

ESOPHAGEAL MOTILITY AND REFLUX TESTING

What, when and how to measure?

SUSPECTED MOTILITY DISORDER

- Dysphagia/odynophagia: Blocked/painful passage of food through the oesophagus
- Heartburn: Retrosternal burning sensation („Magenbrennen“)
- Regurgitation: Effortless retrograde movement of esophageal or gastric contents
- Chest pain
- Globus sensation: Lump in the throat, not resolved by swallowing or throat clearing

DYSPHAGIA

Sensation of impaired passage of ingested food/liquids on the way from the oral cavity to the stomach

History:

Localisation: cervical, retrosternal?

Affects solids only or solids and liquids?

Temporal course: progressive?, intermittend?

80-85% distinction between oropharyngeal vs. oesophageal dysphagie by careful history

Hila A & Castell DO 2003

**HIGH RESOLUTION ESOPHAGEAL MANOMETRY STANDARD PROTOCOL
CHICAGO CLASSIFICATION VERSION 4.0[©]**

STUDY PROCEDURE

Study begins in supine position [use supine normative values]

- ≥ 60 second adaptation period
- Document position with at least 3 deep inspirations
- ≥ 30 second baseline period
- 10 supine wet (5mL) swallows
- 1 multiple rapid swallow (MRS) sequence (MRS may be repeated up to 3 sequences if failed attempt or abnormal response)

Change position to upright [use upright normative values]

- ≥ 60 second adaptation period
- Document position with at least 3 deep inspirations
- ≥ 30 second baseline period
- ≥ 5 upright wet (5mL) swallows
- 1 rapid drink challenge

If no major motility disorder is found consider the following manometric evaluations

- For high probability of a missed EGJ outflow obstruction: Solid test swallows, solid test meal, and/or pharmacologic provocation
- For suspected rumination/belching disorder: Post-prandial high-resolution impedance observation

If equivocal results are found and/or there is suspicion for an obstruction that does not fulfill criteria for achalasia, consider the following supportive tests

- Timed barium esophagram, preferably with tablet
- Endoluminal functional lumen imaging planimetry (FLIP)

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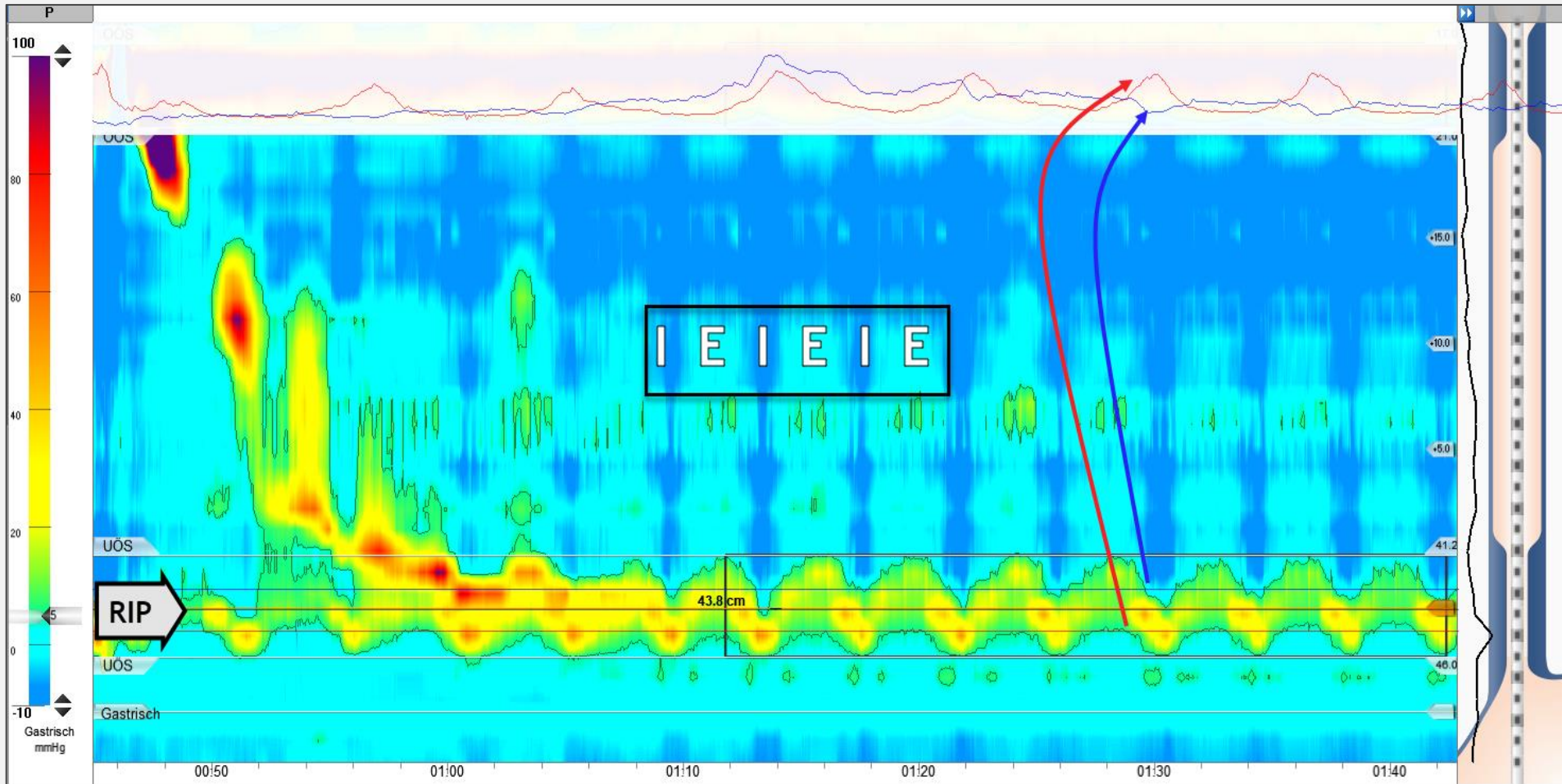


ORIGINAL ARTICLE

Esophageal motility disorders on high-resolution manometry: Chicago classification version 4.0[©] | **WILEY**

Esophageal motility disorders on high-resolution manometry:
Chicago classification version 4.0[©]

EGJ PRESSURE TOPOGRAPHY



Identify pressure zone at the EGJ

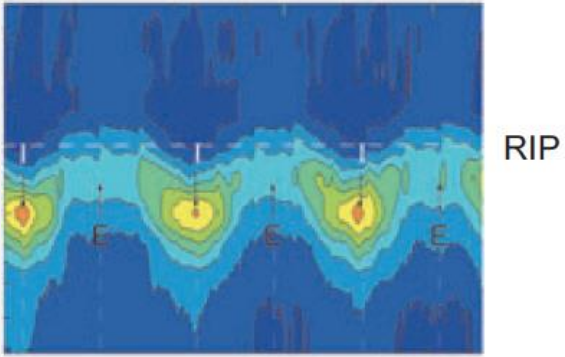
Respiratory phase:
I = Inspiration
E = Expiration

RIP = Respiratory pressure inversion point \approx border between abdominal and thoracic pressure compartment, i.e. pressure increases with inspiration distal and decreases proximal to this level

Line tracings on top are 1 cm proximal (blue) and distal (red) to the RIP mark

EGJ TOPOGRAPHY TYPES

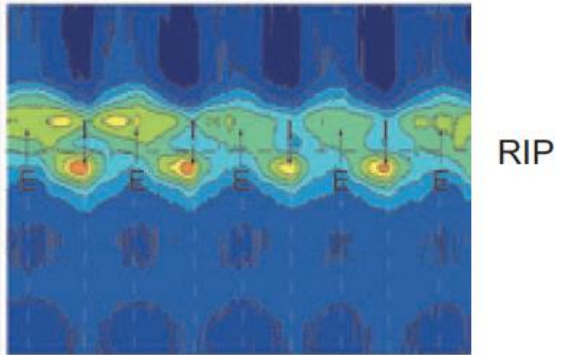
Type I



Type I:

Complete overlap of LES and diaphragmatic crura

Type II



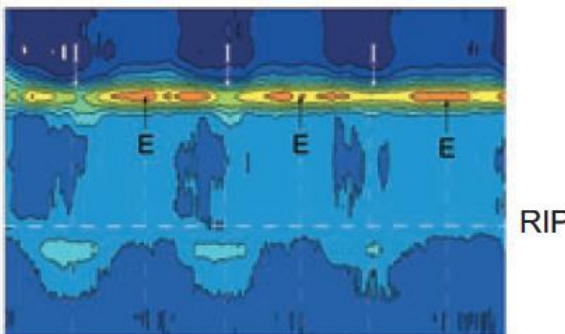
Type II:

Separation of LES and diaphragm 1-2 cm

Type III:

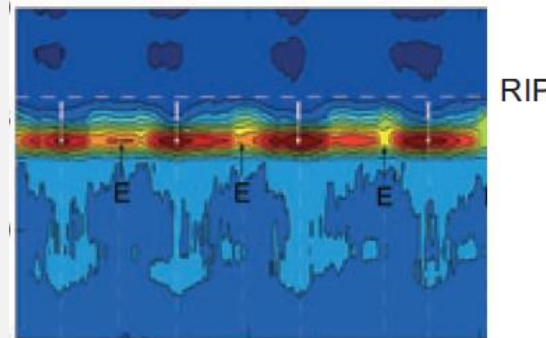
Distance between LES and diaphragm >2 cm
(=hiatal hernia)

Type IIIa



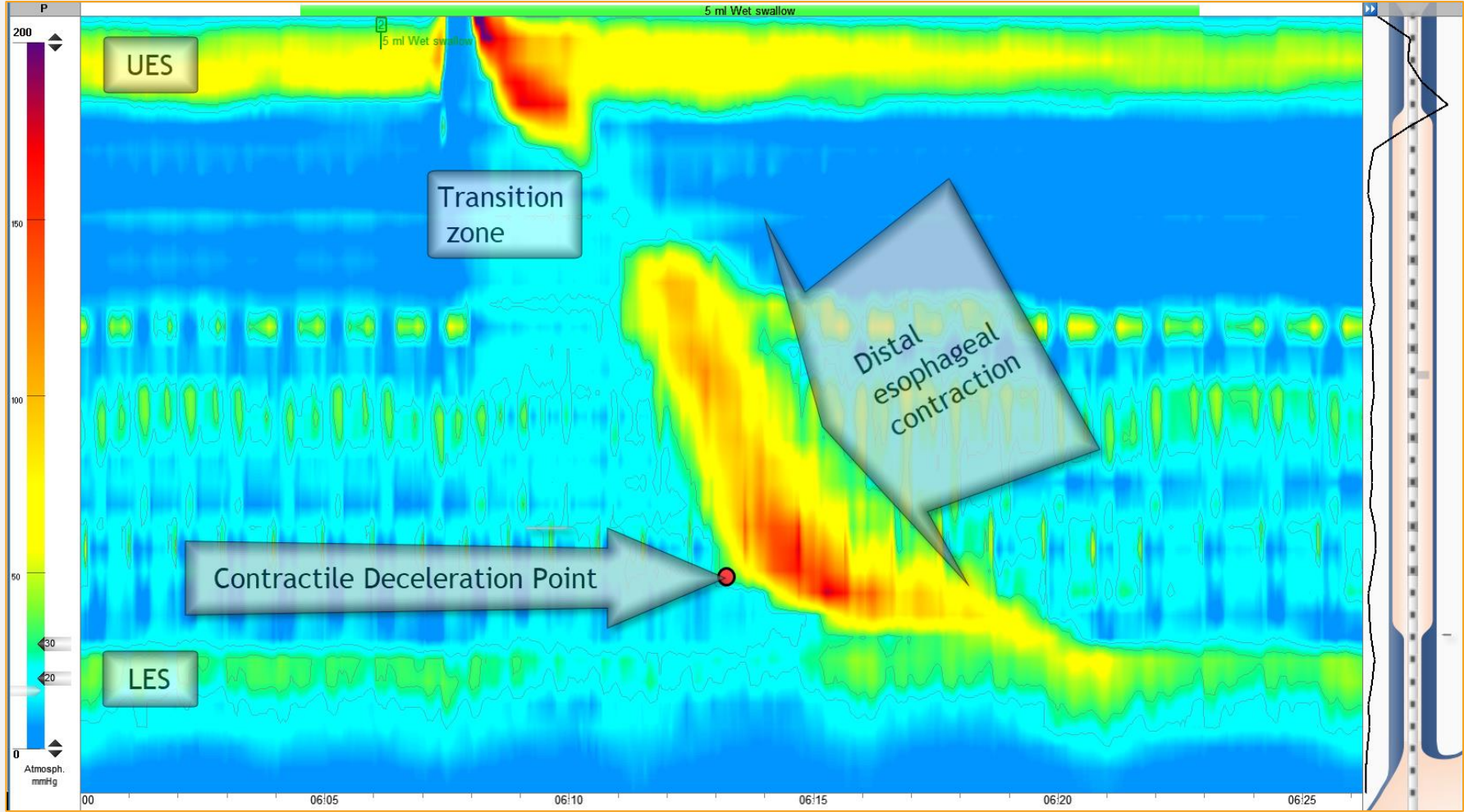
IIIa: Respiratory inversion point (RIP)
at level of diaphragm

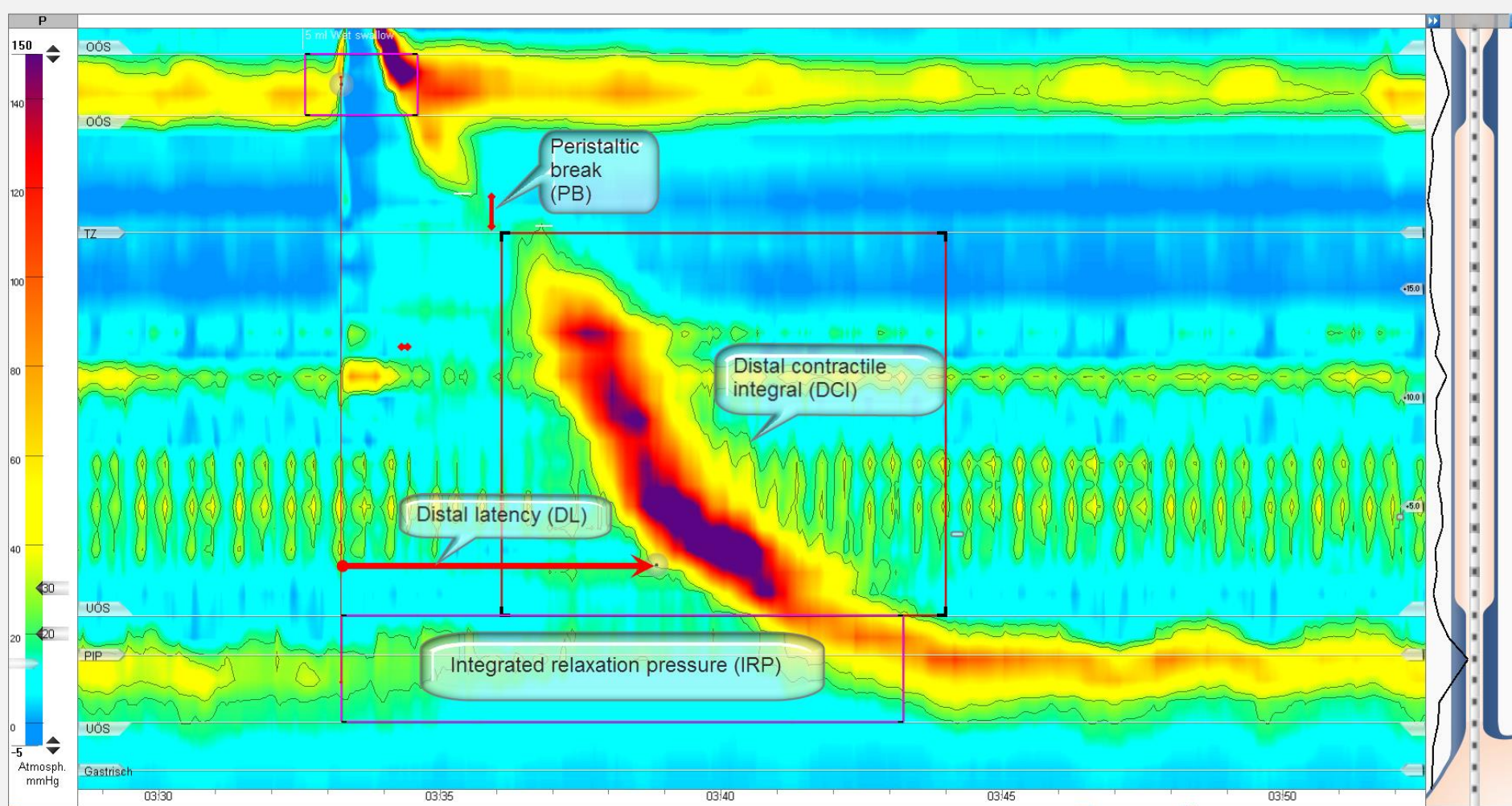
Type IIIb



IIIb: RIP at level of LES

LANDMARKS





Apply Chicago Metrics:

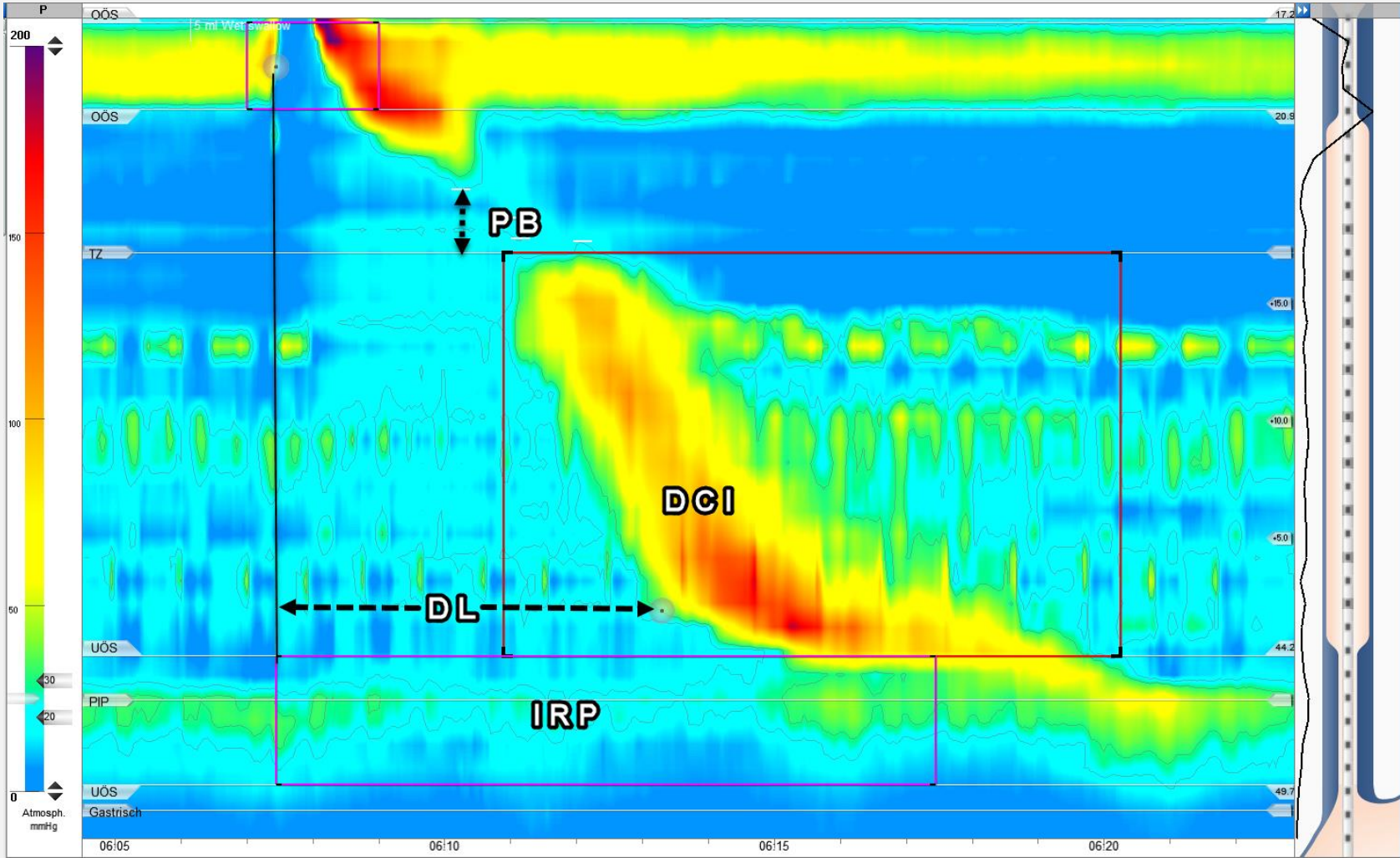
IRP: Integrated Relaxation Pressure (mmHg)

