

Measuring abdominal compliance for laparoscopic procedures

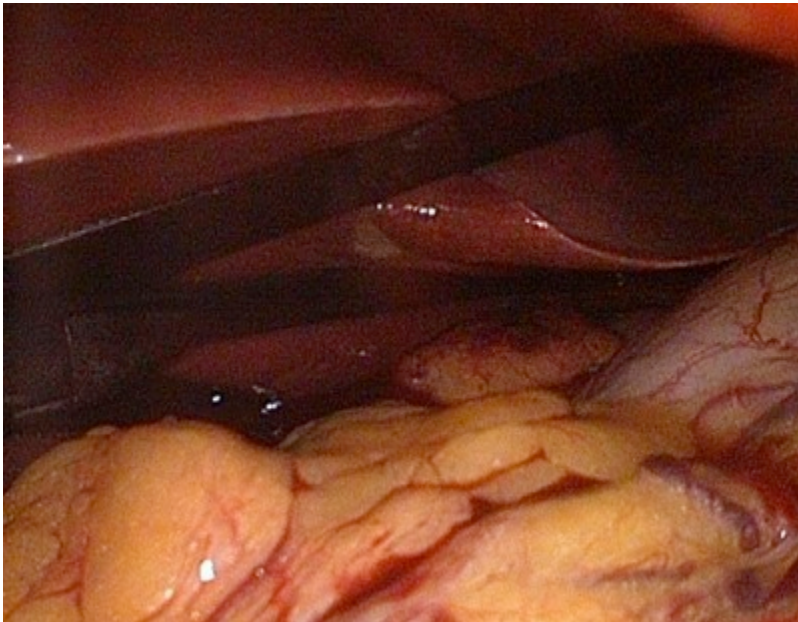
Jan Mulier
Jose Lara Tamayo

9:15 – 10:15
10:30 – 11:30

Friday 17 feb 2012

Workshop session IBIZA

Can we do something to improve the situation?



Intraabdominal pressure ?
Intraabdominal volume?
Workspace?

Surgeon: I haven't enough workspace

Anesthesiologist: I am OK

Surgeon: Look at the video screen. I can't work

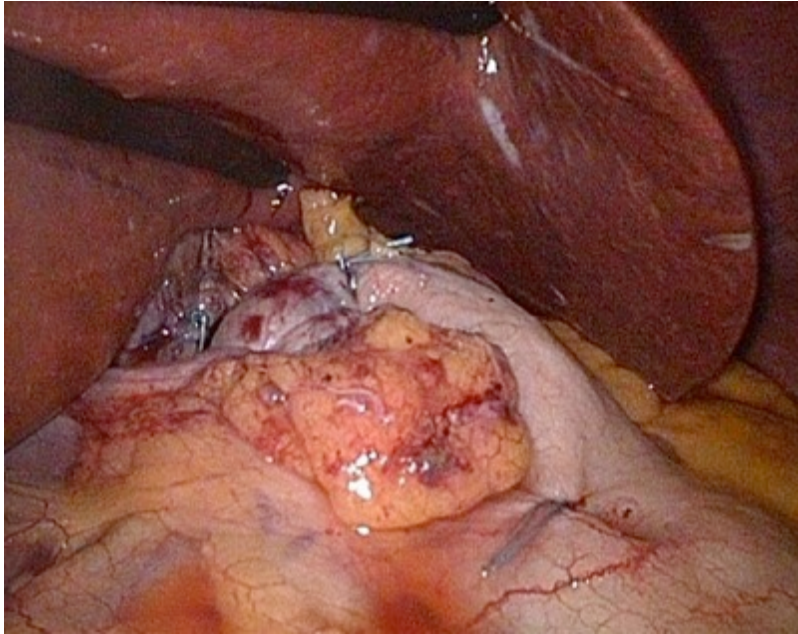
Anesthesiologist: If you want more volume, you should increase the pressure

Surgeon: !!!But it is over 18 mmHg!!!

Anesthesiologist: The patient has only one TOF response in the AP. Last time this was enough. Why not today?

Surgeon: I don't know what "one TOF response" means. What I said is I can't work

iiii YES WE CAN !!!!!



Surgeon: Now I have very good surgical conditions

Anesthesiologist: The patient is OK

Surgeon: Look at the screen. I have enough workspace and the IAP is low

Anesthesiologist: The patient is now on a deep neuromuscular block

Surgeon: How many PTCs has the patient in the adductor pollicis?

Anesthesiologist: only 3 PTCs. I will keep him on a deep NMB until the end

Surgeon: Thanks. Then we will end in time and can have drink afterwards.

