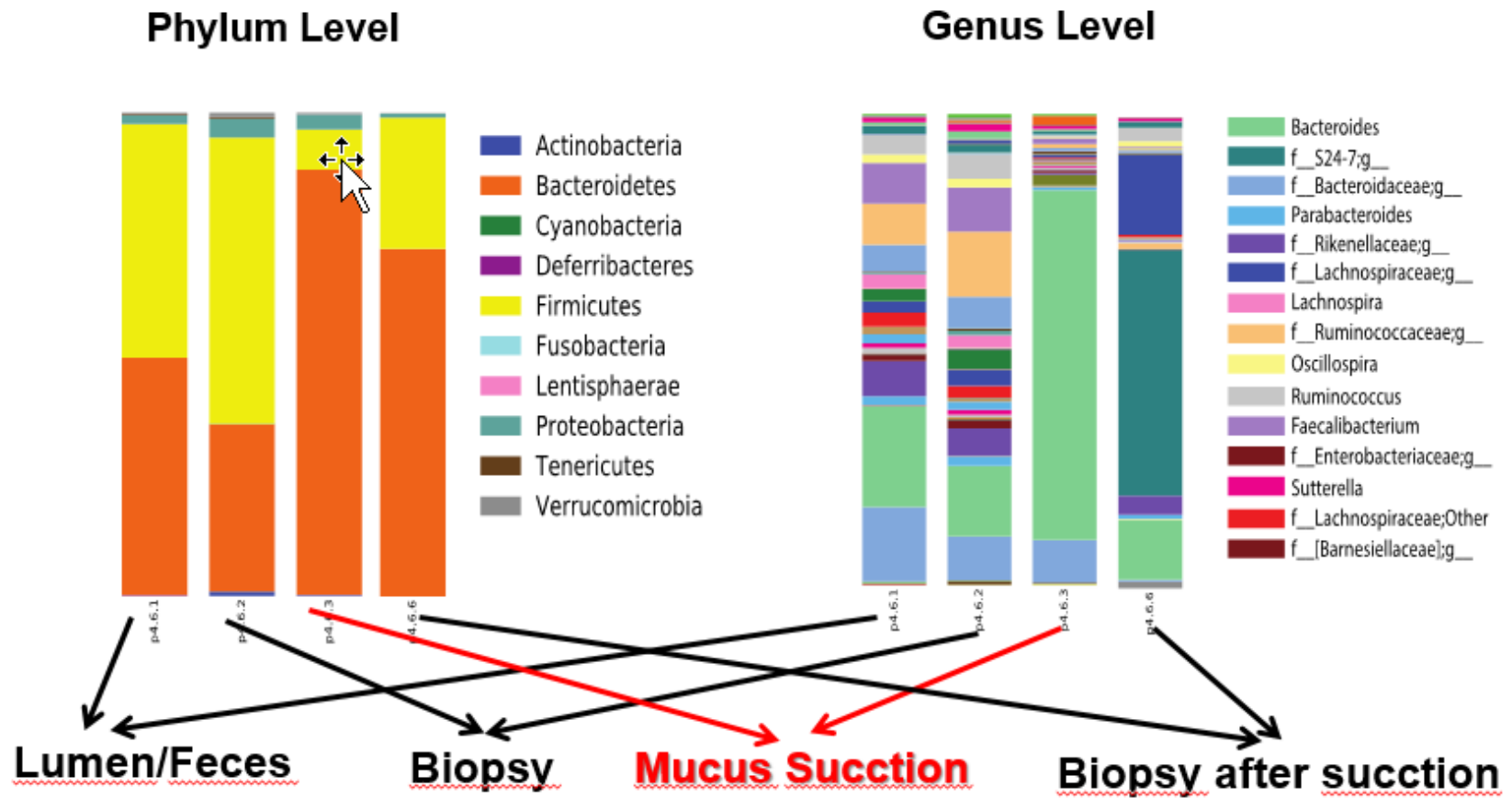
Alpha-Diversity



Beta-Diversity



Horizontal Compartmentalization: Mucus-Schicht = spezielle Nische



Outlook-zurück zum Mikrobiom

Power-Spiral-Enteroskop ermöglicht:

Charakterisierung Mikrobiota-Komposition

Entlang des gesamten Dünndarm (anaerobe Schwelle?)