DCI: Distal Contractile Integral (mmHg.s.cm), use 20 mmHg isobaric contour

DL: Distal Latency, use 30 mm Hg isobaric contour

PB: Peristaltic Break, length of interruption in 20 mmHg isobaric contour

PRESSURE TOPOGRAPHY METRICS



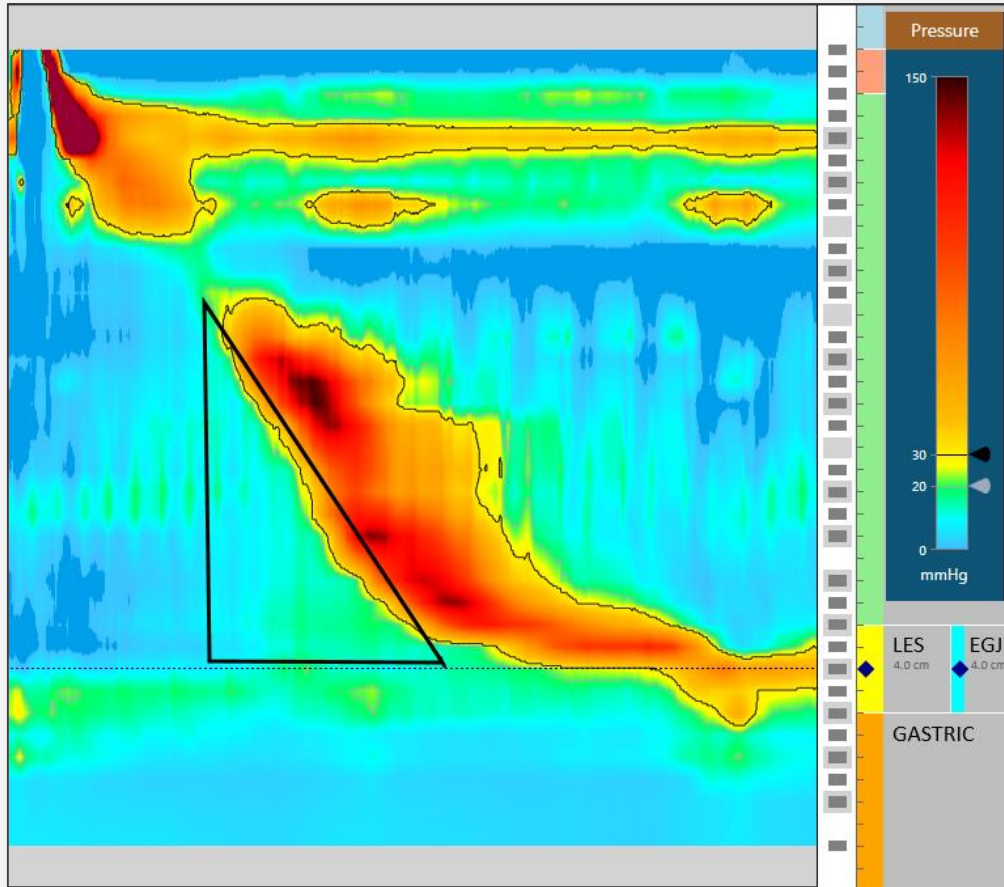
PB = Peristaltic Break

DCI = Distale Contractile Integral

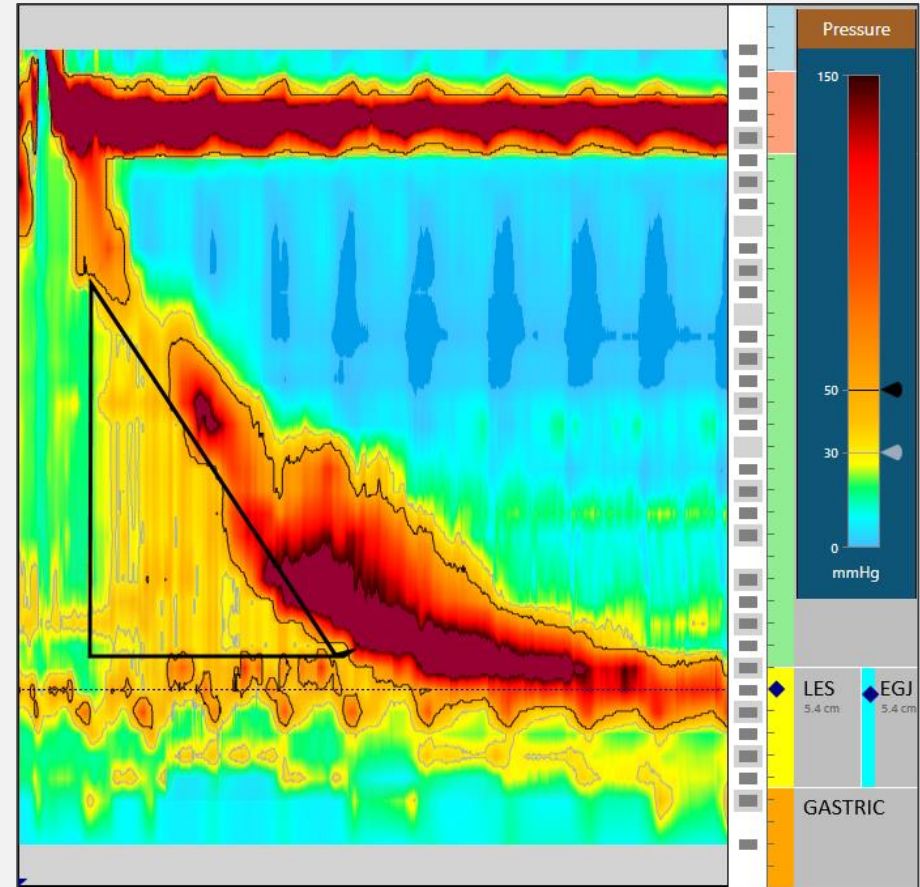
DL = Distal Latency

IRP = Integrated Relaxation Pressure

PRESSURIZATION TYPES I

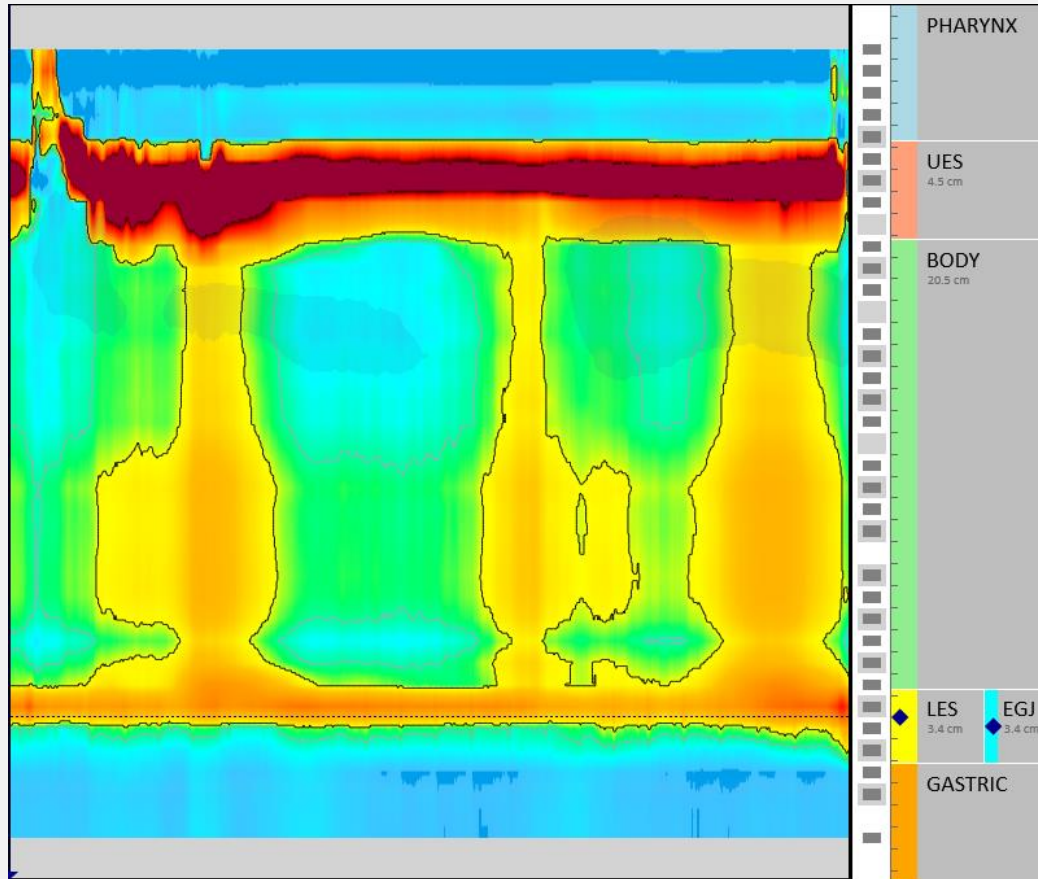


Normal = no pressure >30 mmHg before onset of the contraction wave. Isocontours at 20 and 30 mmHg (standard setting).

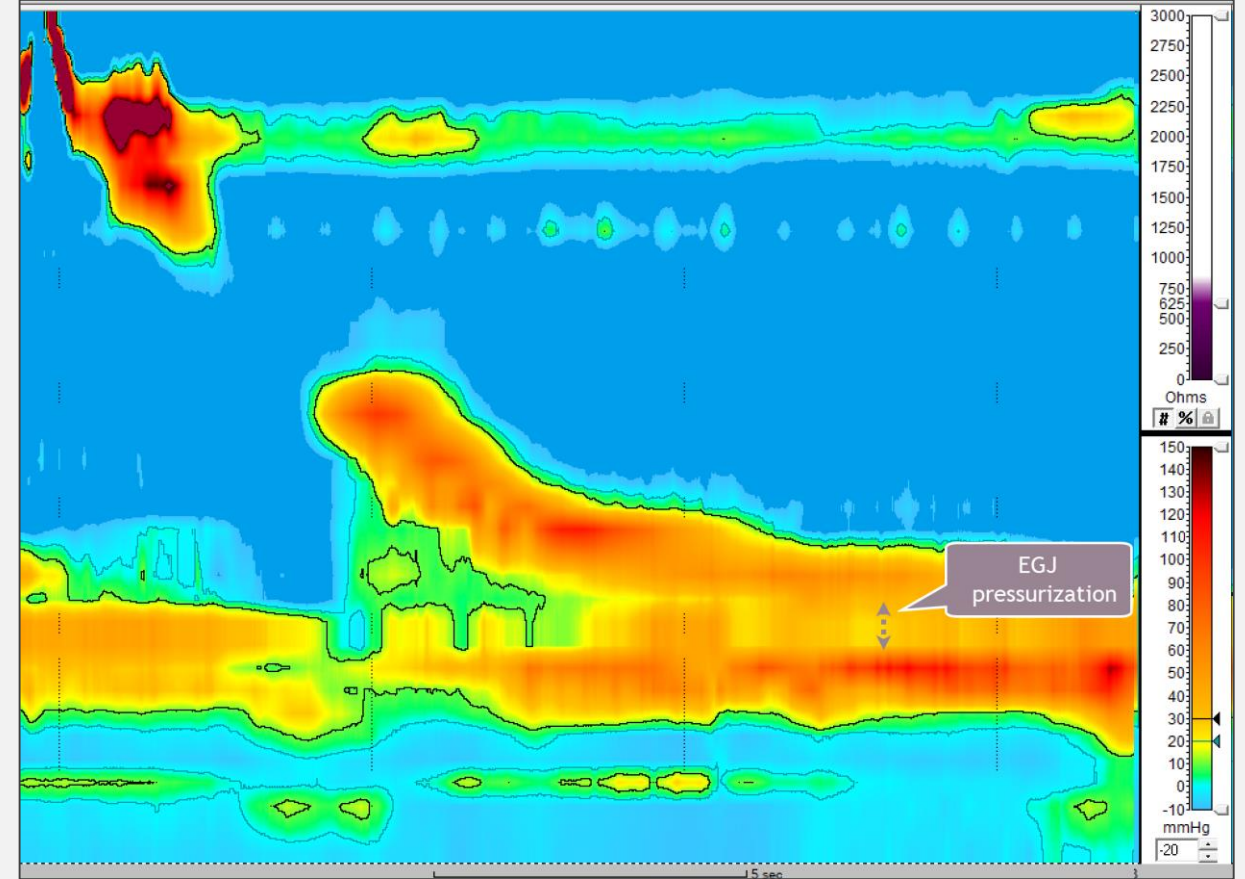


Compartmentalized pressurization = pressure >30 mmHg ahead of the contraction wave. Isocontours at 30 and 50 mmHg.

PRESSURIZATION TYPES II



Panesophageal pressurization: No peristaltic contraction wave. Pressure >30 mmHg extending between UES and LES.



EGJ pressurization: Pressure >30 mmHg extending between LES and diaphragm in EGJ type III.

PRESSURE TOPOGRAPHY METRICS

Integrated Relaxation Pressure (IRP, mmHg):

Mean of the 4 s of maximal deglutitive relaxation in the 10-s window beginning at UES relaxation. Contributing times can be contiguous or non-contiguous (e.g., interrupted by diaphragmatic contraction). Referenced to gastric pressure.

Distal Contractile Integral (DCI, mmHgscm):

Amplitude *duration *length of the distal esophageal contraction exceeding 20 mmHg from the transition zone to the proximal margin of the LES. Referenced to atmospheric pressure

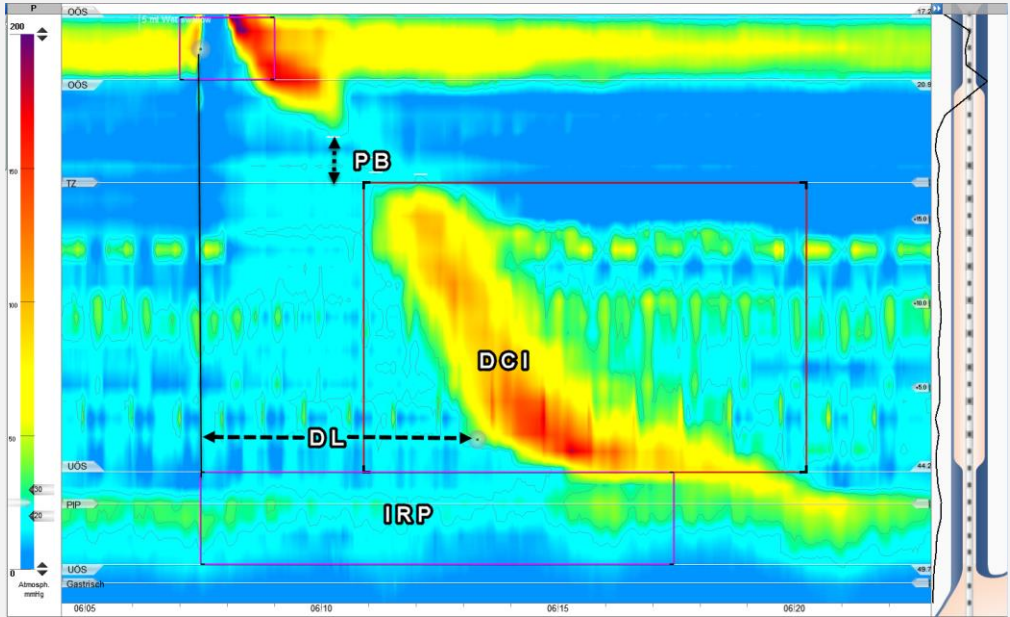
Distal Latency (DL, s):

Interval between UES relaxation and the contractile deceleration point (CDP). The CDP represents the inflection point along the 30 mmHg isobaric contour at which propagation velocity slows. The CDP must be localized within 3 cm of the proximal margin of the LES.

Peristaltic Break (PB, cm):

Breaks in the 20 mmHg isocontour.

PRESSURE TOPOGRAPHY METRICS



Apply metrics

- PB = Peristaltic Break
- DCI = Distal Contractile Integral
- DL = Distal Latency
- IRP = Integrated Relaxation Pressure

Score individual swallows:

- LES Relaxation: IRP
- Contraction vigor: DCI
- Contraction pattern: DL + PB
- Pressurization pattern

SCORING OF INDIVIDUAL SWALLOWS I

IRP (referenced to intragastric pressure):

IRP measurements are technology- and device-specific.

Upper limit of normals (examples):

Sierra circumferential sensors:	15 mmHg
Unisensor circumferential sensors (MMS, Sandhill):	21 mmHg
Dentsleeve water perfused system:	19 mmHg

Intrabolus pressure pattern (30 mmHg isobaric contour referenced to atmospheric)

Pan-esophageal pressurization :

Uniform pressurization of >30 mmHg extending from the UES to the EGJ

Compartmentalized esophageal pressurization:

Pressurization of >30 mmHg extending from the contractile front to the EGJ

EGJ pressurization:

Pressurization restricted to zone between the LES and CD in conjunction with LES-CD separation

Normal:

No bolus pressurization >30 mmHg

SCORING OF INDIVIDUAL SWALLOWS II

Contraction vigor

Failed: DCI <100 mmHg.s.cm

Weak: DCI >100 mmHg.s.cm, but <450 mmHg.s.cm

Ineffective: Failed or Weak

Normal : DCI >450 mmHg.s.cm and <8000 mmHg.s.cm

Hypercontractile: DCI \geq 8000 mmHg.s.cm

Contraction pattern

Premature: DL <4.5 s

Fragmented: Large break (>5 cm length) in the 20-mmHg isobaric contour
with DCI >450 mmHg.s.cm