Question

- Did you experience an unhappy surgeon telling you he has no workspace?
- Did you use NMB? Did you use NM monitoring?
 - was NMB moderate or deep?
- Can you remember some patient data?
 - Morbid obese?
 - Man versus woman?
 - First laparoscopy?
 - Previous surgery?
- What did you/surgeon do and was the surgeon pleased?

Let us measure the abdominal compliance and understand what happens

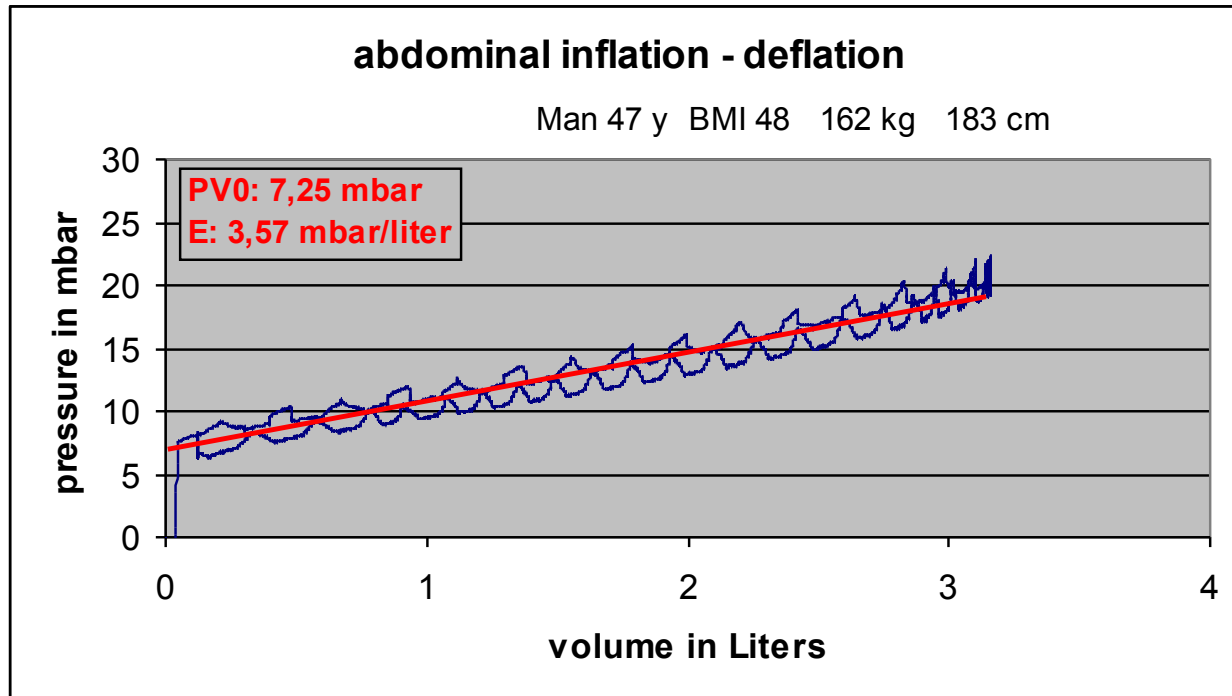
1. Laboratory set up to measure of abdominal compliance.
2. Clinical measurement at the start of laparoscopy
3. Fast clinical guess at first insufflation

1. Laboratory measurement

- First inflate abdomen and place large trocar
 - Verify position of trocar
 - Stomach and bladder empty?
- Deflate abdomen while palpating abdomen
 - Making repetitive measurements possible in the same condition.
- Slow inflation/deflation of pneumoperitoneum
 - Measure flow and pressure (P) continuous
 - Calculate inflated volume: V
 - Set out in P/V loop
 - Linear fit of curve: calculate $P = E \cdot V + PV_0$

1. Laboratory set up

- Flow and pressure monitor between insufflator and abdomen
- Slowly inflate and deflate the abdomen while measuring pressure and integrating flow to volume