In verschiedenen Kompartments...

luminal/aspirat vs. Biopsie und zudem



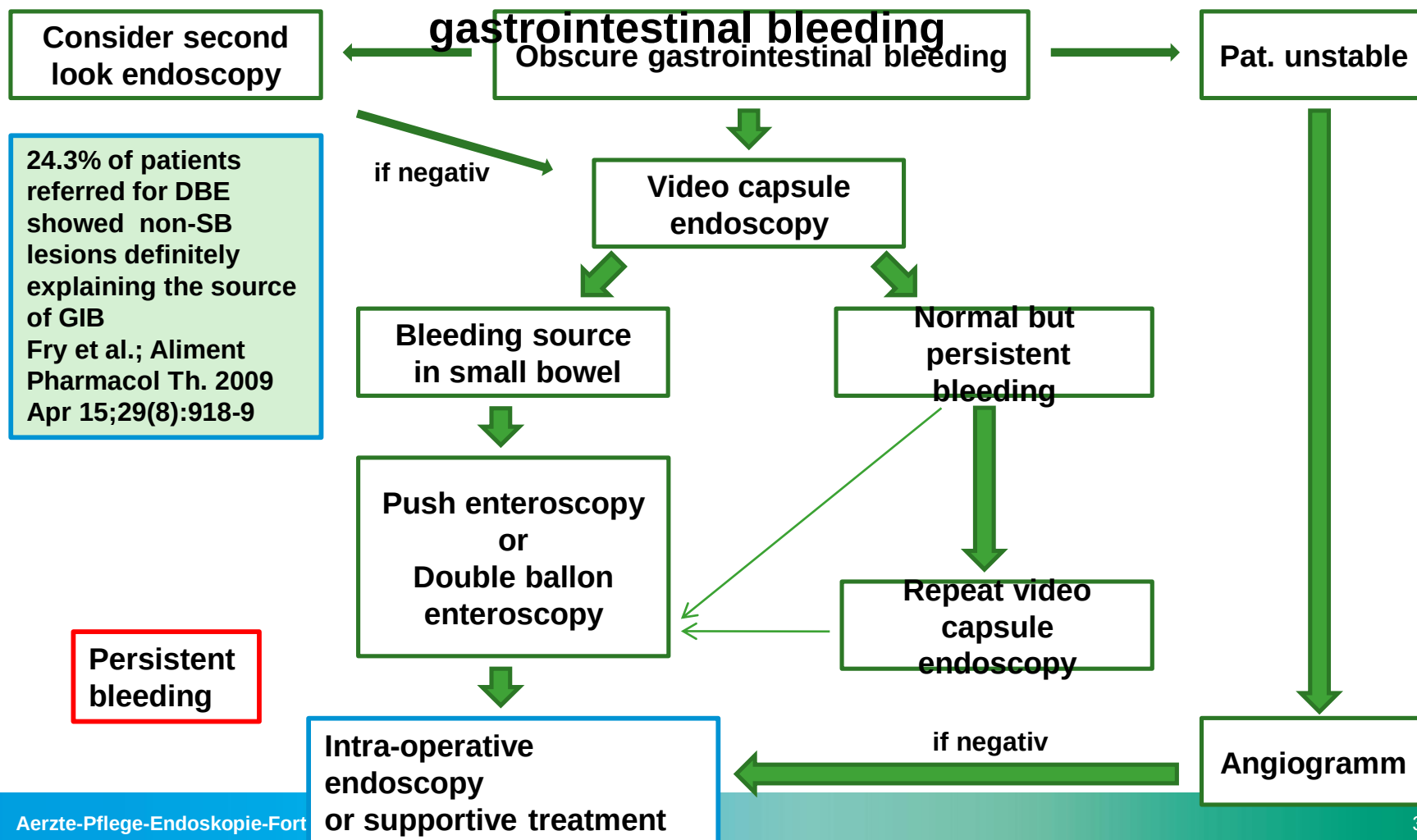
**Beim Rückzug
abgeschilfter
Mukus**

*Was ist das Schwerste von allem?
Was dir das Leichteste dünket,
mit den Augen zu sehn,
was vor den Augen dir liegt.*

Goethe

Proposed role of CE and enteroscopy for the investigation of patients with obscure

gastrointestinal bleeding









Total enteroscopy by antegrade motorized spiral enteroscopy under conscious sedation for overt obscure GI bleeding

Raymond S.Y. Tang, Marc T.L. Wong, Jimmy C.T. Lai, Philip W.Y. Chiu
The Chinese University of Hong Kong
Prince of Wales Hospital



Motorized Spiral Enteroscopy

The PowerSpiral enteroscope uses a unique technology where a user-controlled motor rotates the PowerSpiral overtube that is mounted on the enteroscope. The enteroscope itself does not rotate.