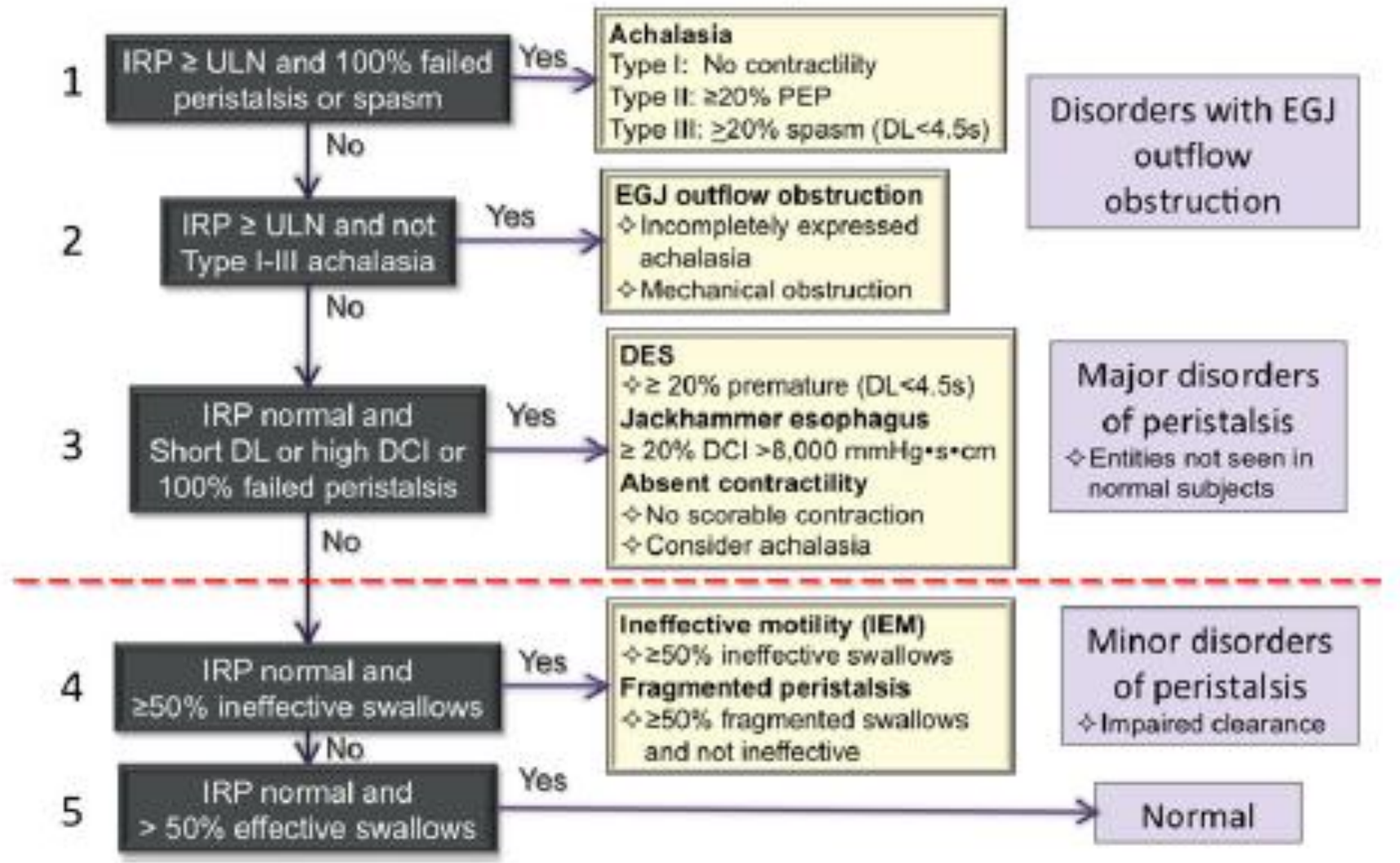
Intact: Not achieving the above diagnostic criteria

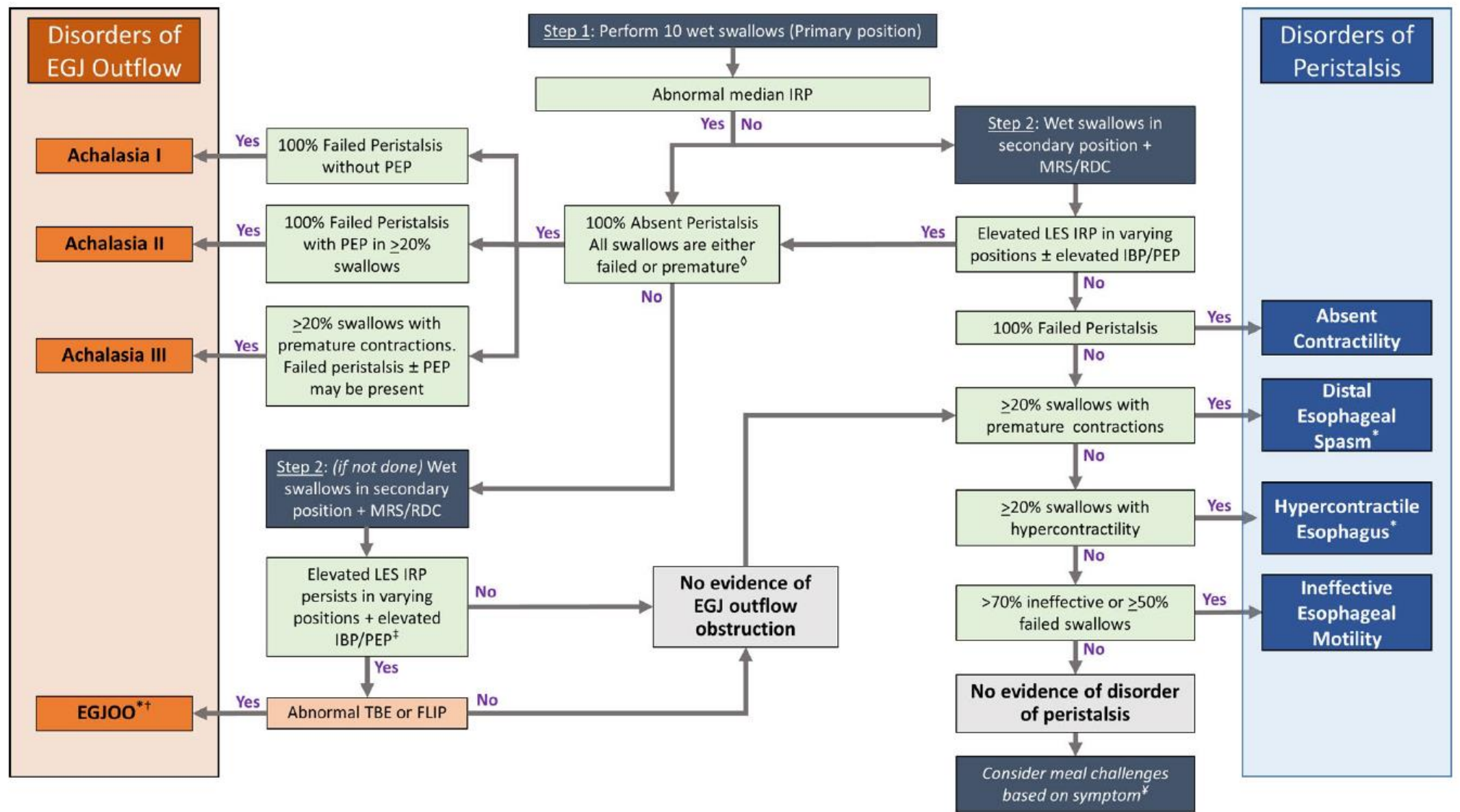
**Normal swallow: IRP in normal range, DCI 450-8000 mmHg.s.cm, DL >4.5 s,
no break >5 cm in 20 mmHg isobaric contour**

A QUICK GUIDE TO HRM INTERPRETATION

- Identify landmarks
- Rate EGJ pressure topography
- Apply pressure topography metrics to swallows and rate individual swallows
- Interpret HRM study in hierarchical order of findings according to the Chicago classification

The Chicago classification v3.0
Hierarchical analysis





LIQUID

LIQUID

LIQUID

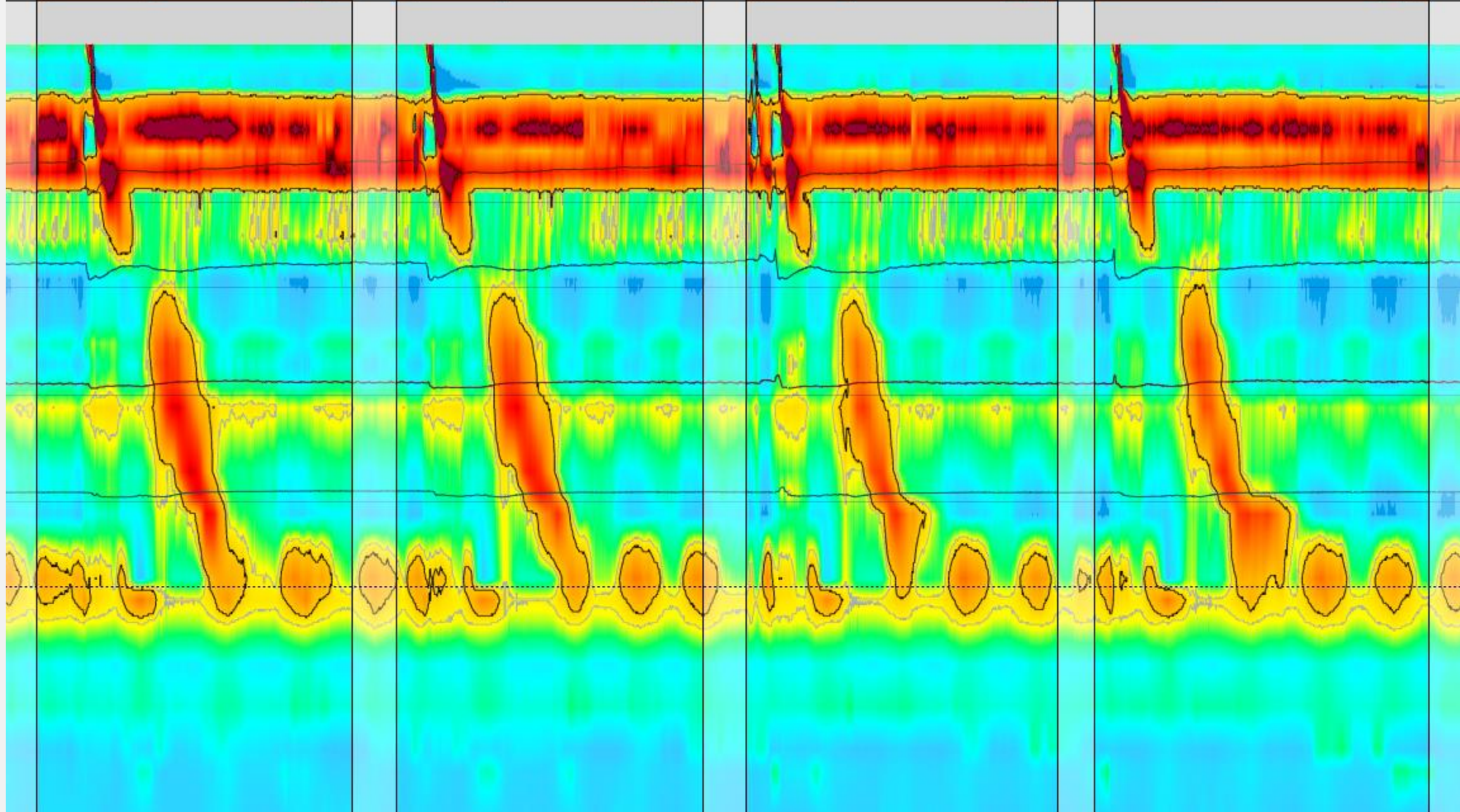
LIQUID

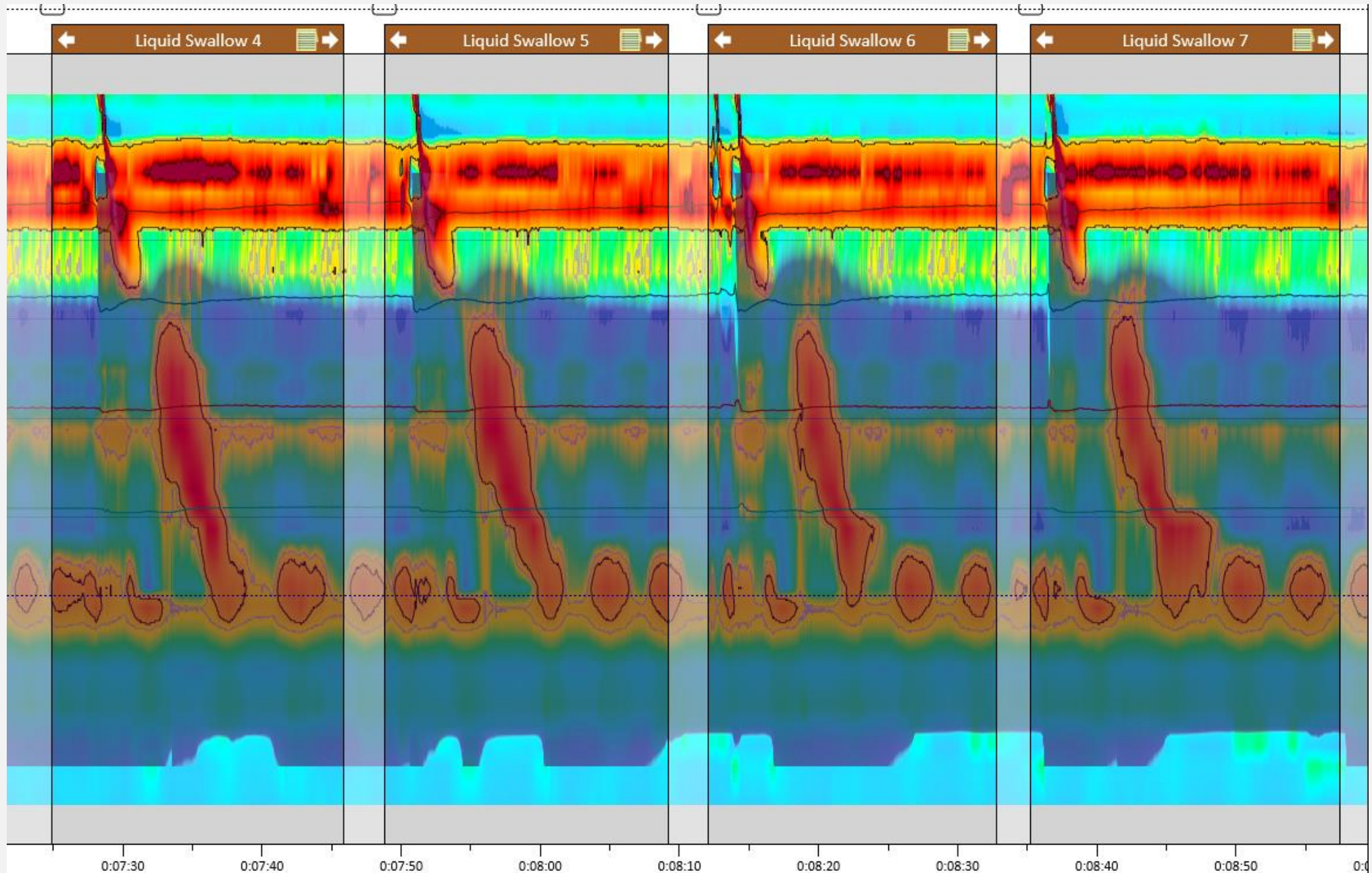
← Liquid Swallow 4 →

← Liquid Swallow 5 →

← Liquid Swallow 6 →

← Liquid Swallow 7 →

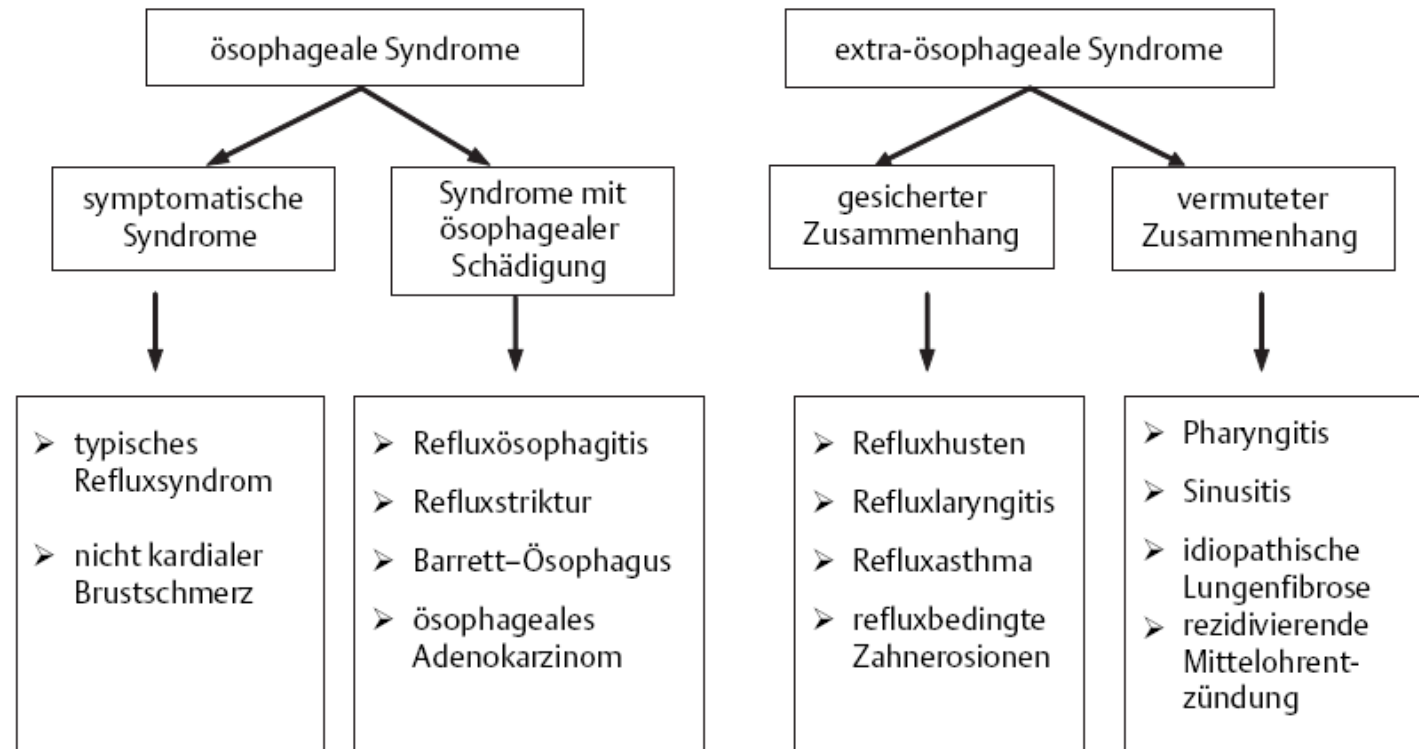




Liquid bolus retention despite normal esophageal body motility and borderline normal LES relaxation in a patient with eosinophilic esophagitis

MONTREAL DEFINITION DER REFLUXKRANKHEIT

GERD ist eine Erkrankung, die sich entwickelt, wenn der Reflux von Mageninhalt belästigende Symptome und/oder Komplikationen verursacht



ANAMNESE

Liegen nur typische Symptome vor?

Sodbrennen, saures Aufstoßen

Besteht ein Mischbild von typischen und atypischen Sy.?

z. B. Sodbrennen und Husten

Liegen nur atypische Symptome vor?

z. B. Globusgefühl und Räuspern

DIAGNOSTIK: PPI-THERAPIEVERSUCH

PPI in Standarddosierung

(1x 40 mg Esomeprazol Äquivalent 30 min. vor Mahlzeit)

Einnahmedauer 8 Wochen

Klinisches Ansprechen: Absetzversuch

Fehlendes Ansprechen: Verdoppelung der Dosis

Fehlendes Ansprechen auf doppelte Dosis: Endoskopie

PPI-THERAPIEVERSUCH AUSSAGEKRAFT

GERD:	79% pooled sensitivity (95% CI, 72%-84%) 45% pooled specificity (95% CI, 40%-49%)
ERD:	76% pooled sensitivity (95% CI, 66%-84%) 30% pooled specificity (95% CI, 8%-67%)
NERD:	79% pooled sensitivity (95% CI, 70%-86%) 50% pooled specificity (95% CI, 39%-61%)
NCCP:	79% (95% CI, 69%-86%) 79% (95% CI, 69%-86%)

19 studies (GERD 11, NCCP 8), 1691 patients

GERD: Gastroesophageal reflux disease

ERD: Erosive reflux disease

NERD: Non-erosive reflux disease

NCCP: Non-cardiac chest pain

ENDOSKOPIE UND BIOPSIE

Indikation: Kein Ansprechen auf empirische PPI-Therapie
Evaluationen von Komplikationen und Differentialdiagnosen

Aussagen:

Hochgradige Ösophagitis (LA grades C or D), Barrett-Ösophagus oder peptische Strikturen sind Beweis einer Refluxkrankheit.

Erosive Ösophagitis bei 30% PPI-naiver Patienten und bei <10% der Patienten unter PPI.