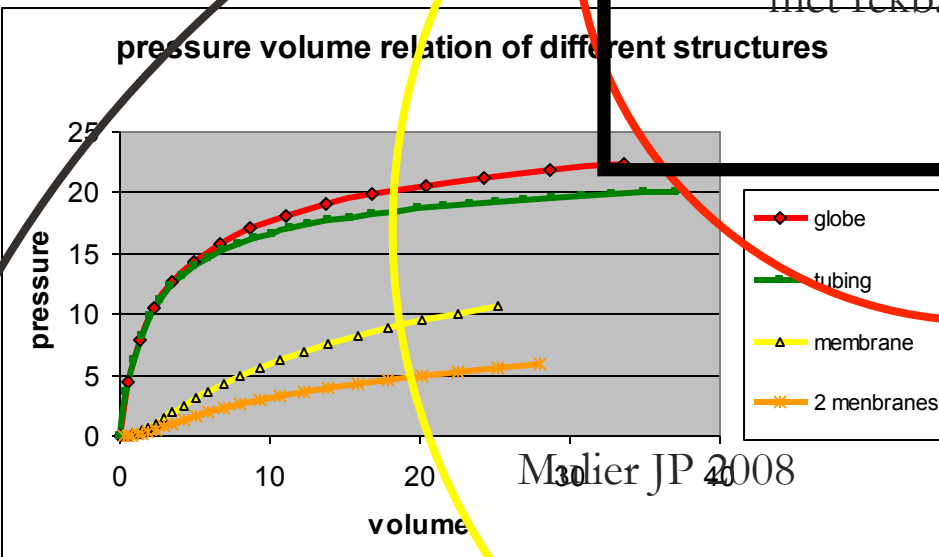


What is abdominal compliance in man?

- The Abdominal pressure volume relation (APVR)
 - Compliance C:
 - change in volume/change in pressure
 - Elastance E: $E=1/C$
 - Change in pressure/change in volume
 - PV0: Crossing of Y axis
 - Pressure at zero volume
- APVR is linear in humans
 - To a value of 20 mmHg
 - Except if abdomen has an apple shape.
 - central obesity with intra abdominal fat

Diameter cirkel daalt bij opblazen buik

Abdomen als vast onderstel
met rekbaar vlies bedekt



Anesthesie voor
che heek

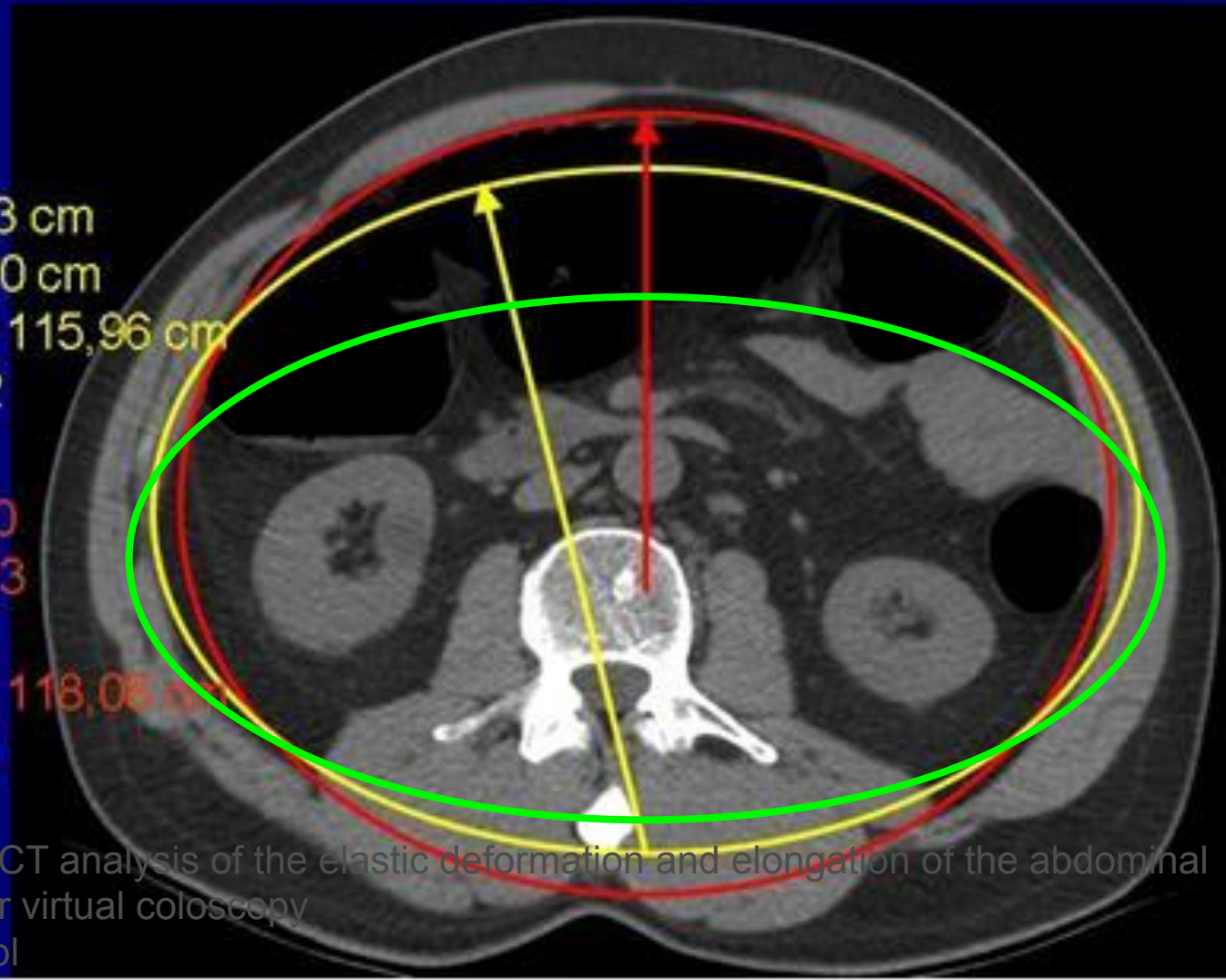
Fitting of cross section abdomen when inflated at 15 (yellow) versus 25 (red) mmHg