Efficient Control

The PowerSpiral control unit controls the rotational direction and speed of the spiral segment, which is displayed visually for monitoring on a force gauge. The force gauge provides the operator with a visual indication of the rotational direction and the motor current throughout the examination. The direction and speed of the rotation of the spiral segment are controlled by an easy-to-operate foot switch.

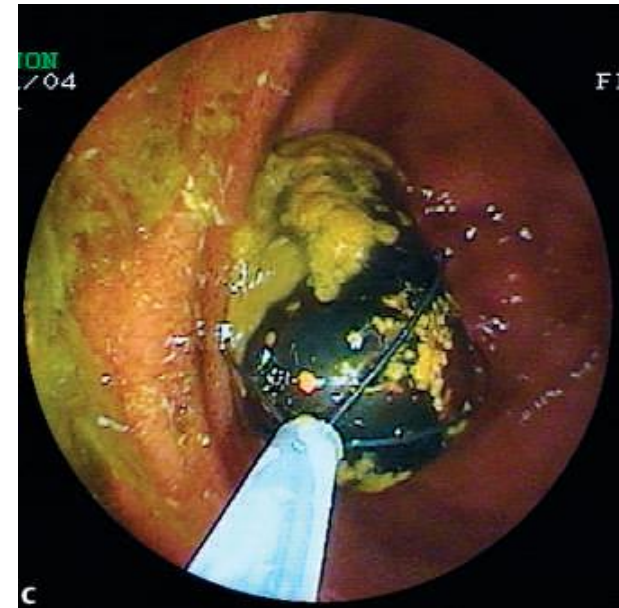
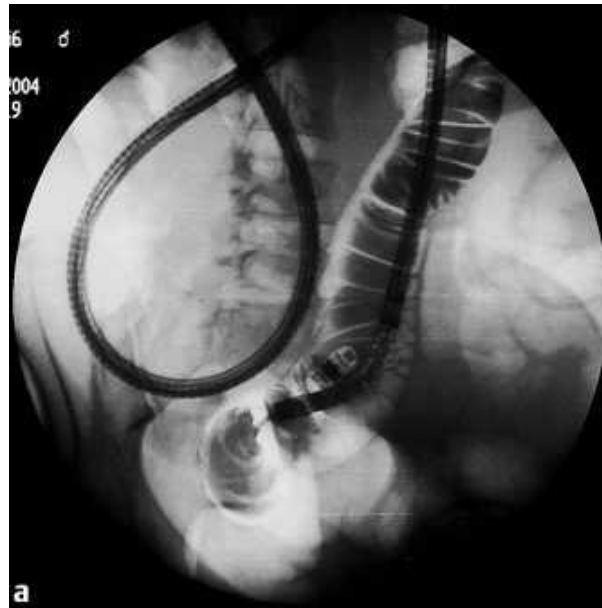
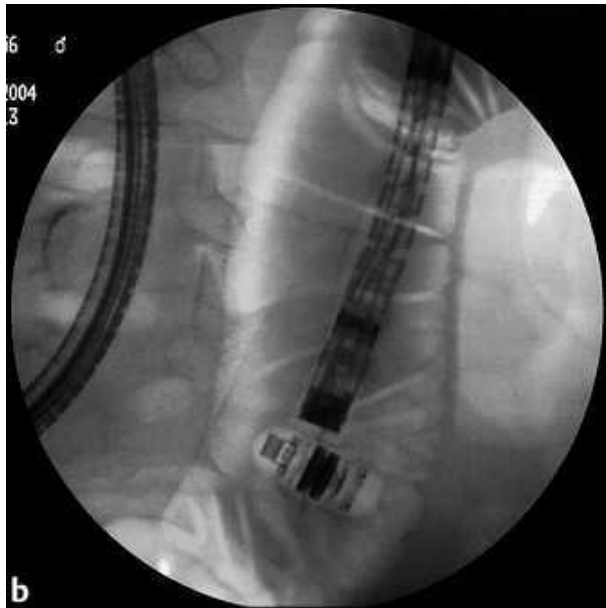


In addition, an automated limit function stops the rotation of the spiral segment when the motor current reaches a certain limit.