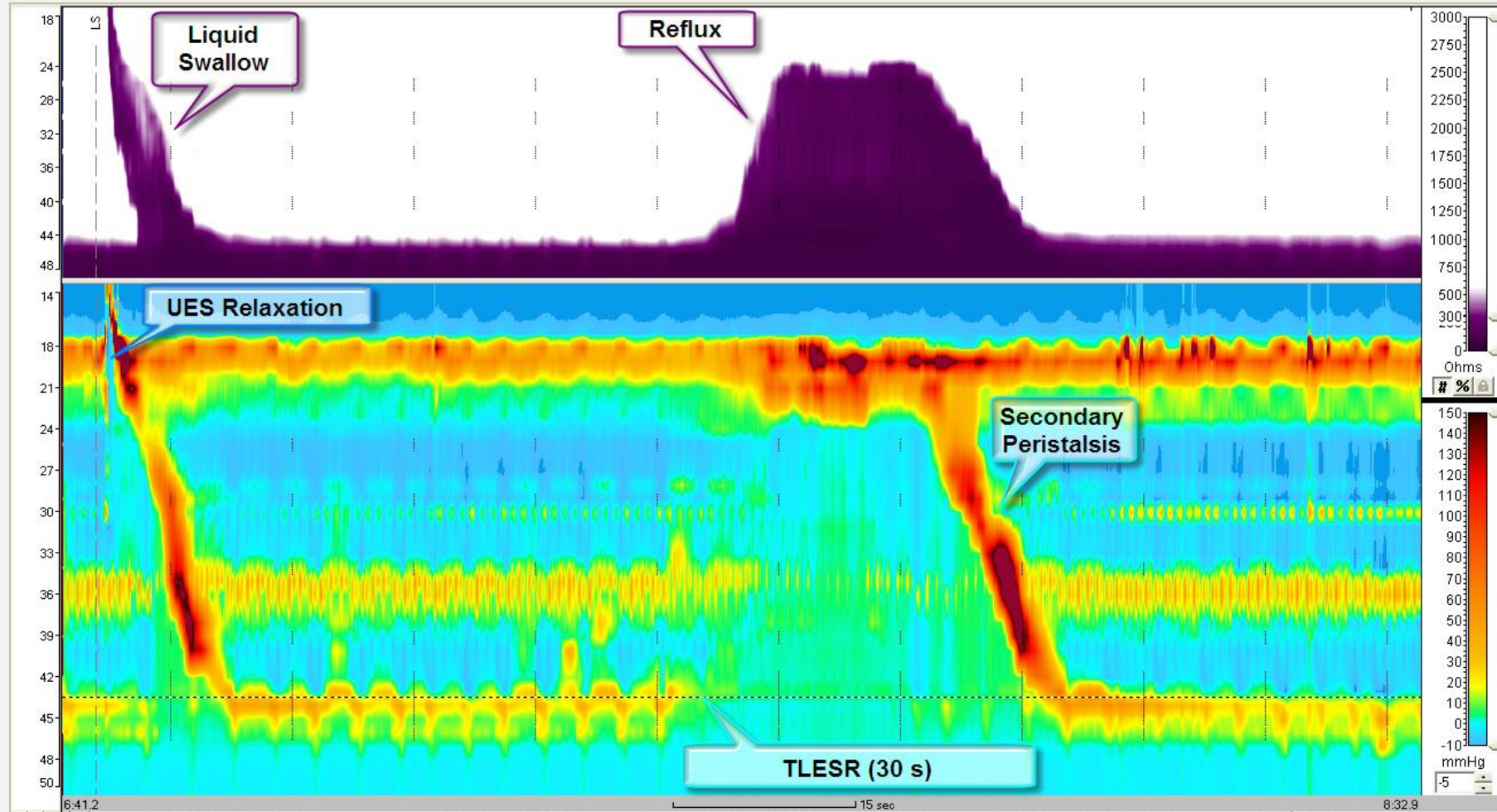
LA Grad A: nicht spezifisch (in 5%–7.5% asymptomatischer Kontrollen)

LA Grad B: Ausreichende Evidenz zur Initiation einer PPI-Therapie,
zusätzliche pH-Metrie vor Antirefluxchirurgie gefordert

Rom IV Konsens: oesophageale Biopsien zum Ausschluss einer eosinophile Ösophagitis

Histopathologie: Strukturiertes histopathologisches Protokoll: Papillenelongation, Basalzellhyperplasie, erweiterte interzelluläre Spalten, mukosale Entzündungszellen

REFLUXMECHANISMUS: TLESR



Transiente Sphincter-Relaxation (TLESR)

AMBULATORISCHES REFLUX MONITORING

Bestätigung der Diagnose Refluxkrankheit bei Patienten mit normaler Endoskopie, atypischen Symptomen oder vor Antireflux-Chirurgie.

Wireless pH monitoring (Bravo Kapsel):

Aufnahmezeit von bis zu 96 Stunden erhöht diagnostische Sicherheit

Endoskopie zur Platzierung erforderlich, aber weniger Beeinträchtigung während Aufzeichnung

Niedrige Samplingrate: kurzdaurende Refluxes nicht erfasst

Teuer

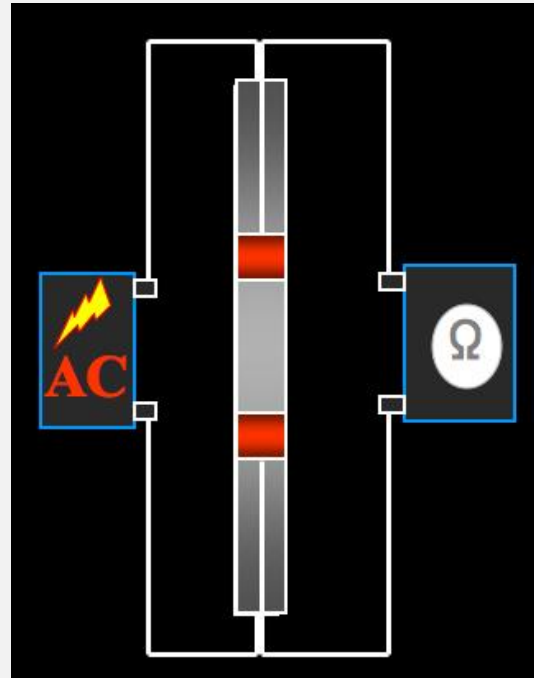
24h-Impedanz-pH-Metrie:

Charakterisiert Refluxes: Flüssig, gasförmig, gemischt, sauer, nicht sauer

Weniger Patientenkomfort

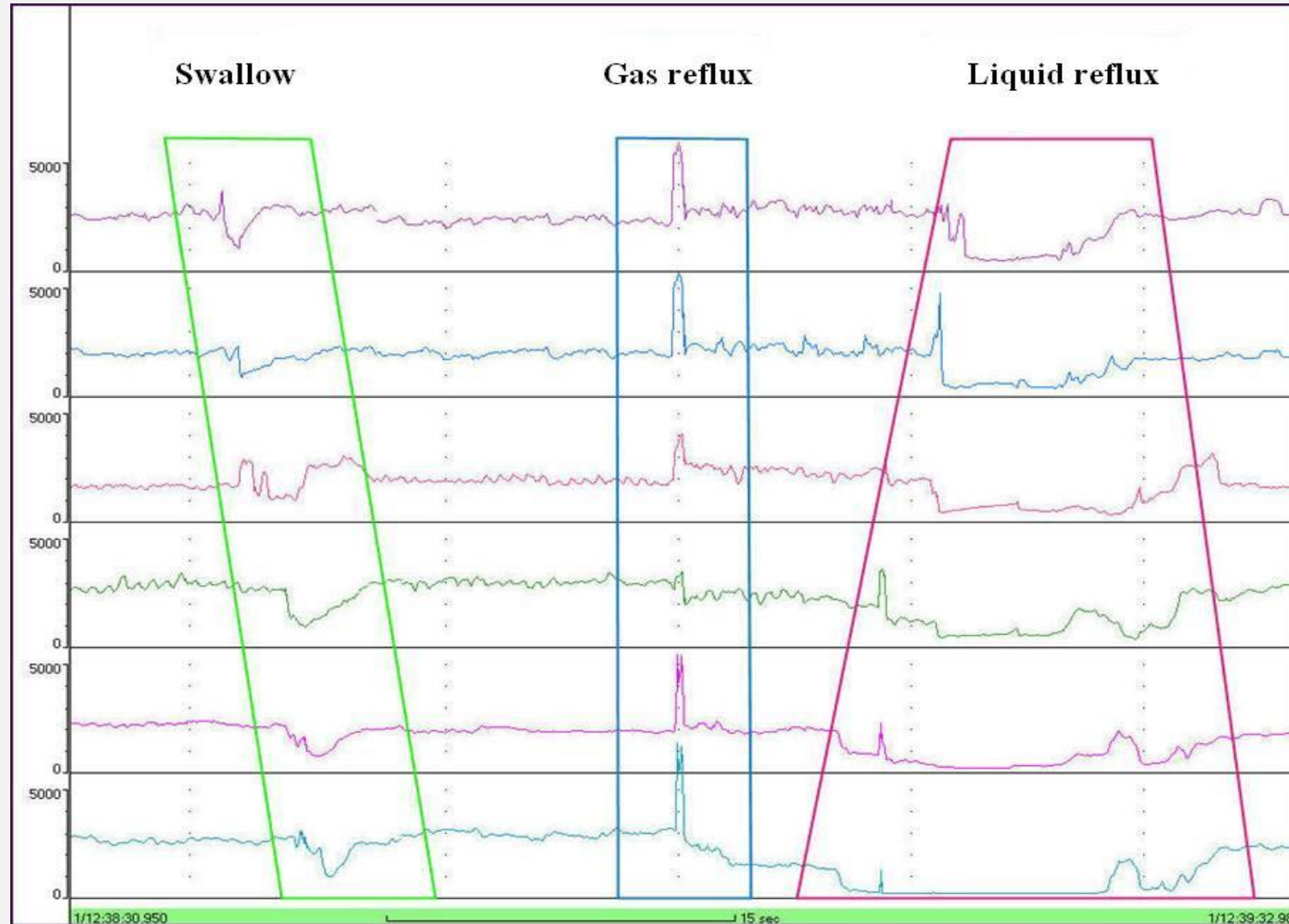
Interpretation zeitaufwändig

IMPEDANZ MONITORING

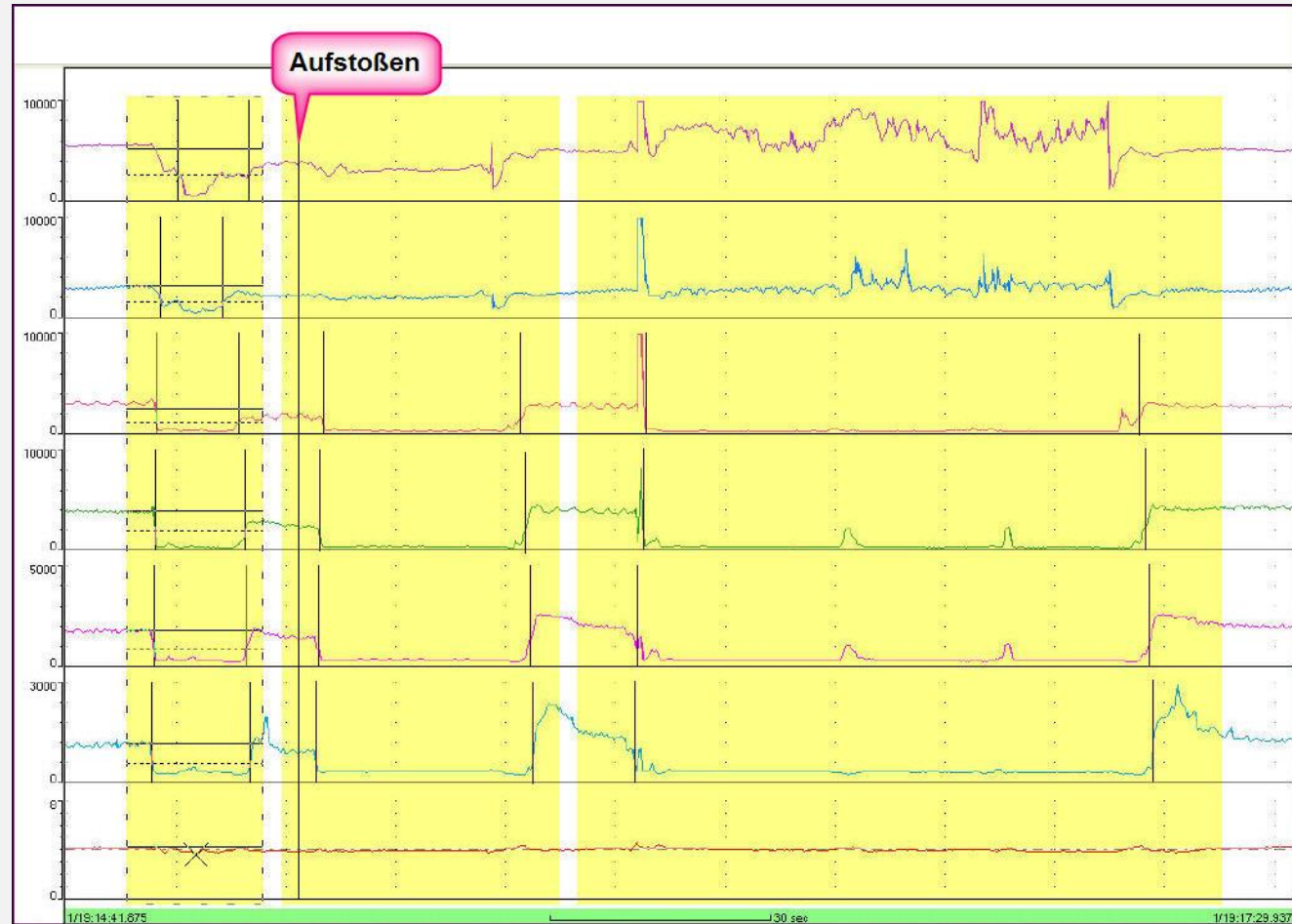


Ringelektroden an Katheter in Schleimhautkontakt
Anlage einer Wechselspannung zwischen Elektrodenpaaren
Messung des Widerstands (Impedanz)

FLÜSSIGKEITS- UND GASBEWEGUNGEN



SYMPTOMASSOZIATION



IMPEDANZ-PH-METRIE: NORMWERTE

Säureexposition

Acid Exposure Time (AET)

% Messzeit pH<4

Normal: <4.2% gesamt
<6.3% aufrecht
<1.2% liegend

Anzahl der Refluxes:

Normal: <73

Shay Am J Gastroenterol 2004; 99: 1037-43

Symptomassoziation:

Symptom Index (SI):

% Sy. < 5 min nach Reflux

Negativ: <50%

Positiv: \geq 50%

Symptom Association Probability

2 min. Zeitfenster

Positiv: >95%

IMPEDANZ-PH-METRIE

Monitoring unter oder ohne PPI?

Ohne PPI:

Lyon Konsens empfiehlt Test ohne PPI bei nicht zuvor nachgewiesener Refluxkrankheit:

keine oder niedriggradige Ösophagitis

keine positive pH-Metrie in der Vorgeschichte

Ein Test «off PPI» wird auch vor eventueller Antirefluxchirurgie vorgeschlagen

Säureexposition wichtigster Parameter

Mit PPI (doppelte Dosis):

Patient mit nachgewiesener Refluxkrankheit (Ösophagitis LA C oder D, long segment Barrett-Ösophagus oder frühere abnorme pH-Metrie LSBE)

- Symptom-Reflux Assoziation
- Inadäquate Säuresuppression
- Mangelnde Compliance

AET AND NUMBER OF REFLUXES

Acid Exposure Time (AET):

- Reproducible
- Reliably extracted from automated analysis (caveat: acidic beverages)
- Predictive of response to medical and surgical reflux therapy.

Lyon GERD Consensus proposes:

AET <4% be considered definitively normal (physiological)

AET >6% be considered definitively abnormal

Intermediate values between these limits being inconclusive.

Number of reflux episodes (acidic, weakly acidic or weakly alkaline)

- overestimated by the automated analysis, requires manual review of the tracing.

The Lyon GERD Consensus proposes:

>80 reflux episodes per 24 hours are definitively abnormal

<40 reflux episodes is physiological

Intermediate values are inconclusive.

SYMPTOM REFLUX ASSOCIATION

Analysis of the temporal association (2 min time frame) between symptoms and reflux episodes.

The Symptom Index (SI):

- percentage of symptom events preceded by reflux episodes (positive $\geq 50\%$)
- Disadvantage: chance association possible , because number of reflux episodes is not

Symptom Association Probability (SAP):

- considered positive if the probability (P value) of the observed association occurring by chance is $< 5\%$.
- Considers all relevant components (number of symptom events, number of reflux episodes),

The combination of a positive SI and positive SAP provides the best evidence of a clinically relevant association between reflux episodes and symptoms.

SI and SAP are predictive of the effect of medical and surgical antireflux therapy, independent of AET.

The outcome of symptom association analysis is more reliable when at least 3 symptom events occur during the test.

NOVEL METRICS

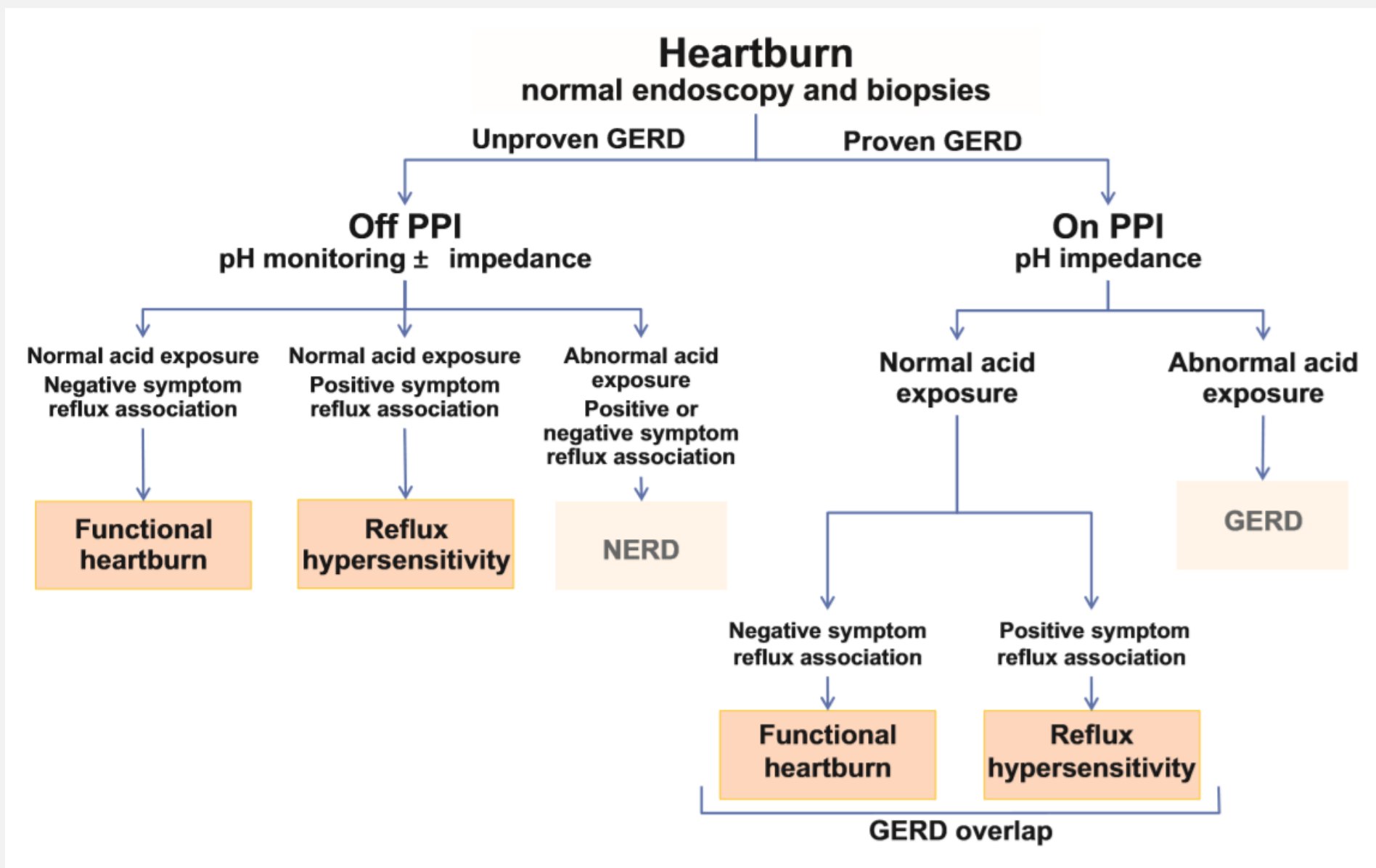
PSPW (**P**ost-reflux **S**wallow-induced **P**eristaltic **W**aves)