- **Yellow:**

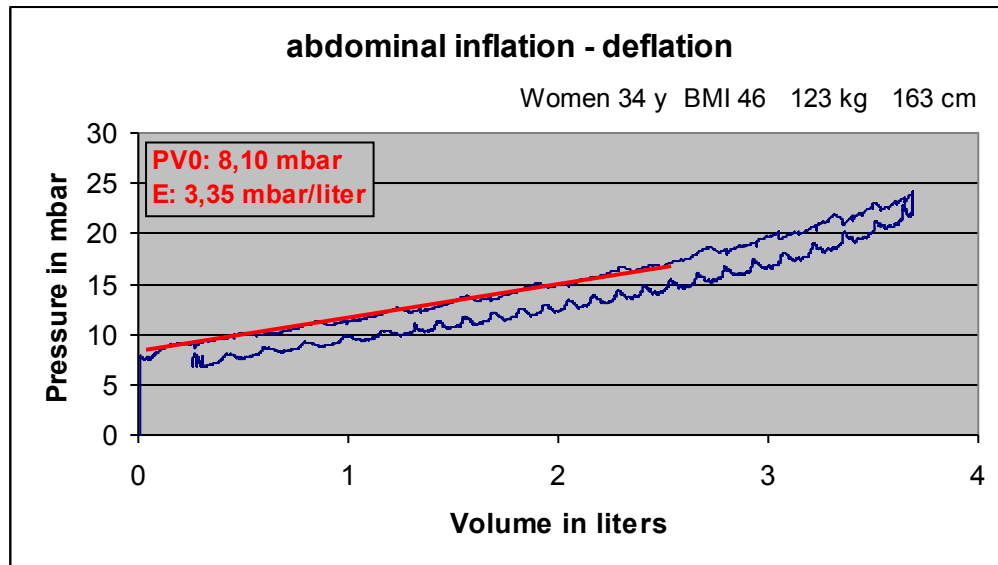
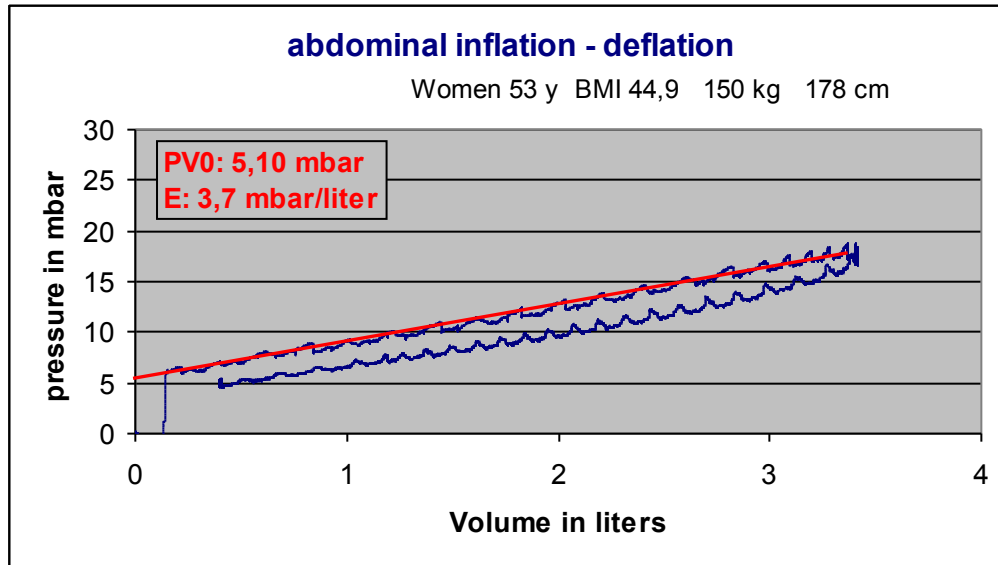
- Long axis: 43,23 cm
- Short axis: 30,00 cm
- Circumference: 115,96 cm
- Area: 1018 cm²