Small bowel endoscopy

Video capsule endoscopy

- Capsule retention



May et al.; Endoscopy 2005;37:591-

Small bowel endoscopy

Double-balloon enteroscopy – Complications

Complications in Double-Balloon-Enteroscopy: Results of the German DBE

Register (Möschler et al.; Z Gastroenterol 2008;46:266-270)

- **Aim and Methods:**

- Evaluation of the complication rate of DBE in a larger group of patients
- All endoscopic units using DBE in Germany in Jan. 2006 were asked for their participation, the examination data and their present complications

- **Results:**

- Participation rate: 64/85 centers (75%)
- 3894 DBE with 1086 interventions were reported
- 48 complications (1.2%) were reported

Acute pancreatitis	9 cases (0.34%)
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Perforation	8 cases (0.21%)
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Major bleeding	6 cases (0.15%)
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Perforation after polypectomy	6/177 (3.4%)
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- **Conclusion:**

- DBE is a safe procedure

Small bowel endoscopy

Diagnostic yield of DBE in patients with OGB

Autor	Patienten (n)	Untersuchungen (n)	Zugangsweg anal (cm)	Zugangsweg oral (cm)	Panenteroskopie	diagn. Ausbeute
Ell et al (9)	100	147	220 ± 90	130 ± 80	16/100 (16 %)¹	72 %
Di Caro et al (8)	62	89	254 ± 174	180 ± 150	10/62 (16,2 %)	80 %
May et al (30)	137	248	240 ± 100	140 ± 90	22/55 (45 %)²	79 %
Yamamoto et al. (48)	123	178	keine Angabe	keine Angabe	24/28 (86 %)³	76 %⁴
Mönkemüller et al. (32)	53	70	200 (30–470)	70 (1–220)	4/53 (8 %)	67 %
Heine et al. (19)	275	316	270 ± 104	156 ± 116	26/62 (42 %)⁵	73 %⁴

¹ Untersuchung wurde beendet, wenn eine definitive Blutungsquelle detektiert wurde; ² Panenteroskopie nur bei 55 Patienten angestrebt; ³ Panenteroskopie nur bei 28 Patienten angestrebt; ⁴ Angaben nur für Patienten mit Verdacht auf Dünndarmblutung; ⁵ Panenteroskopie nur bei 62 Patienten angestrebt

Obscure gastrointestinal bleeding

Small bowel endoscopy

- Capsule endoscopy (CE) has been shown to be superior to conventional radiologic methods in the context of OGB
 - Barium follow through
 - Enteroclysis

(Marmo et al., Aliment Pharmacol Ther 2005;22: 595-604; Triester et al., Am J Gastroenterol 2005;100: 2407-18; Liangpunsakul et al., Gastrointestinal Endosc Clin N Am 2004;14:43-50)
- CE has a superior diagnostic yield compared to push enteroscopy (PE) in patients with OGB
 - A meta-analysis of 14 studies on patients with OGB reported yields of 63% for CE and 28% for PE

(Triester et al., Am J Gastroenterol 2005;100: 2407-18)

Obscure gastrointestinal bleeding

Small bowel endoscopy

Capsule Endoscopy versus Push Enteroscopy in Patients with Occult Gastrointestinal Bleeding

Hartmann et al., Z Gastroenterol 2003;41: 377-382

Patients and methods

- Capsule endoscopy was performed in 48 patients with suspected disorders of the small intestine between July 2001 and October 2002
- 37 patients with occult gastrointestinal bleeding and negative bidirectional endoscopy were screened for the trial
- **Standard diagnostic work-up** included
 - Gastroscopy and colonoscopy
 - MR- or conventional enteroclysis
 - Abdominal angiography
 - Blood pool/Meckel's scintigraphy
- Push enteroscopy was done 1-3 days before capsule endoscopy
- Physicians evaluating PE and CE were blinded to the results of the other form of small-bowel endoscopy

Obscure gastrointestinal bleeding

Small bowel endoscopy

Capsule Endoscopy versus Push Enteroscopy in Patients with Occult

Gastrointestinal Bleeding

Hartmann et al., Z Gastroenterol 2009; 41: 277-282

Results

Table 3 Definitive bleeding sources diagnosed by the various diagnostic procedures (n = 33)

	<i>positive findings</i>	<i>type of findings</i>
enterodysma	1	jejunum diverticulosis
scintigraphy	2	bleeding in the upper (n = 1) and lower (n = 1) small bowel
angiography	2	segmental angiodysplasia (n = 2)
push enteroscopy	7/33 (21 %)	angiodysplasia (n = 5), diverticulosis of jejunum (n = 1), ulcers (n = 1)
capsule endoscopy	25/33 (76 %)	angiodysplasia (n = 15), Meckel's diverticulum (n = 1), ulcers (n = 7), ileum diverticulosis (n = 1), B-cell-lymphoma (n = 1)