- discriminates patients with GERD from those with functional heartburn.
- Antegrade progression of impedance decline within 30 s of a reflux episode
- PSPW index: proportion of reflux episodes on pH-impedance monitoring followed by a PSPW.
- **Currently not programmed into the analysis software**

Baseline impedance

- Reflect the permeability of the oesophageal mucosa, linked to alteration in intercellular space and tight junctions.
- lower values found in erosive and non-erosive GERD.^{91 92} Low baseline oesophageal mucosal impedance
- Mean nocturnal baseline impedance (MNBI): averaged from three 10 min periods spaced an hour apart.
- Low MNBI (<2292 ohms) independently predicts response to antireflux therapy

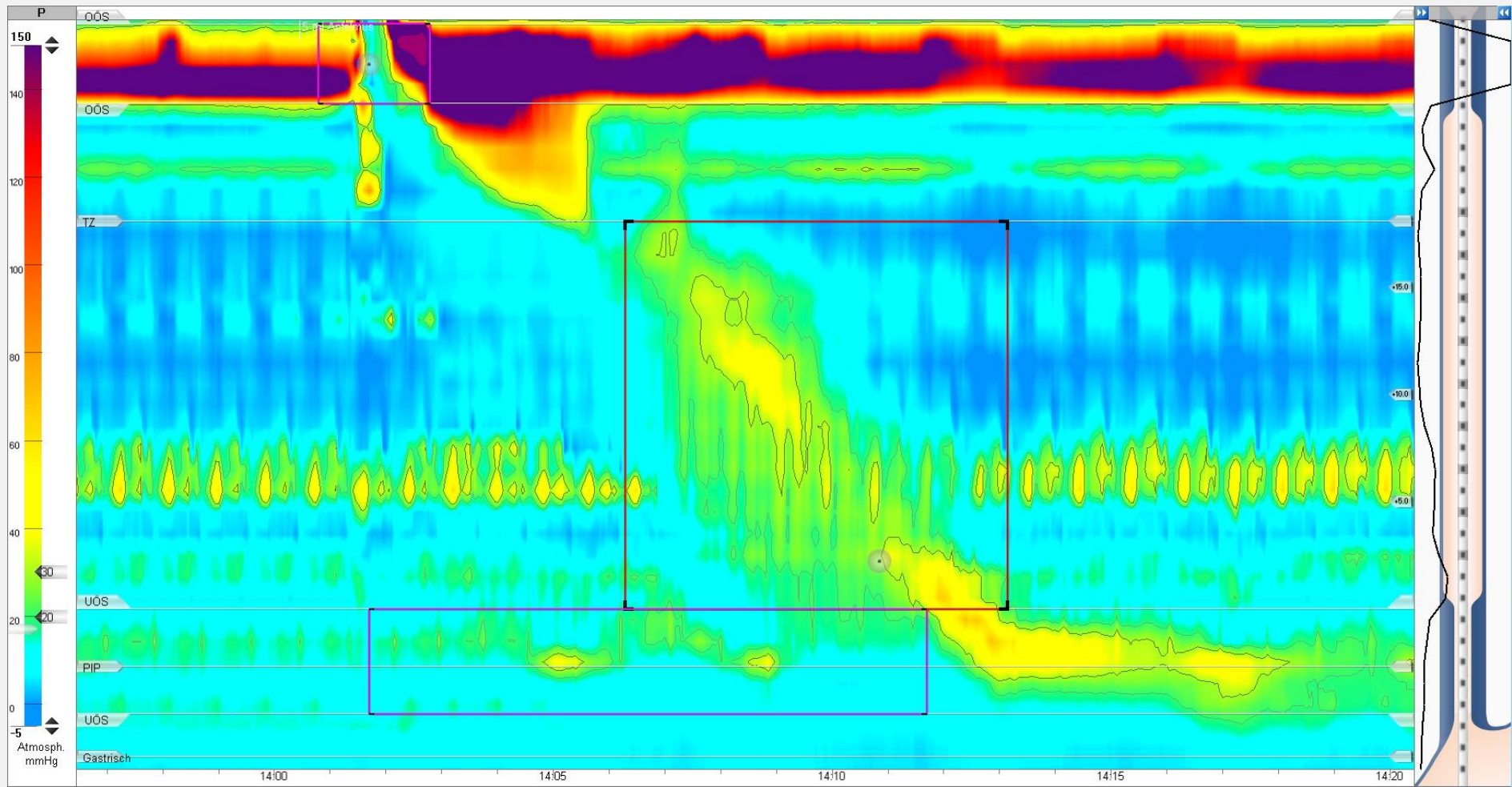
	ENDOSCOPY	pH or pH-IMPEDANCE	HRM
CONCLUSIVE EVIDENCE FOR PATHOLOGIC REFLUX	LA grades C&D esophagitis Long segment Barrett's mucosa Peptic esophageal stricture	AET >6%	
BORDERLINE OR INCONCLUSIVE EVIDENCE	LA grades A&B esophagitis	AET 4-6% Reflux episodes 40-80	
ADJUNCTIVE OR SUPPORTIVE EVIDENCE*	Histopathology (score) Electron microscopy (DIS) Low mucosal impedance	Reflux-symptom association Reflux episodes >80 Low MNBI Low PSPWI	Hypotensive EGJ Hiatus hernia Esophageal hypomotility
EVIDENCE AGAINST PATHOLOGIC REFLUX		AET <4% Reflux episodes <40	