- **Red:**

- Long axis: 40,80 cm
- Short axis: 34,23 cm
- Circumference: 118,05 cm
- Area: 1097 cm²



Examples of P V loops in the abdomen



2. Clinical calculation at start of pneumoperitoneum

- PV0 and the C can be easily calculated at the start of pneumoperitoneum.
 - During procedure: deflation and reinflation while no leak.
- Inflate to 0,5 L; 1 L; 1,5 L or 1L; 2L; 3 L
 - Stop insufflator and measure lowest value (end expiration)
- Set out in PV diagram and fit linear line
 - PV0: Crosses with Y axis
 - $E = 1/C$: Angle of line

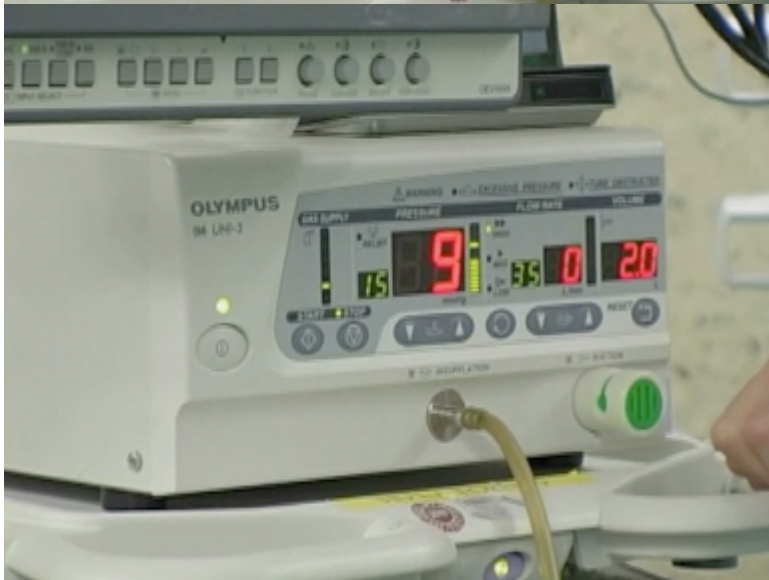
2. Simplified three points measurement of abd C