- Video capsule endoscopy and double balloon endoscopy have similar diagnostic rates in patients with OGB
 - Diagnostic yields: 43-60% for DBE and 60-80% for CE
(Nakamura et al., Endoscopy 2006;38: 59-66; Hadithi et al., Am J Gastroenterol 2006;101: 52-7)
- Compared to intra-operative endoscopy the video capsule endoscopy has a sensitivity of 95% and a specificity of 75 %
(Hartmann et al., Gastrointest Endosc 2005;61: 826-32)

Obscure gastrointestinal bleeding

Small bowel endoscopy

Bleeding source?



TABLE 2. Capsule endoscopy findings in 47 patients with obscure GI bleeding

Diagnosis	n (%)
Positive findings	
Angioectasias (multiple or bleeding)	22 (46.8)
Ulcers	5 (10.6)
Active bleeding without seeing a bleeding source	2 (4.3)
Meckel's diverticulum	1 (2.1)
Tumor	3 (6.4)
Bleeding ileal diverticulosis	1 (2.1)
Varices	1 (2.1)
Suspicious findings	
Isolated, nonbleeding angioectasias	3 (6.4)
Erosions	2 (4.3)
Venous ectasia	1 (2.1)

Hartmann et al., Gastrointest Endosc 2005;61:826-32

Obscure gastrointestinal bleeding

Small bowel endoscopy

Bleeding sources

- Angioectasia (50-60 %)



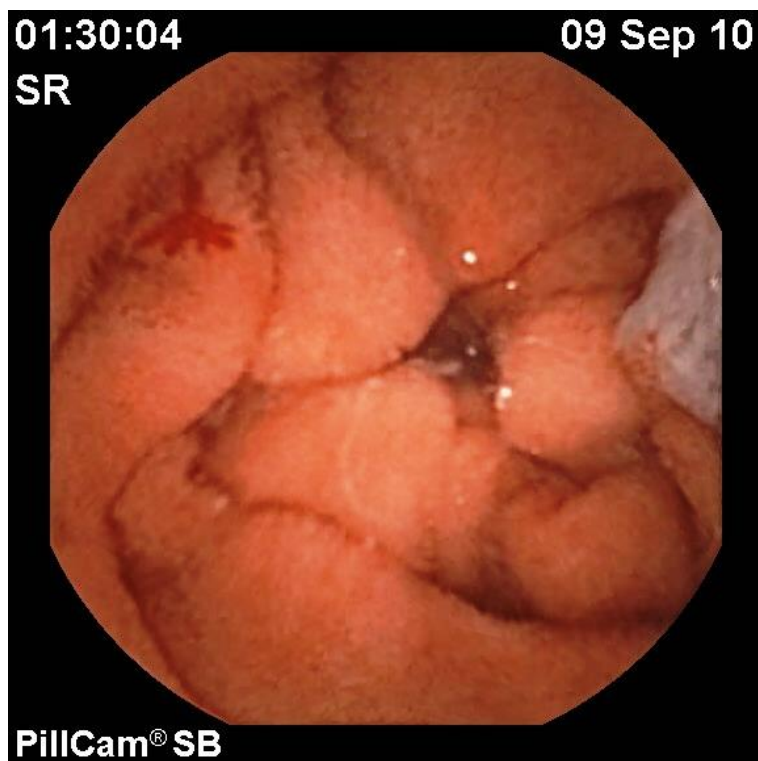
Albert et al.; Dtsch med. Wochenschr 2008;
133:1136-1141

Obscure gastrointestinal bleeding

Small bowel endoscopy

Bleeding sources

- Angioectasia (50-60 %)