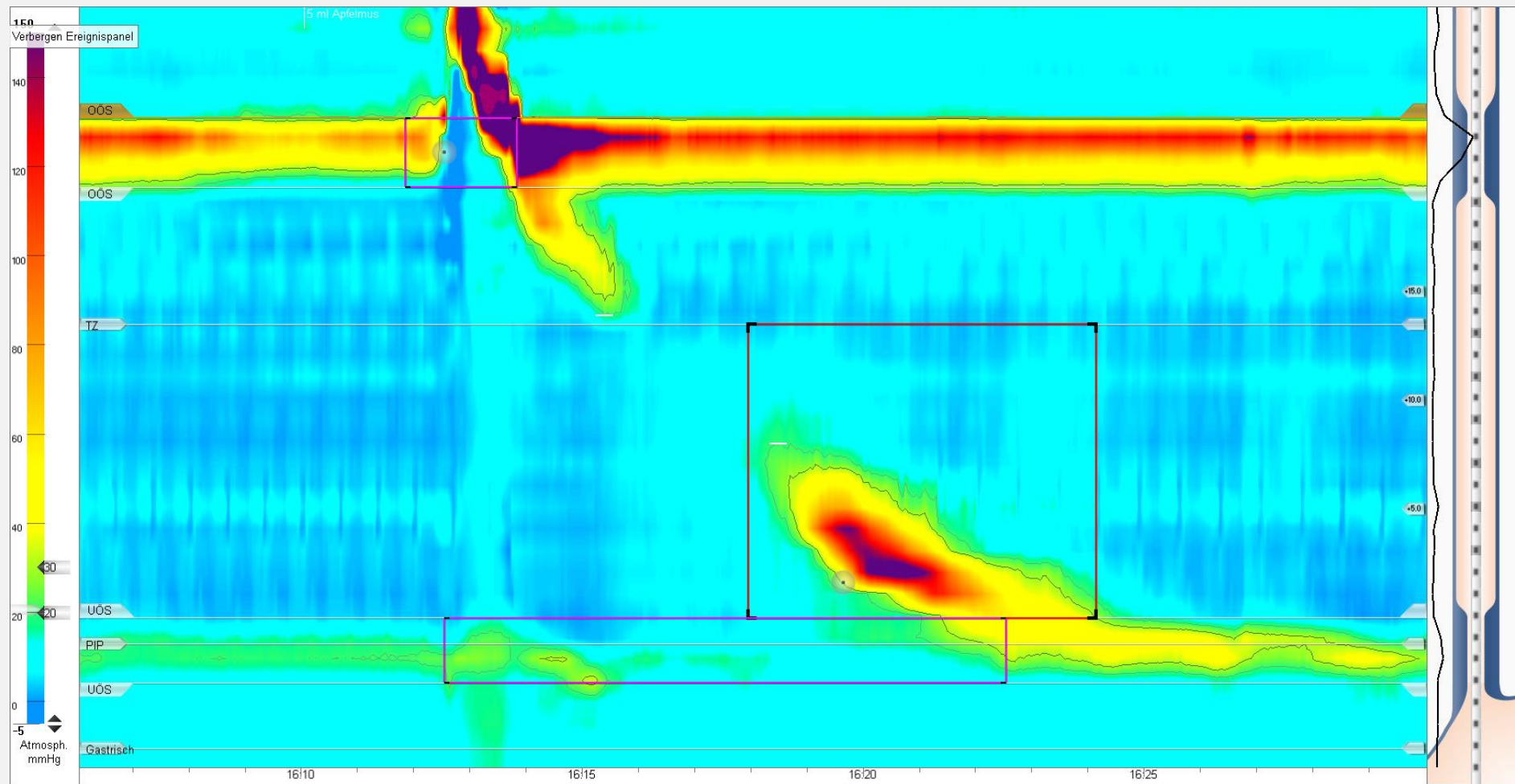
QUIZ

Score the swallows

Solution on last slide

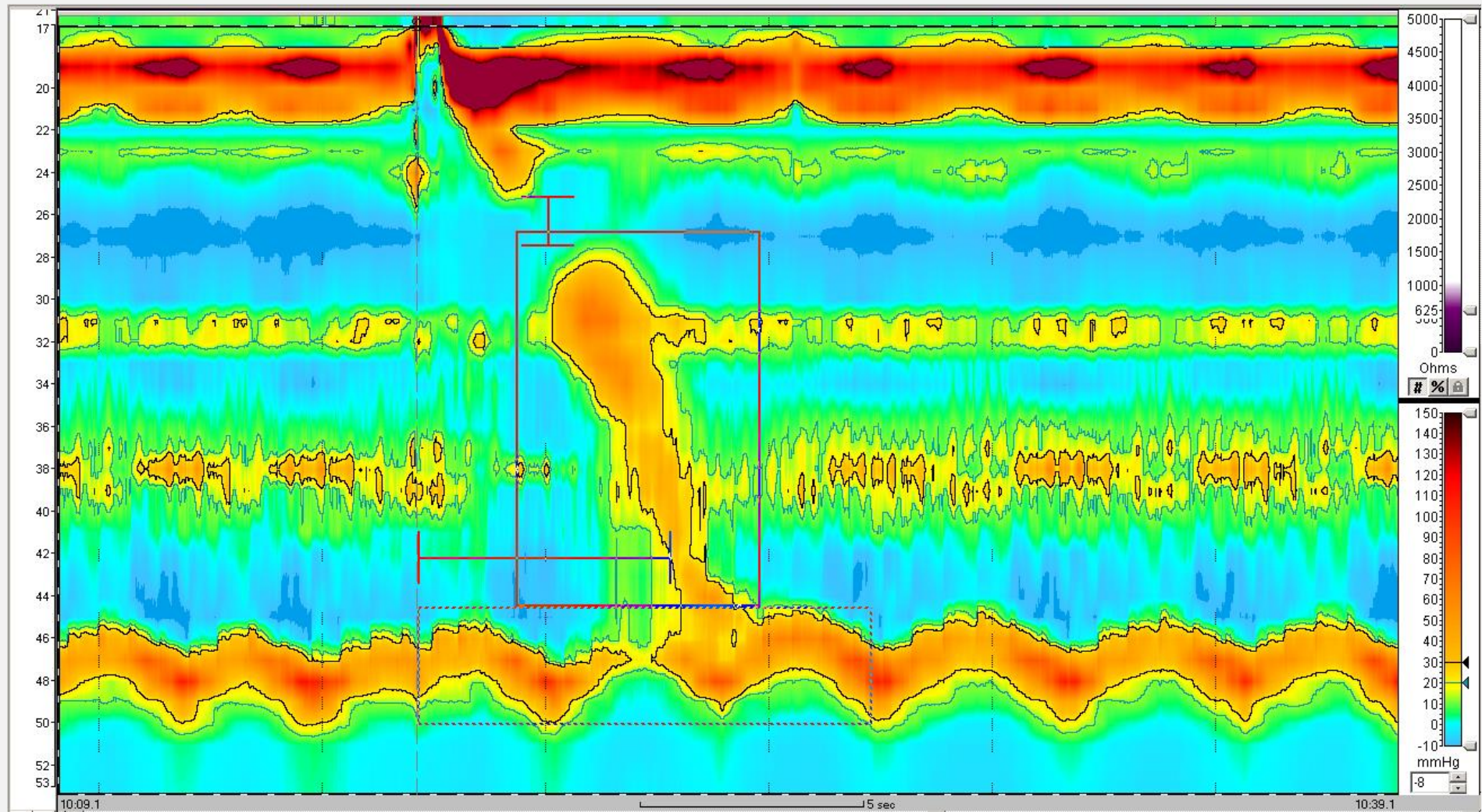


IRP 10 mmHg
 DCI 386 mmHg.s.cm
 DL 9.1 s
 PB --



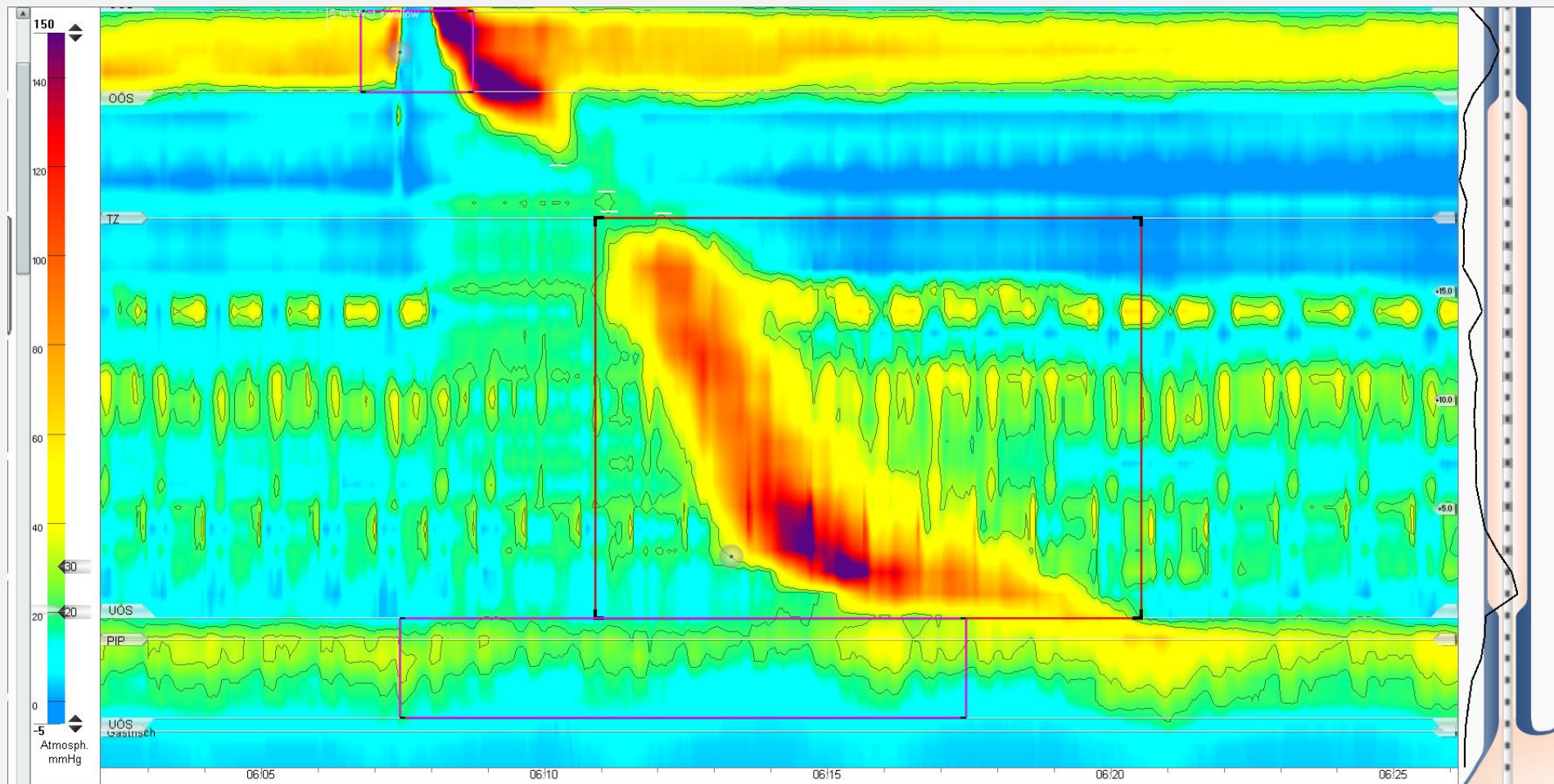
2

IRP 6 mmHg
DCI 940 mmHg.s.cm
DL 7.1 s
PB 5.8 cm



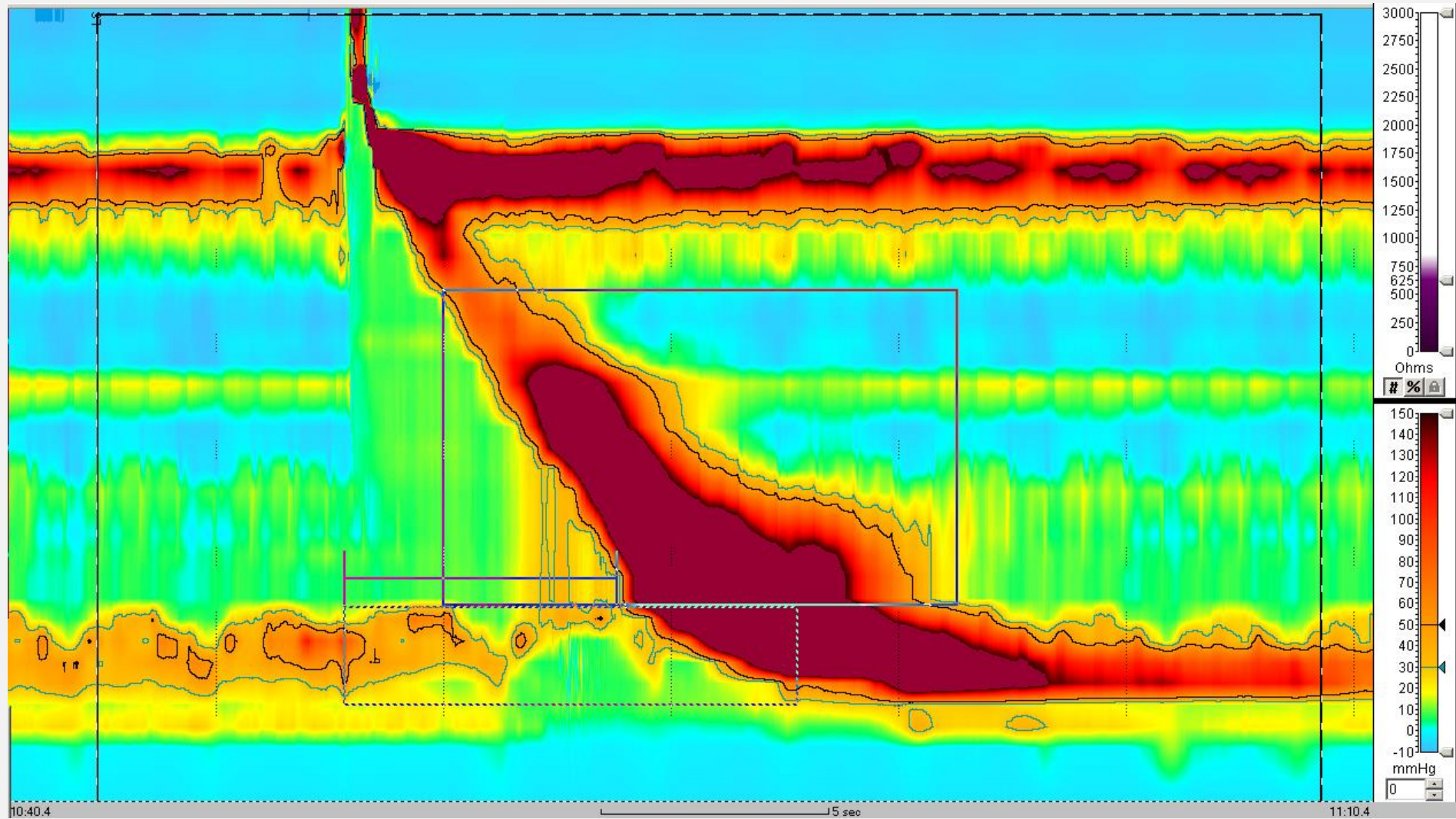
3

IRP 38 mmHg
 DCI 686 mmHg.s.cm
 DL 5.8 s
 PB 2.4 cm



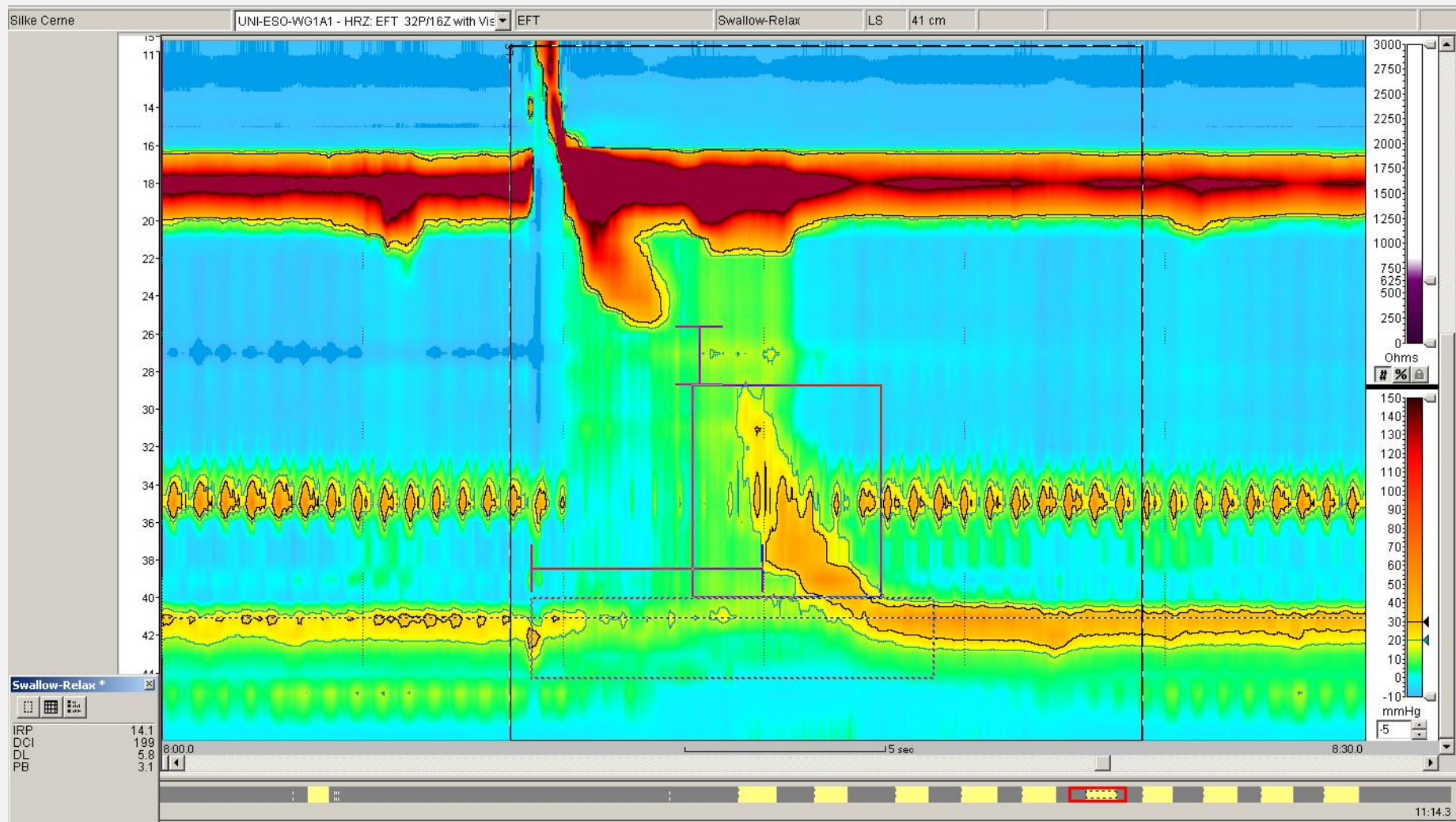
4

IRP	16 mmHg
DCI	3620 mmHg.s.cm
DL	5.8 s
PB	1.9 cm



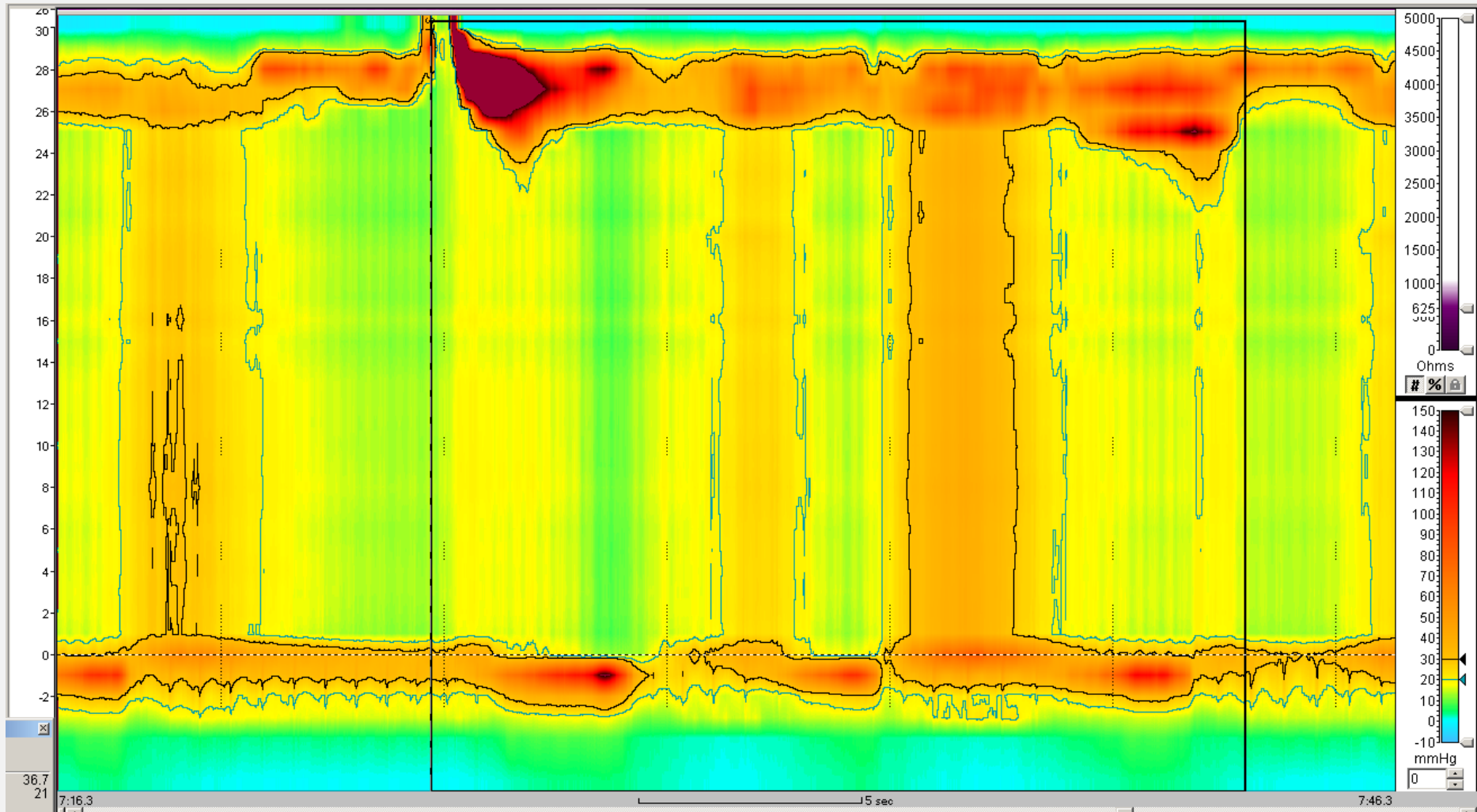
5

IRP 42.1 mmHg
 DCI 9083 mmHg.s.cm
 DL 6.0 s