Volume 1 L	Pressure 8
Volume 2 L	Pressure 9
Volume 3 L	Pressure 10

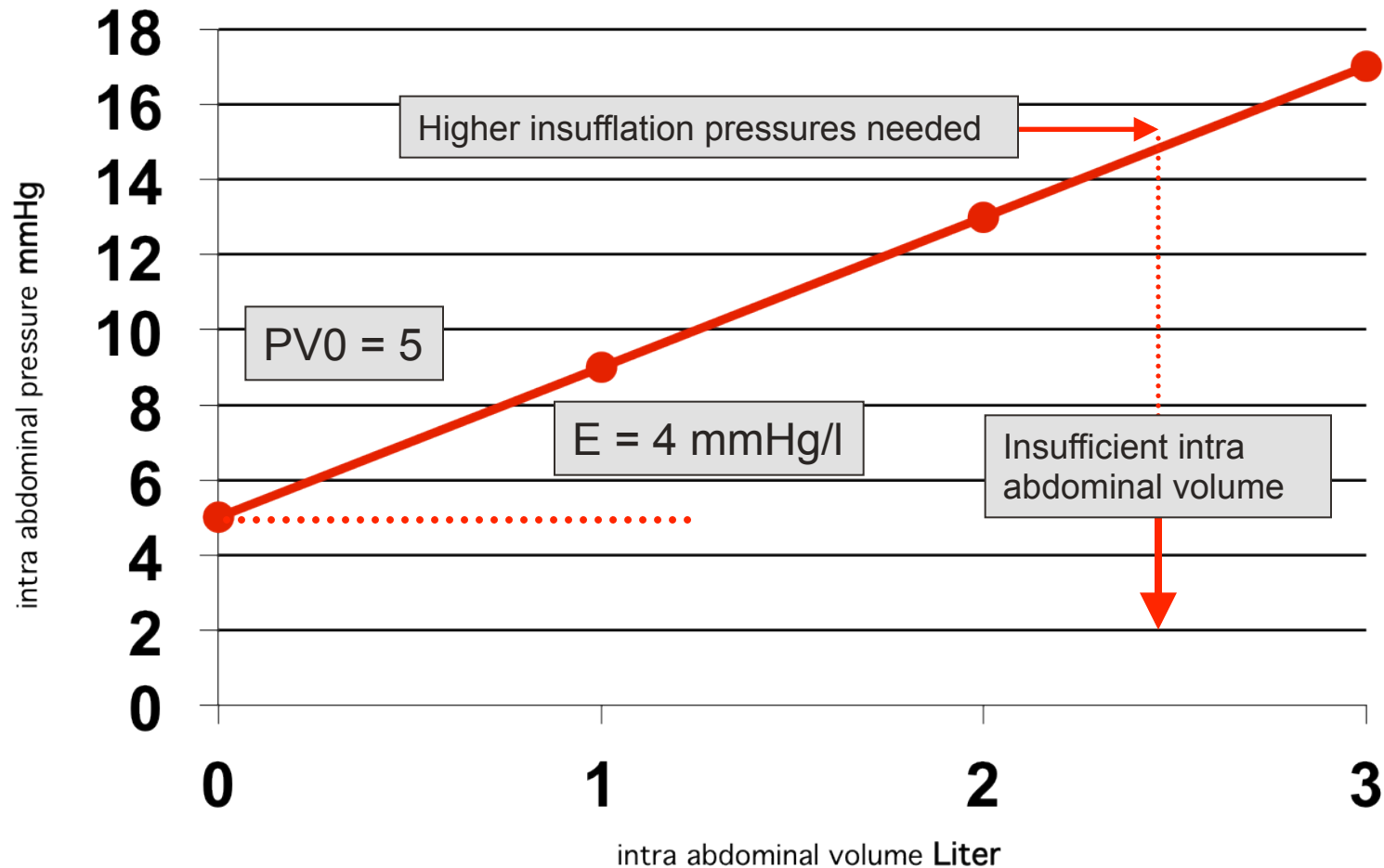
PV0 : 7 mmHg

E: 1 mmHg/L
C: 1 L/mmHg



Compliance (C) and Elastance (E)

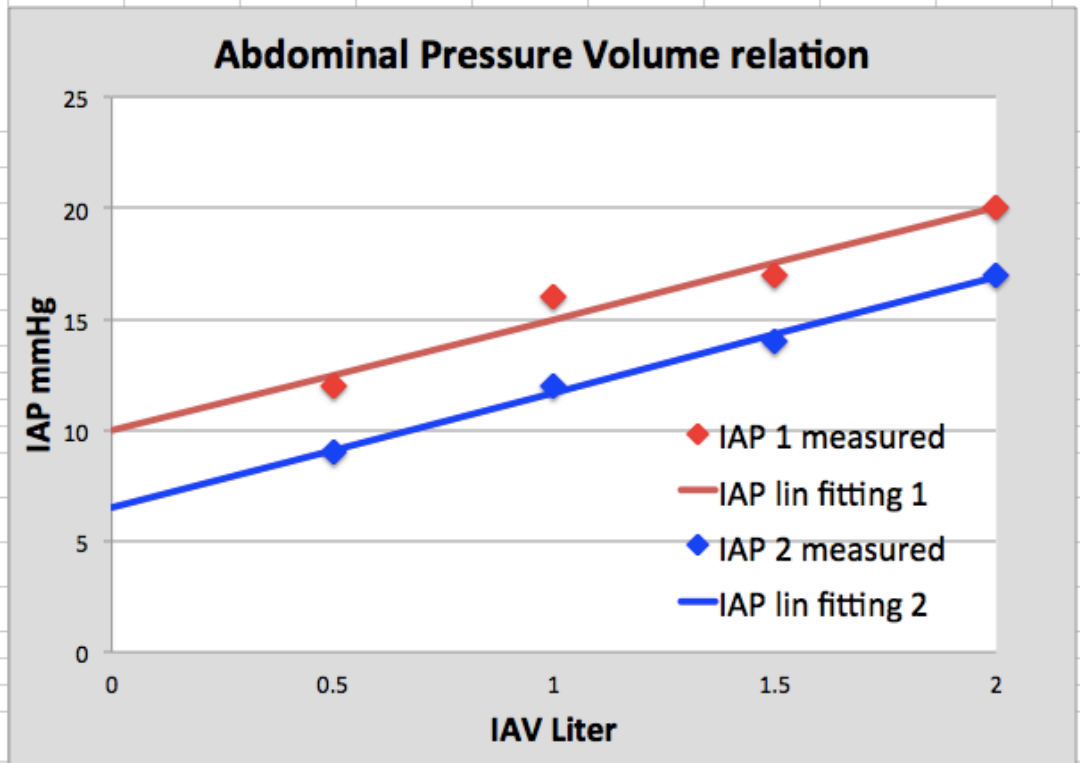
$C = \text{change in } V / \text{change in } P$ ($C = 1/E$)



J Mulier, B Dillemans, M Crombach, C Missant, A Sels
On the abdominal pressure volume relationship.
The Internet Journal of Anesthesiology. 2009; 21: 1.