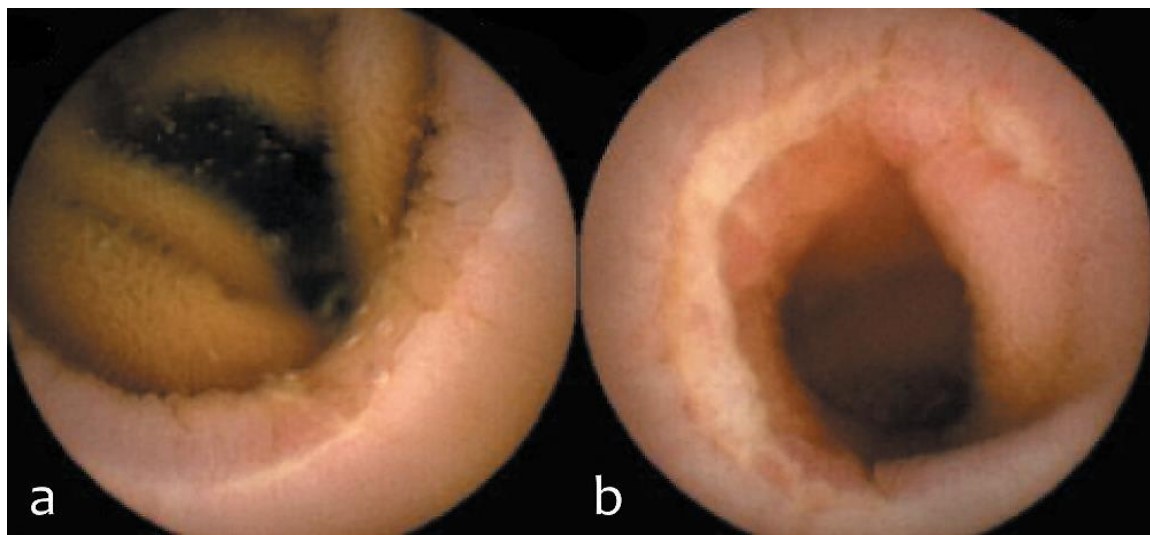


Obscure gastrointestinal bleeding

Small bowel endoscopy

Bleeding sources

- Ulcers/erosions (NSAID-enteropathy, 15%)



Albert et al.; Dtsch med. Wochenschr 2008;
133:1136-1141

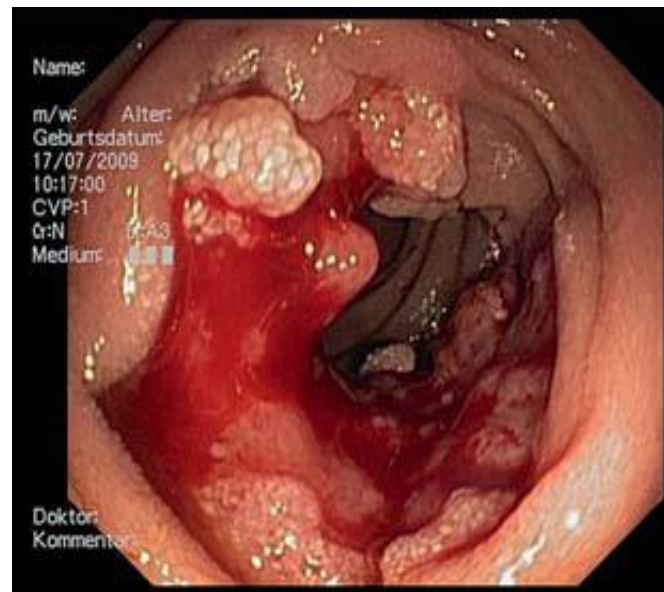
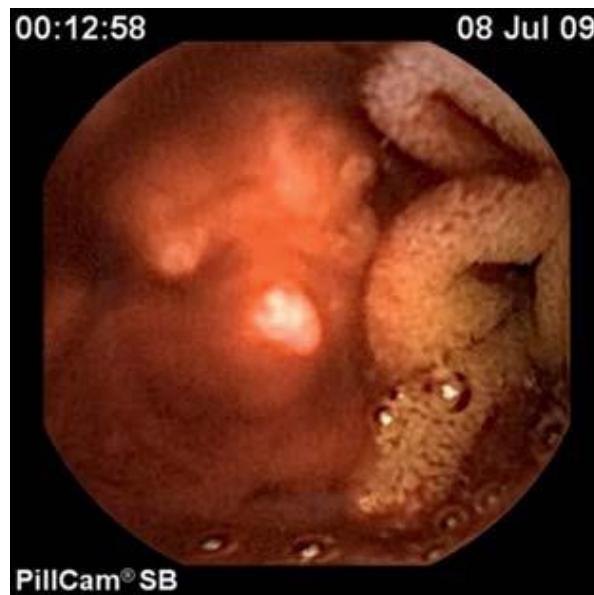


Obscure gastrointestinal bleeding

Small bowel endoscopy

Bleeding sources

- Tumor (5%)