 PB --



6

IRP 14.1 mmHg
DCI 199 mmHg.s.cm
DL 5.8 s
PB 3.5 cm



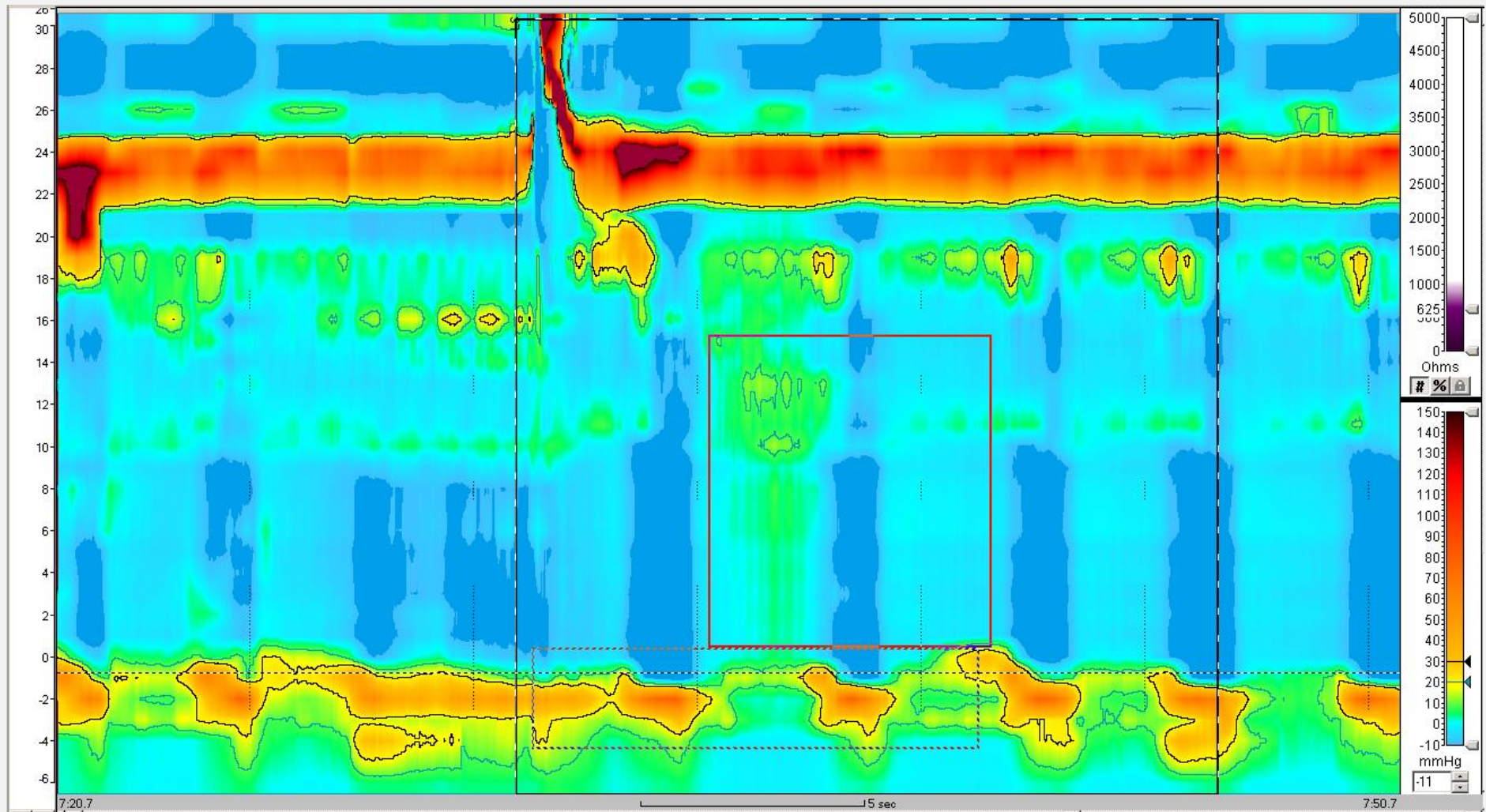
7

IRP 36.7 mmHg

DCI --

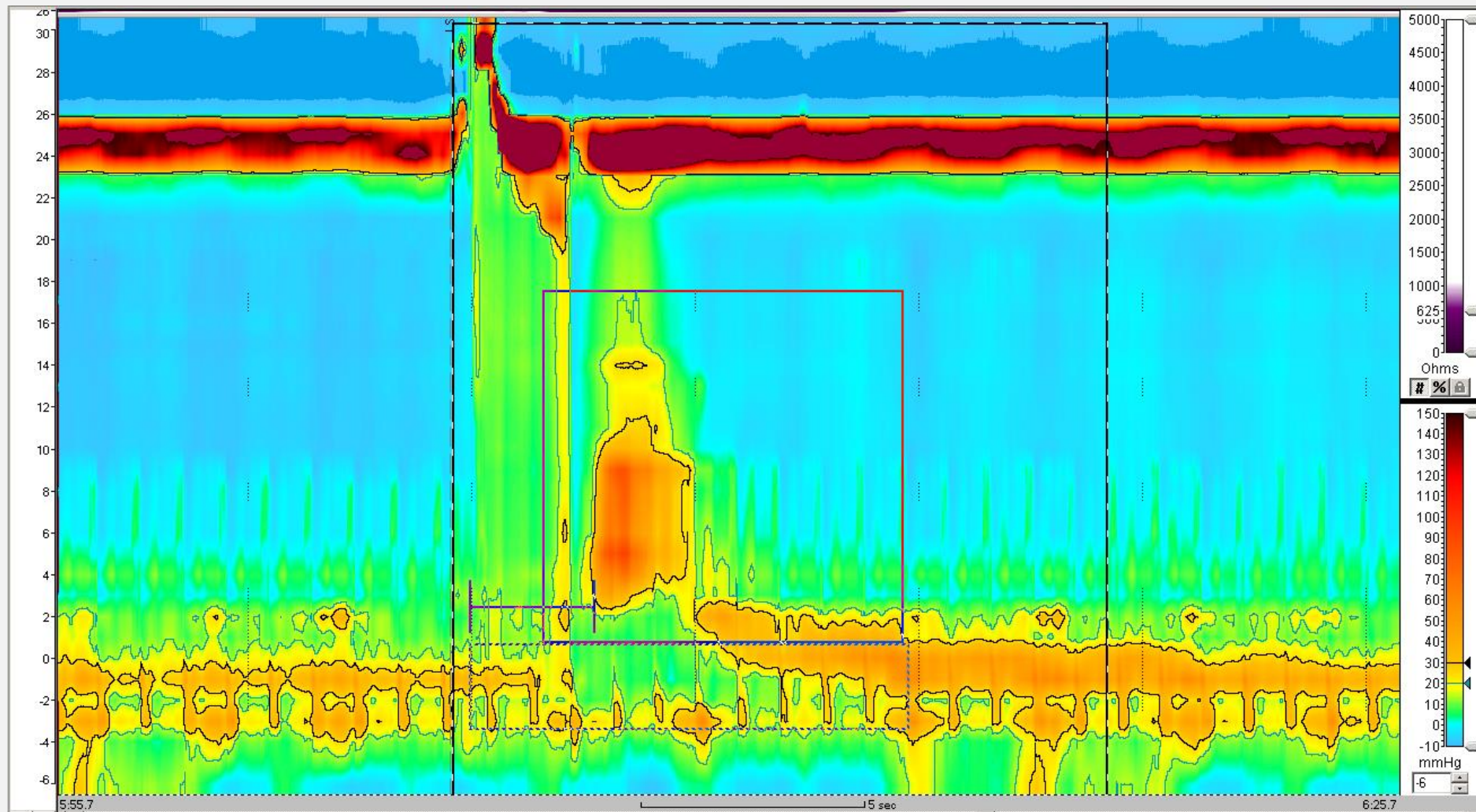
DL --

PB --



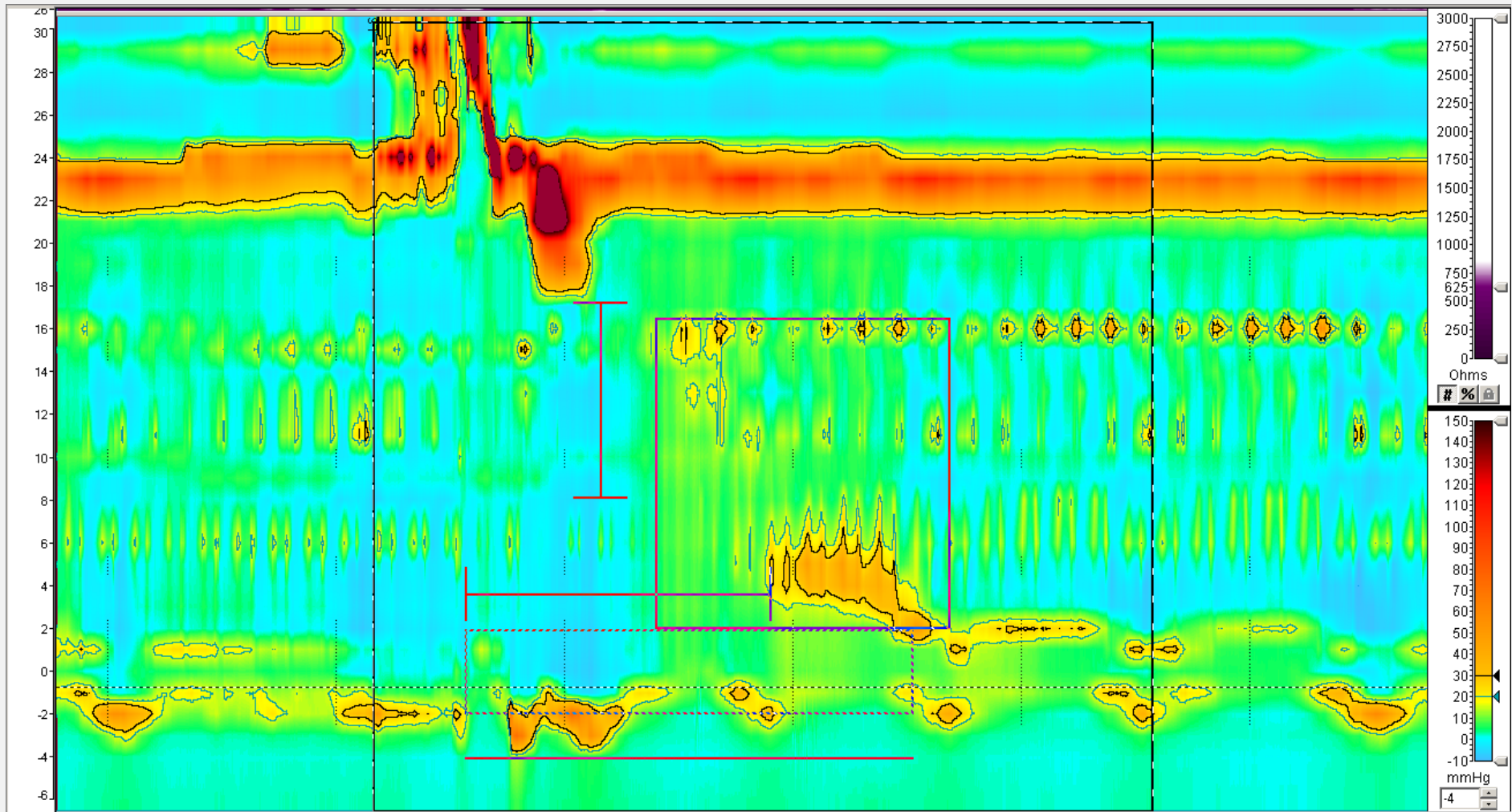
8

IRP 15 mmHg
DCI 3 mmHg.s.cm
DL --
PB --



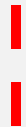
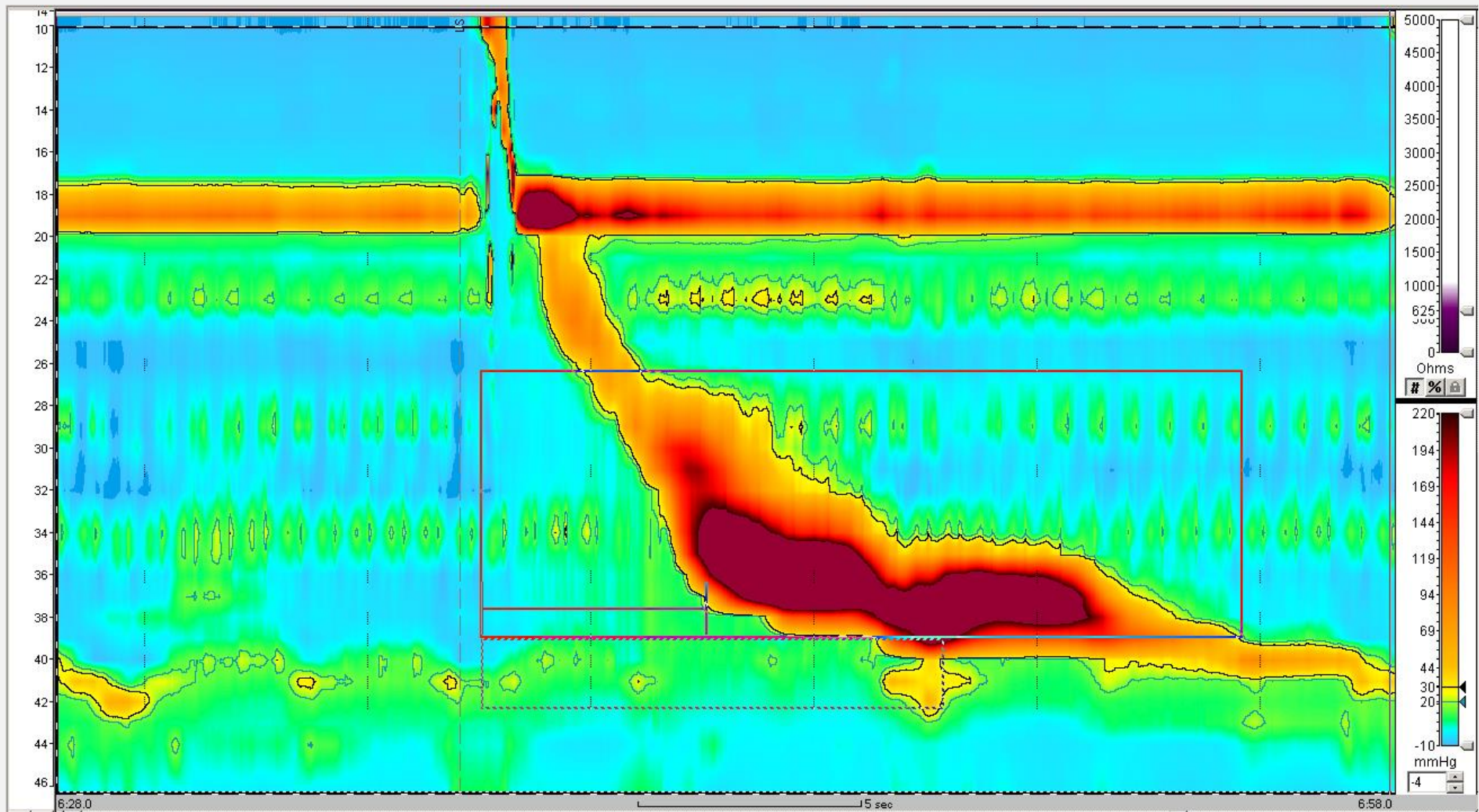
9

IRP	21.9 mmHg
DCI	698 mmHg.s.cm
DL	2.8 s
PB	--

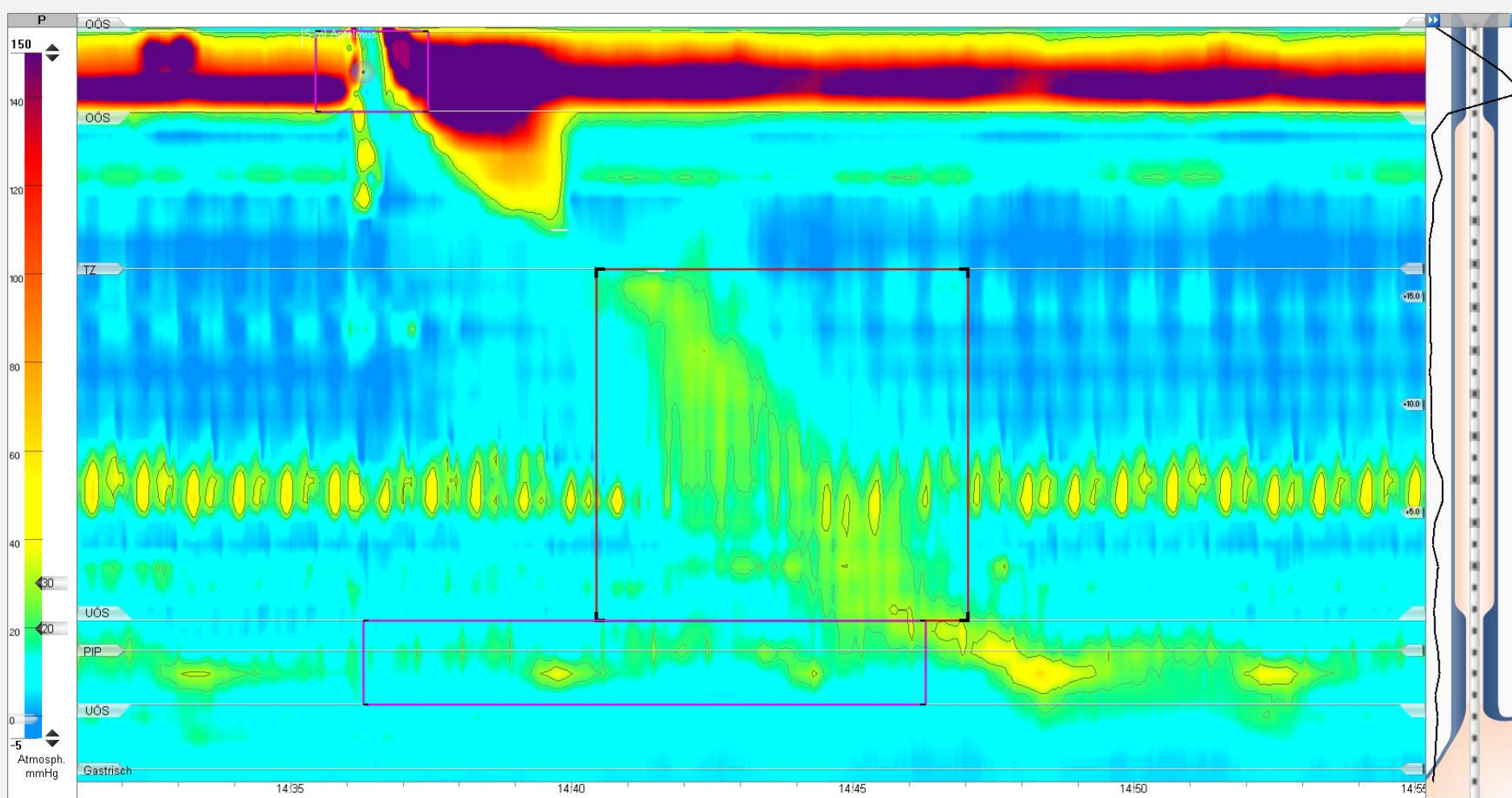


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IRP	10	mmHg
DCI	150	mmHg.s.cm
DL	6.7	s
PB	9.1	cm