Per operative measurements at first inflation

IAV	IAP 1 measured	IAP lin fitting 1	IAV	IAP 2 measured	IAP lin fitting 2
0		10	0		6,5
0,5	12	12,5	0,5	9	9,1
1	16	15	1	12	11,7
1,5	17	17,5	1,5	14	14,3
2	20	20	2	17	16,9
5	10		5,2	6,5	
PVO	10 mmHG		PVO	6,5 mmHG	
E	5 mmMHg/L		E	5,2 mmMHg/L	
25 mmHg: pressure to reach 3 liter					



3. Fast clinical guess at first insufflation

- Set insufflator at fixed pressure: ex 15 mmHg
- Measure inflated volume: X liter
- If < 2 liter: problem difficult to solve
 - Deep NMB, higher IAP, laparotomy,...
- If < 4 liter: maximal therapy helps
 - Deep NMB, keep IAP
- If > 4 liter: choice:
 - Reduce IAP and keep deep NMB
 - Keep IAP 15 and reduce NMB

3. Example: 1,2 L versus 7,2 L



Deep NMB do not help sufficient



NMB needed?
Yes and drop the IAP

Practical Team Work

Can we predict difficulty?

Determinants of E and PV0

	PV0	P _{VO} sig	E	E sig
Age	Neg	0.828	Pos	0.003*
Length	Neg	0.356	Neg	0.245
Body weigth	Pos	0.012*	Pos	0.294
Bmi	neg	0.054	Neg	0.272
Sex	Neg	0.596	Neg	0.536
Gravidity	Neg	0.305	Neg	0.049*
Prev abd operation	Neg	0.191	Neg	0.009*
Muscle relaxation	Neg	0.001*	Neg	0.376

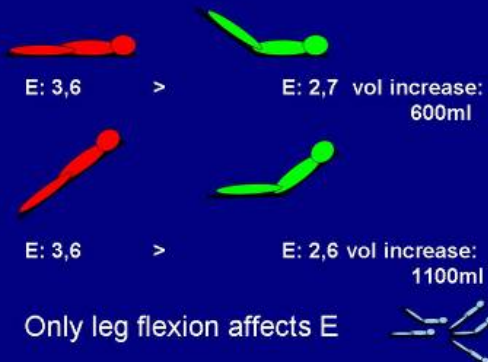
* Sig p<0.05 Mulier JP 2007

Can we do something?

How to change C : hip flexion

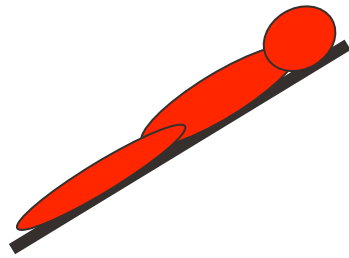
•• Mulier JP, Dillemans B Obes Surg 2010

Effect of position on E in mmHg/L

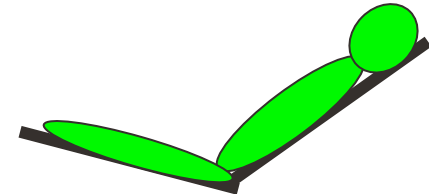


Impact of patient's body position on the laparoscopic workspace

Reverse trendelenburg chair



Beach



E (mmHg/L)

3,6

2,6

PV0 (mmHg)

4,8

4,8

IAV (L)

2,99

3,76

Impact of the patient's body position on the intraabdominal workspace during laparoscopic surgery.
Mulier JP, Dillemans B, Van Cauwenberge S.
Surg Endosc. 2010.

Surgical workspace effect of NMB in an obese patient BMI 46:

Volume	IAP no NMB	IAP deep NMB
1 Liter	11 mmHg	8 mmHg
2 Liter	13 mmHg	10 mmHg
3 liter	15 mmHg	12 mmHg
4 Liter	-	14 mmHg

Patient got inhalation of Desflurane at 1 Mac
Remifentanyl infusion with no effect on relaxation
Ventilation 600 ml 12 x with 7 cm H2O peep

Rocuronium bolus of 1,2 mg/kg IBW with continuous infusion of 50 mg/hour was given after first measurements

Second measurements when PTC < 3 at the thumb



Pressure 15 gives volume of 3 liter
Workspace.