F. Wiedbrauck, Endo heute 2010;23:129-136

Obscure gastrointestinal bleeding

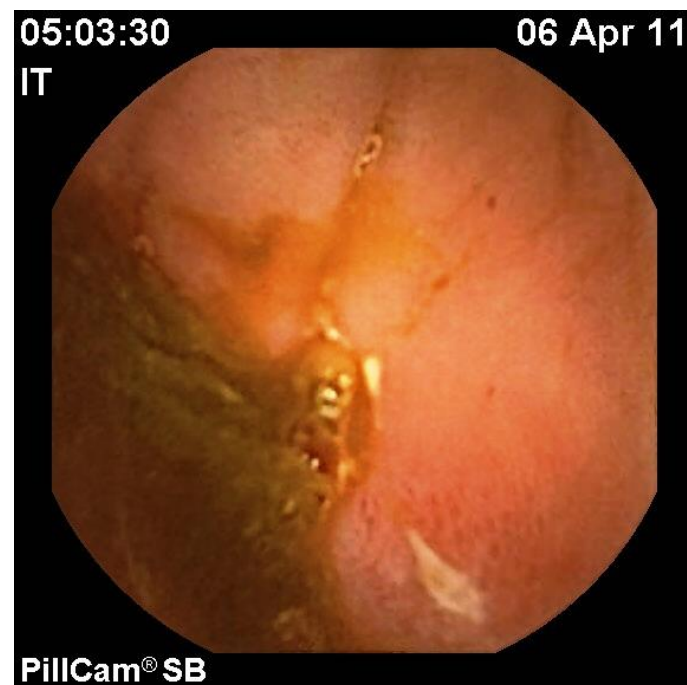
Small bowel endoscopy

Bleeding sources

- Small bowel CD (2%)



Albert et al.; Dtsch med. Wochenschr 2008;
133:1136-1141



Jejunum: The understudied meeting place of dietary lipids and the microbiota



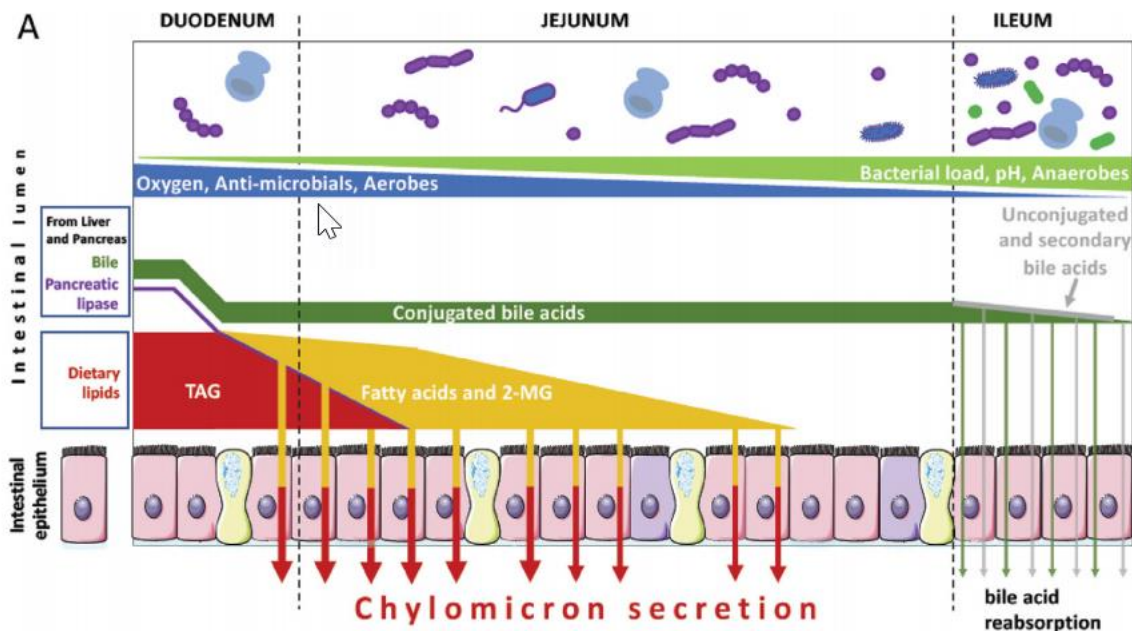
Ingrid Lema ^{a, b, 1}, João Ricardo Araújo ^{c, d, 1}, Nathalie Rolhion ^{a, 2}, Sylvie Demignot ^{a, b, *, 2}