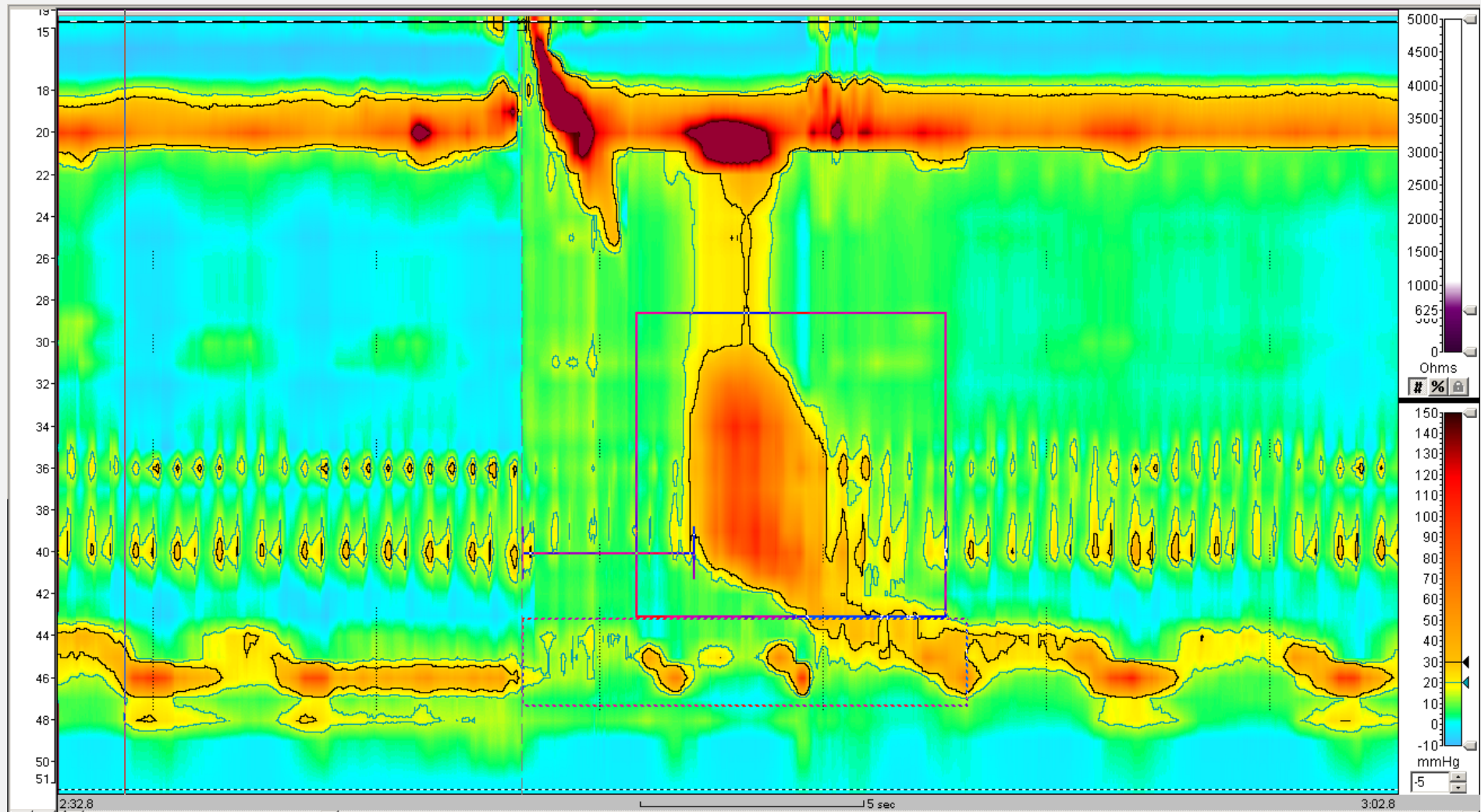


IRP 11 mmHg
 DCI 10429 mmHg.s.cm
 DL 5.1 s
 PB - -



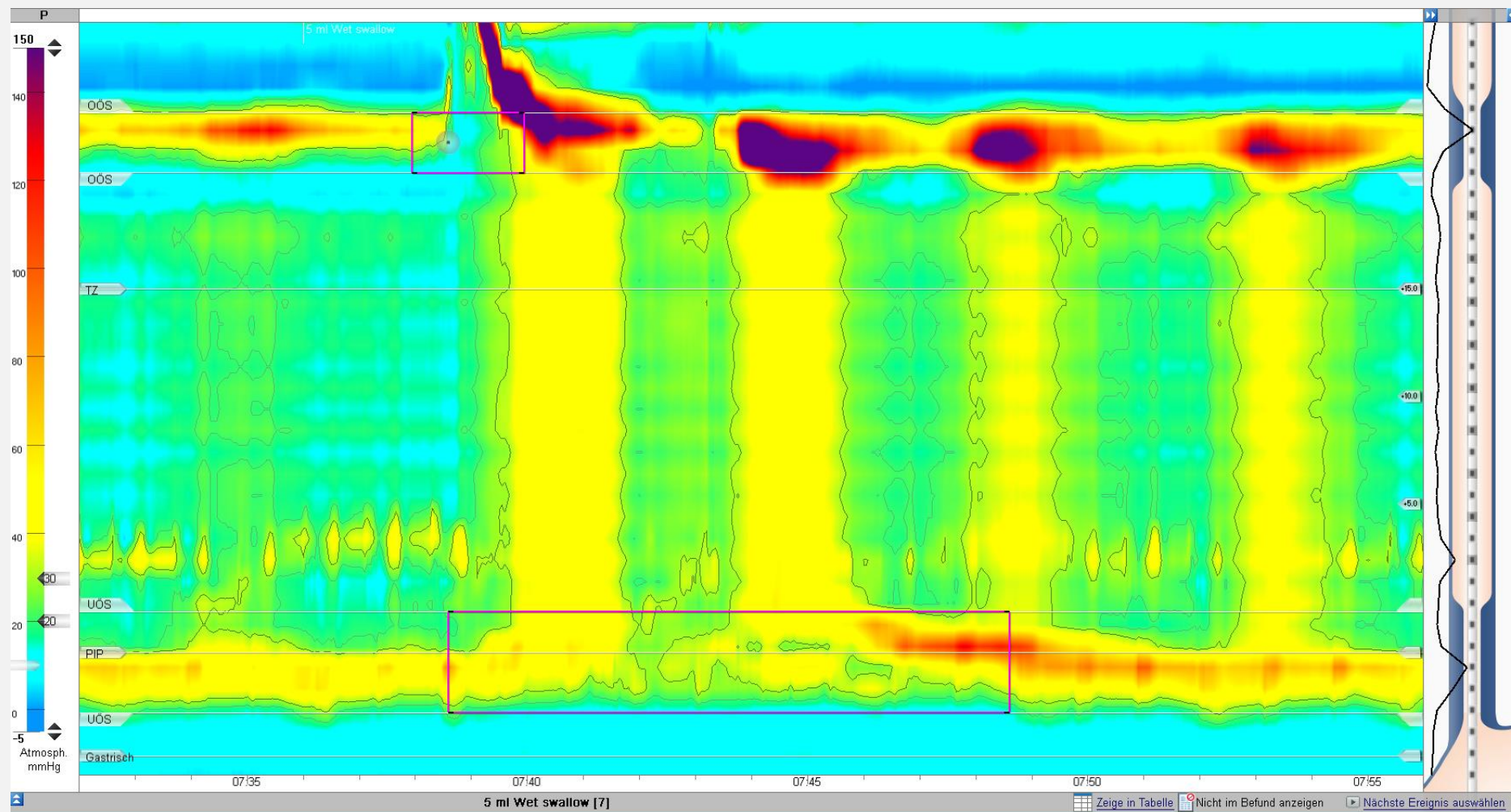
1
2

IRP	9	mmHg
DCI	134	mmHg.s.cm
DL	--	
PB	1.8	cm



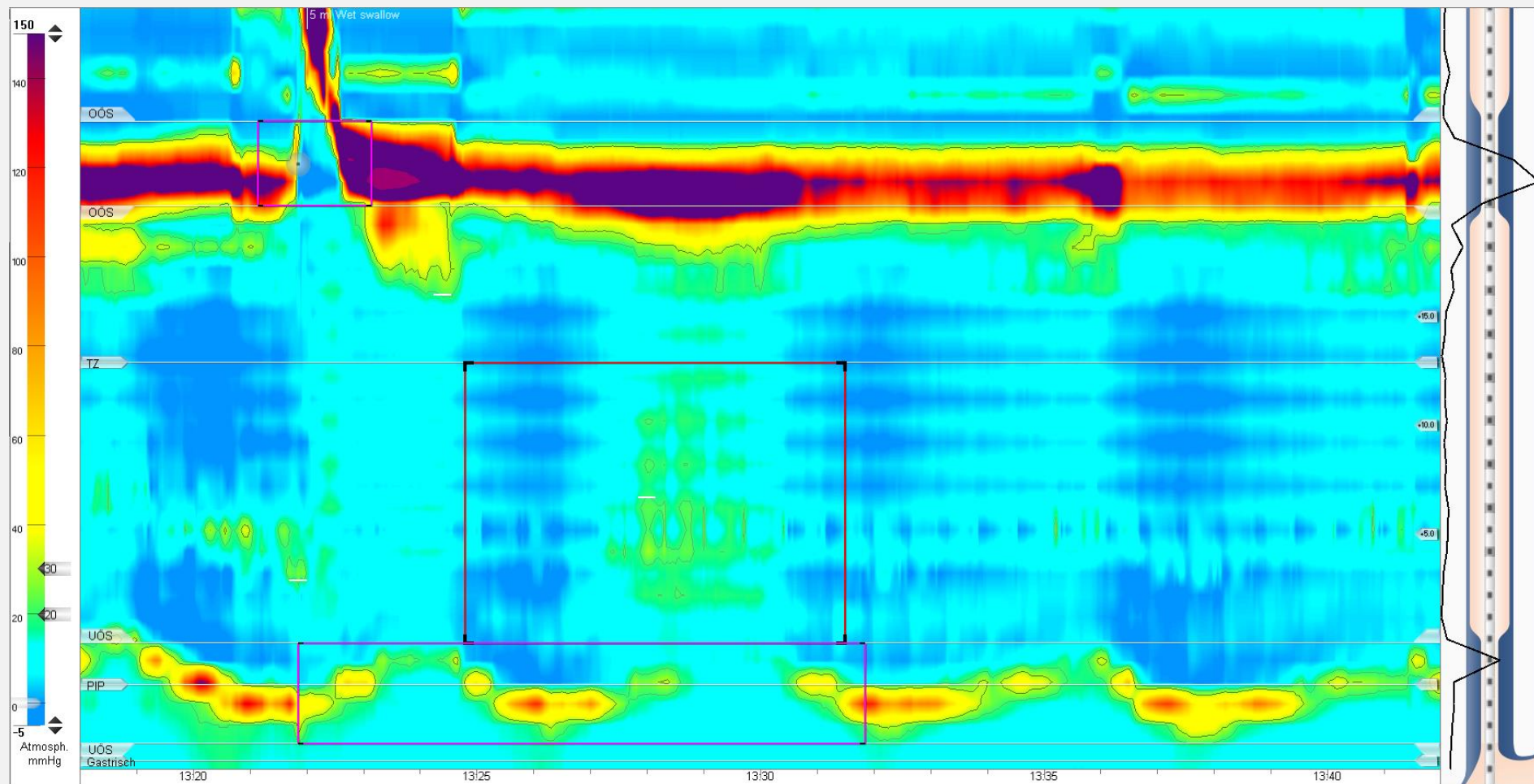
I
3

IRP 14 mmHg
 DCI 1464 mmHg.s.cm
 DL 3.1 s
 PB --

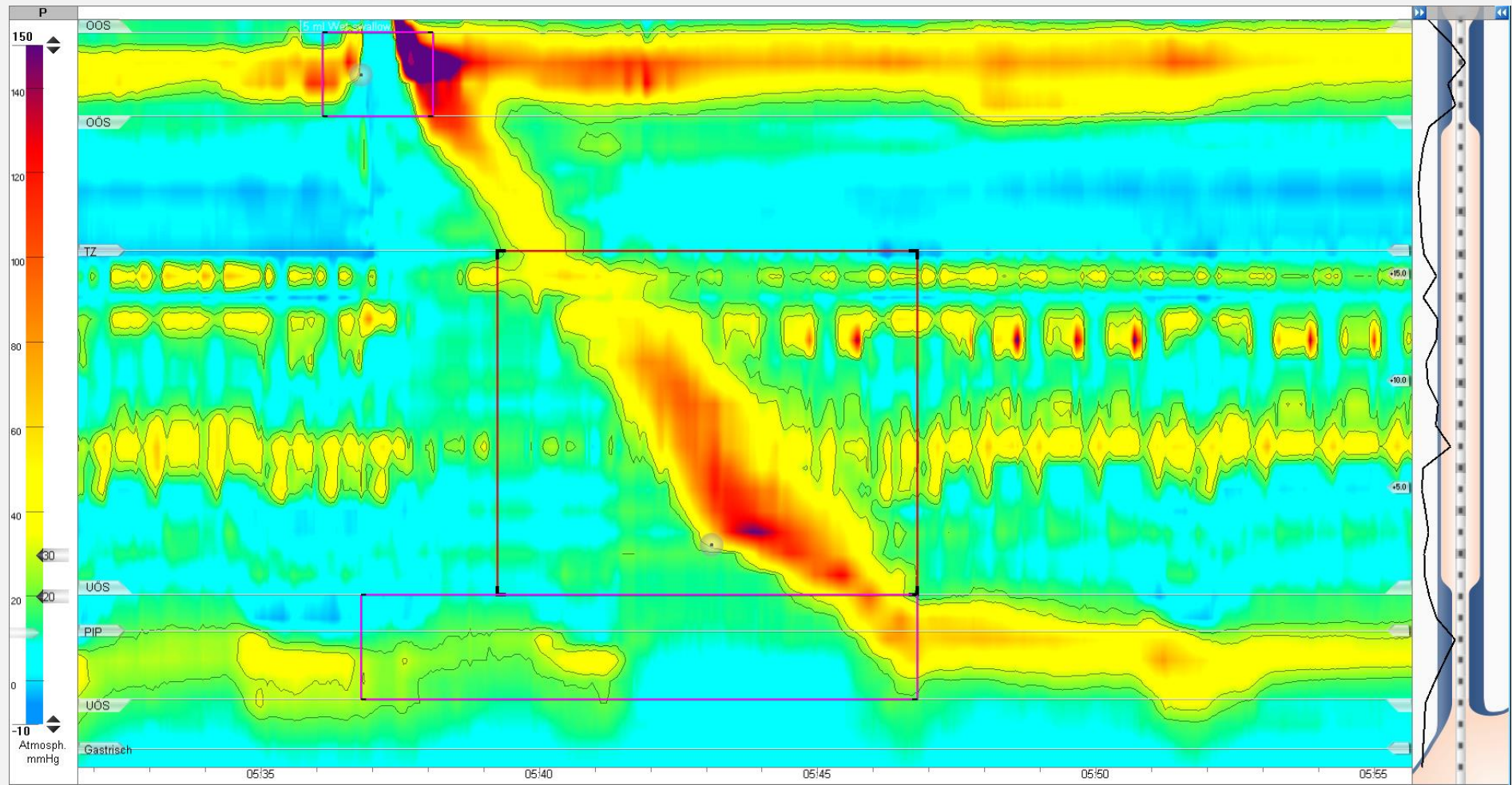


I
4

IRP	38 mmHg
DCI	--
DL	--
PB	--

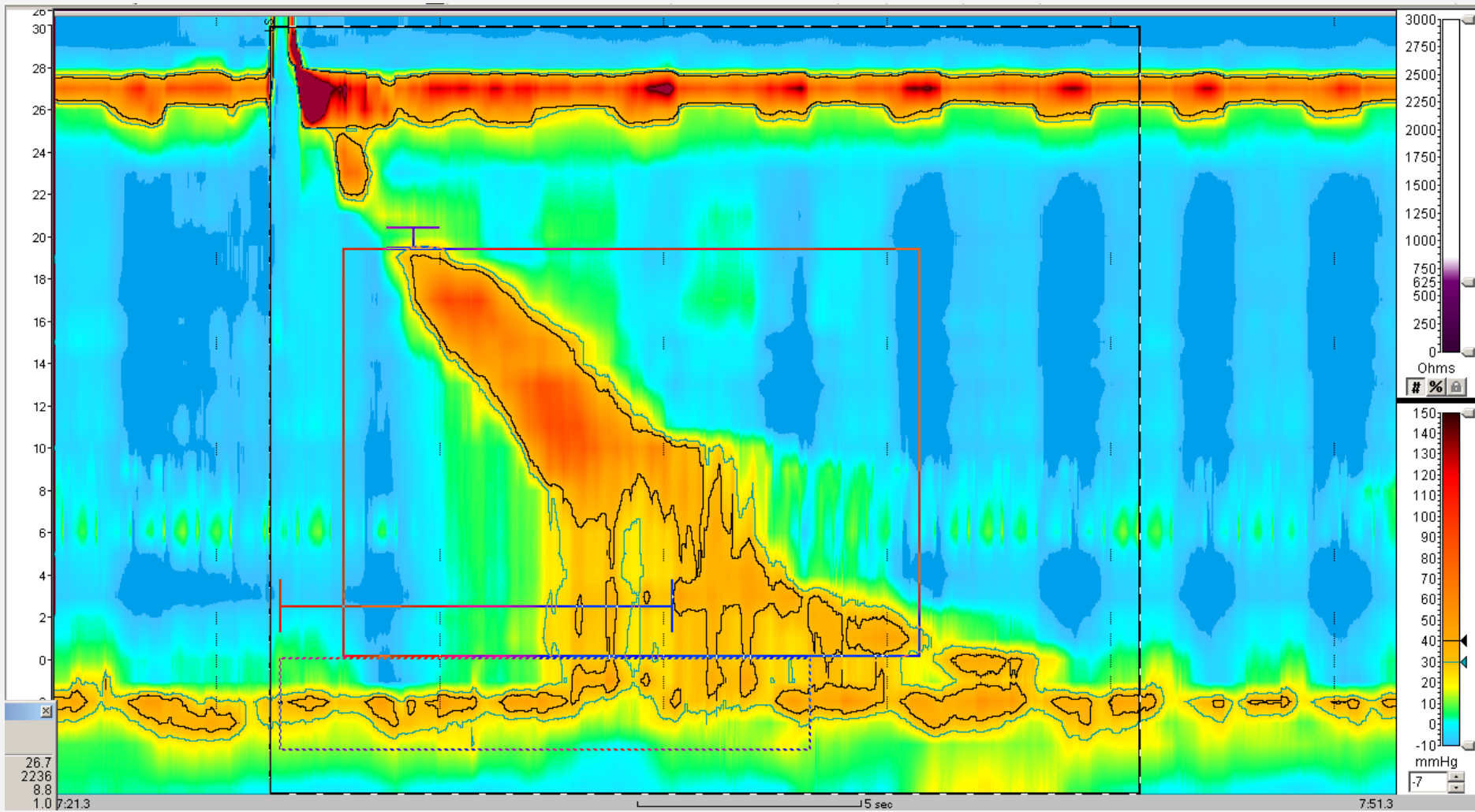


I IRP 10 mmHg
5 DCI 3 mmHg.s.cm
 DL --
 PB 12.1 cm



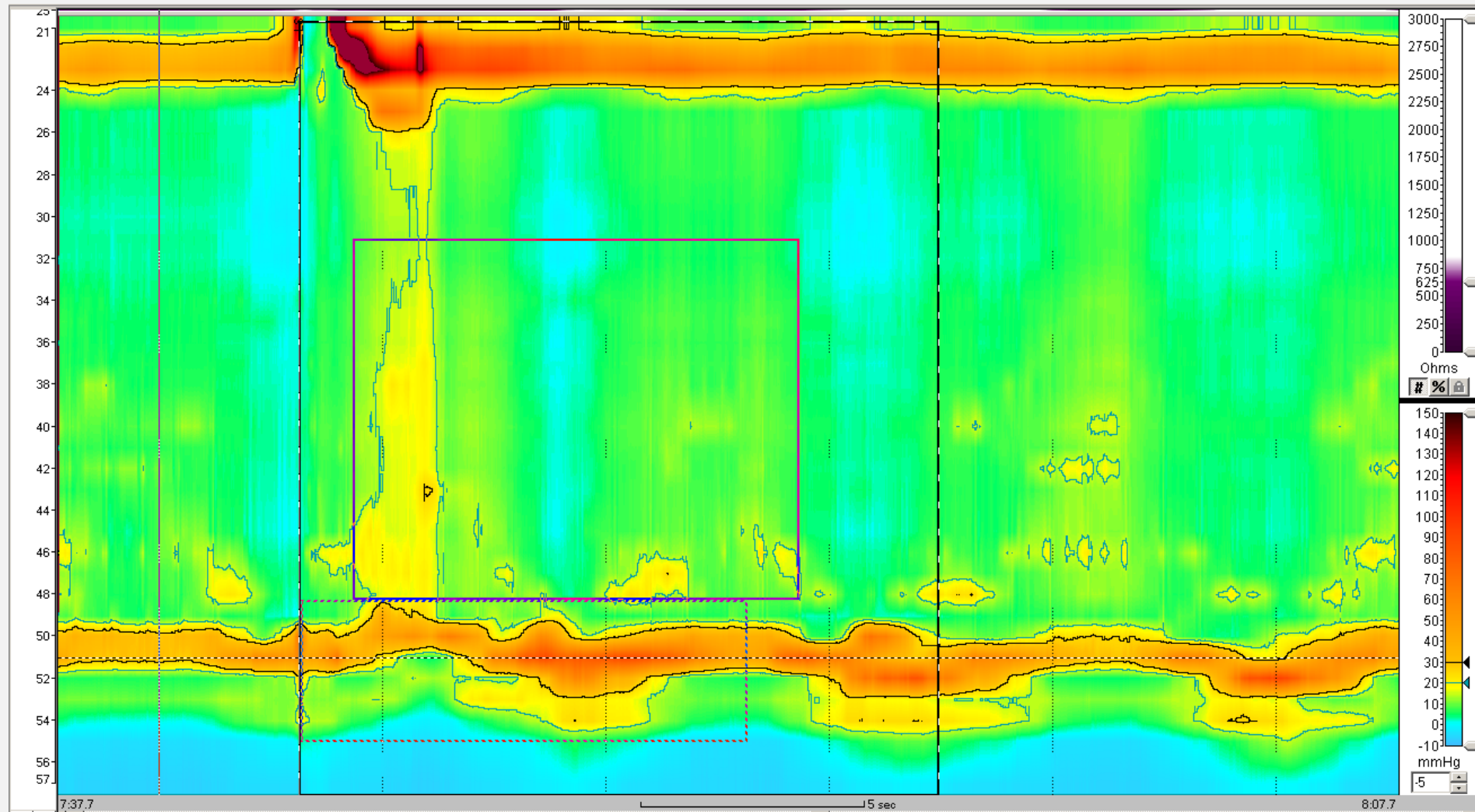
I
6

IRP 9 mmHg
DCI 1898 mmHg.s.cm
DL 6.3 s
PB --



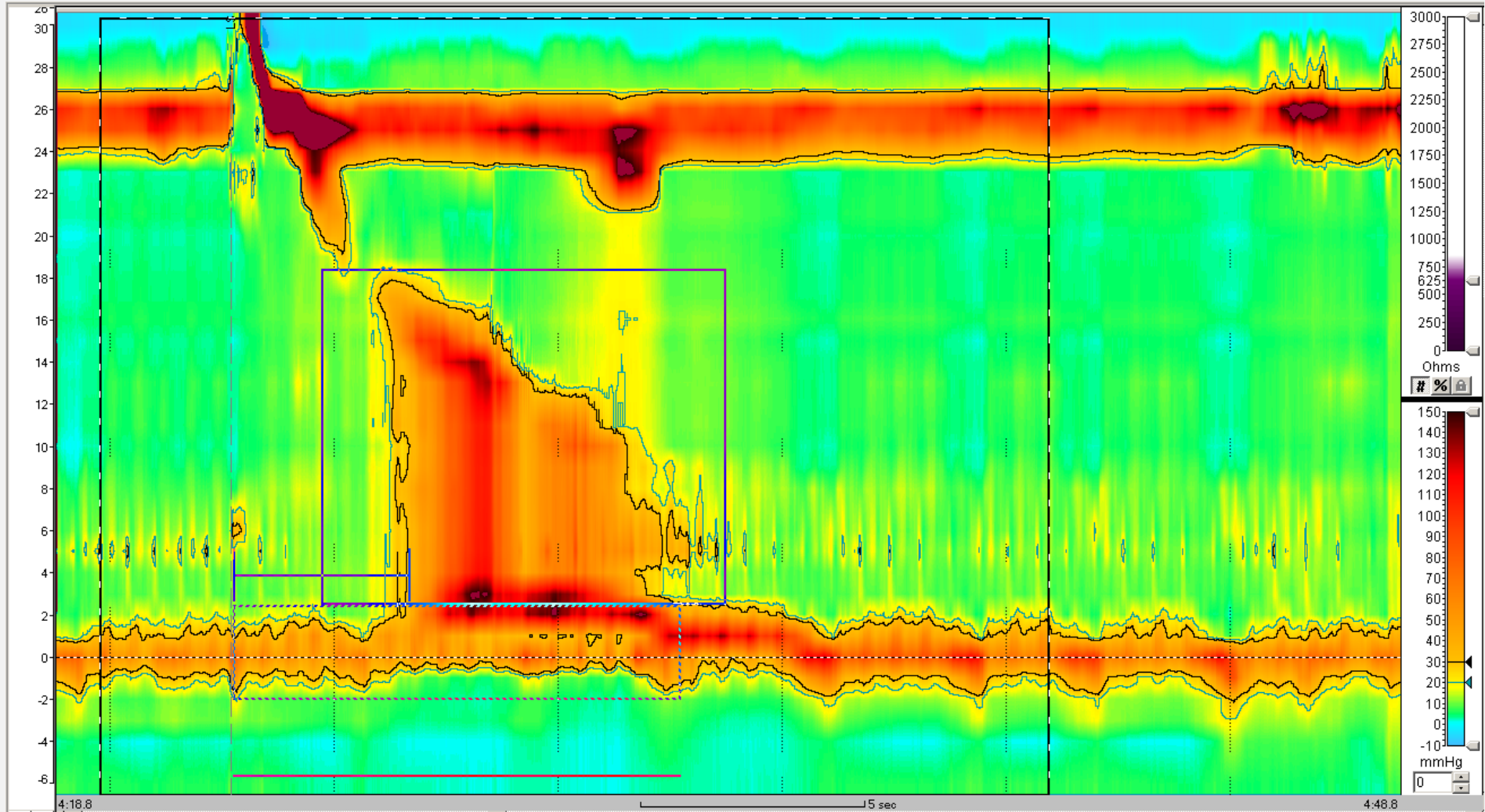
I
7

IRP 26.7 mmHg
 DCI 2236 mmHg.s.cm
 DL 6.0 s
 PB 1.9 cm



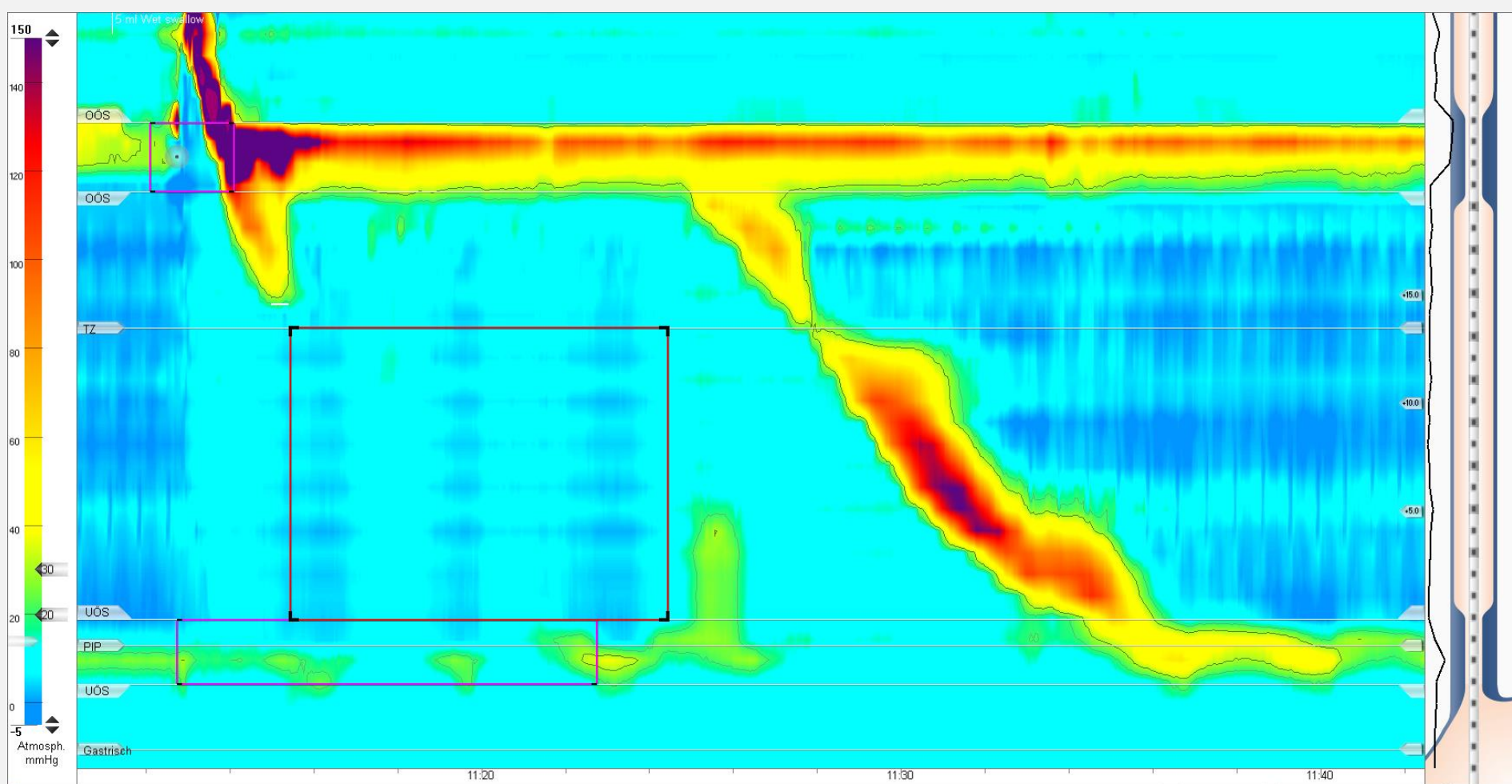
I
9

IRP 51 mmHg
 DCI 59 mmHg.s.cm
 DL --
 PB --



2
0

IRP 51 mmHg
 DCI 3075 mmHg.s.cm
 DL 3.6 s
 PB -- cm



2
1

IRP 5 mmHg
 DCI 0 mmHg.s.cm
 DL --
 PB 14.6 cm

SOLUTIONS

1. Weak contraction
2. Fragmented contraction
3. Outflow obstruction
4. Normal contraction
5. Hypercontractile + outflow obstruction
6. Weak contraction
7. Outflow obstruction, no peristalsis,
panesophageal pressurization
8. Failed contraction
9. Premature contraction (+ borderline
outflow obstruction at level of diaphragm)
10. Weak contraction
11. Hypercontractile swallow
12. Weak contraction
13. Premature contraction
14. Outflow obstruction, no peristalsis,
panesophageal pressurization
15. Failed contraction
16. Normal contraction
17. Outflow obstruction,
compartmentalized pressurization
18. Normal contraction
19. Outflow obstruction, no peristalsis
20. Outflow obstruction, premature
contraction
21. (for the experts) Failed contraction,
followed by secondary peristalsis
(no pharyngeal contraction, no upper
esophageal sphincter relaxation)