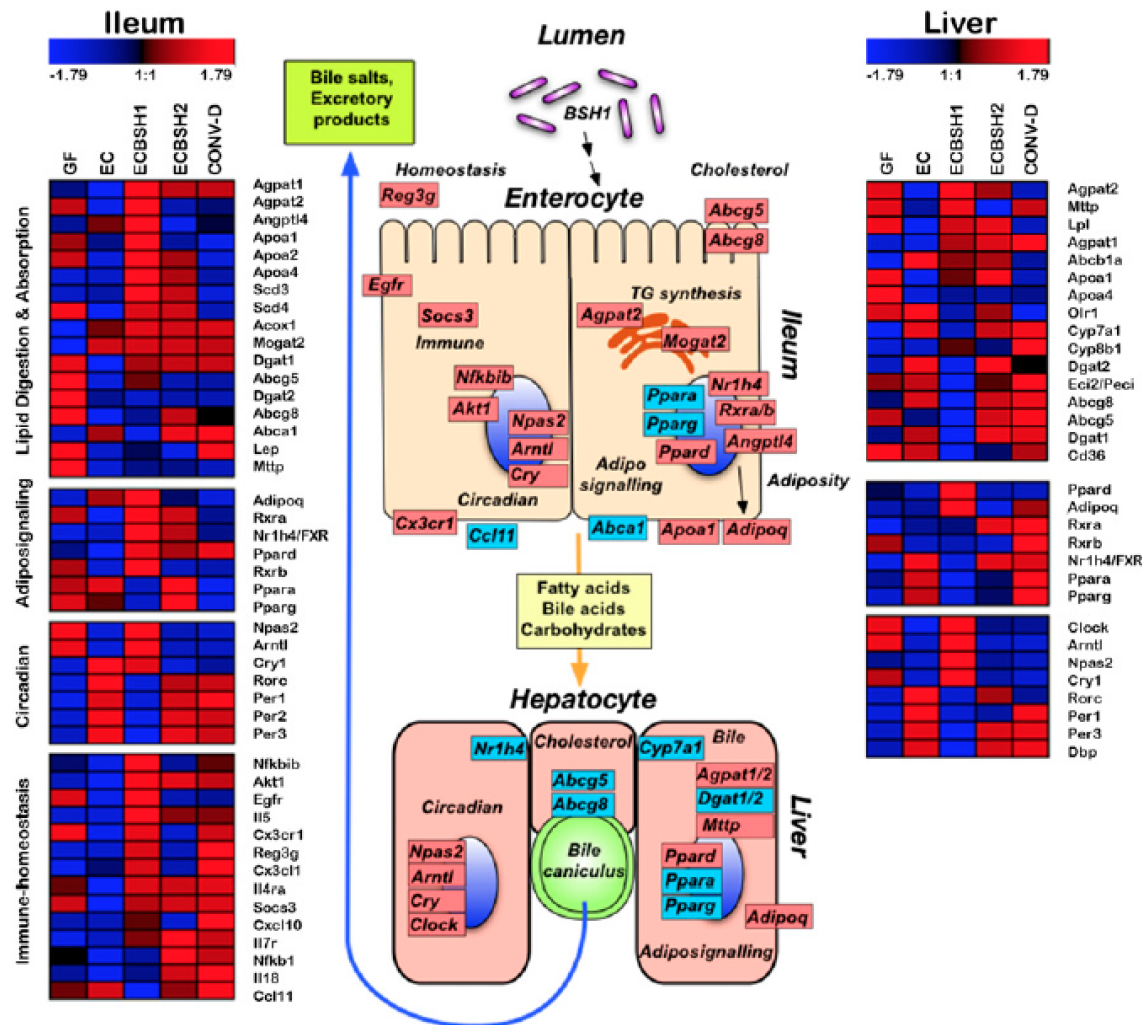
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Joyce SA et al. PNAS

Fig. 3. BSH expression in the gastrointestinal tract of gnotobiotic mice significantly alters gene-expression patterns in ileal and hepatic tissue. Microarray analysis of ileal and liver tissue from GF mice, CONV-D mice, and mice monocolonized with EC, ECBSH1, or ECBSH2. Shown are heat maps representing gene-expression profiles of selected genes that were significantly ($P < 0.05$) altered through BSH1 expression in our system. Pathways related to lipid digestion and absorption, circadian rhythm, adipo-signaling, and immune homeostasis were most significantly affected, as determined by pathway analysis, and are shown here ($n = 5$ mice per group). The schematic indicates key transcriptional changes affected by BSH1 expression. Genes increased in ECBSH1-colonized mice relative to EC-colonized mice are indicated in red, genes decreased in ECBSH1-colonized mice relative to EC-colonized mice are indicated in blue.