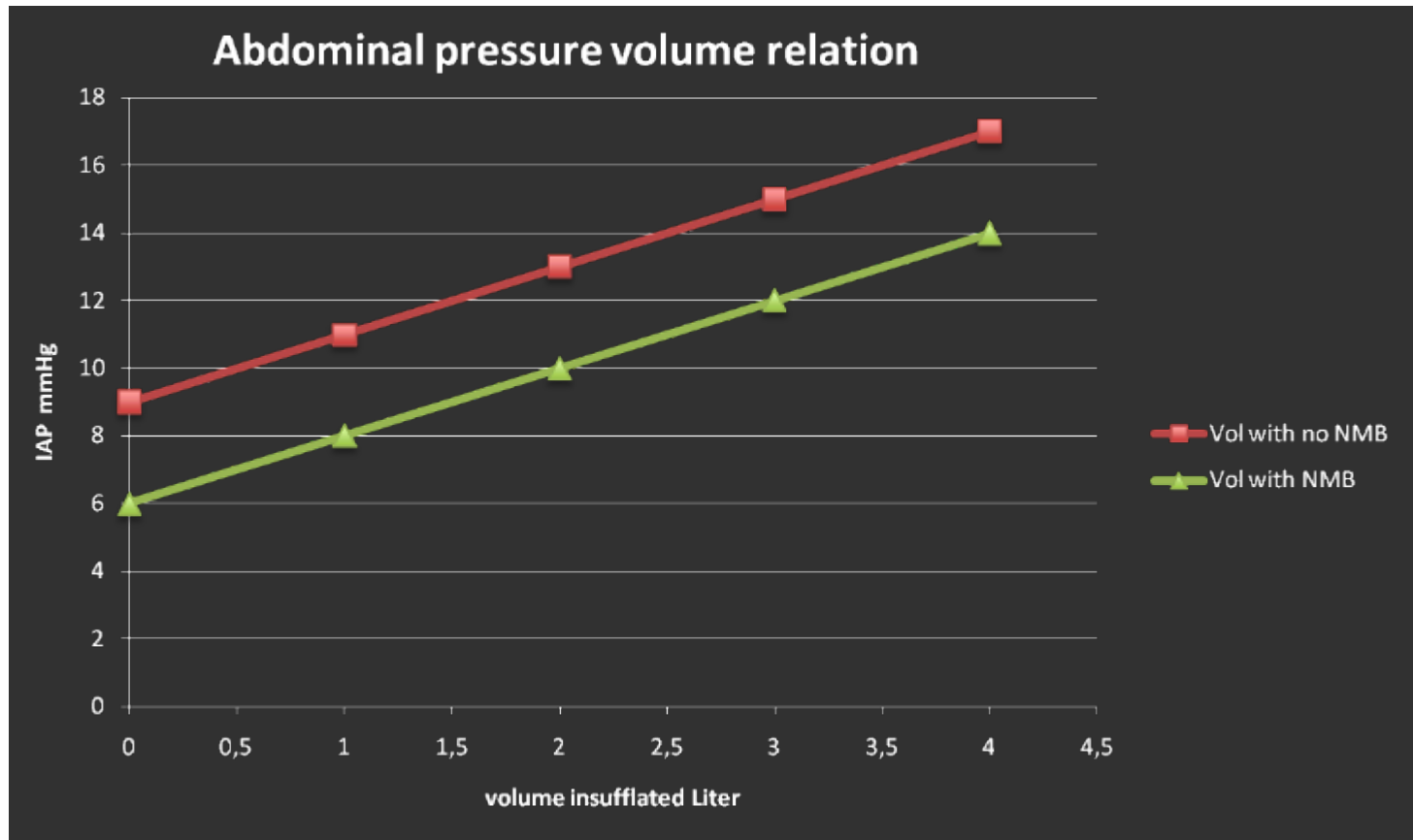


Pressure 14 gives volume of 4 liter
Workspace. View is more from above
More space and better access

Abdominal Pressure Volume Relation

obese patient BMI 46:

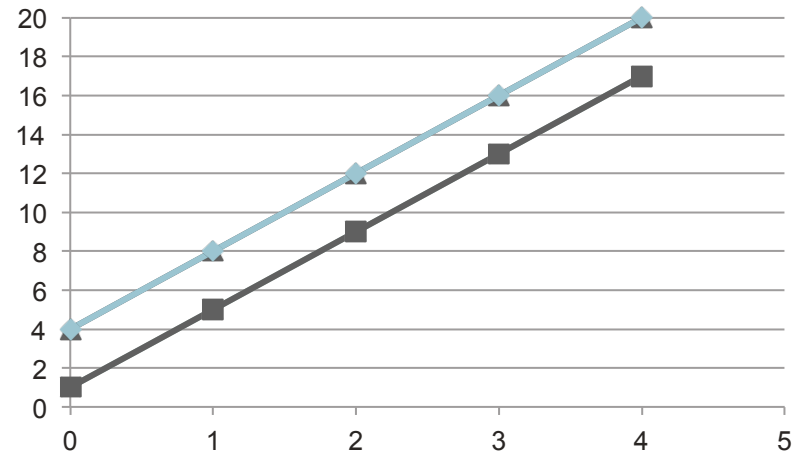
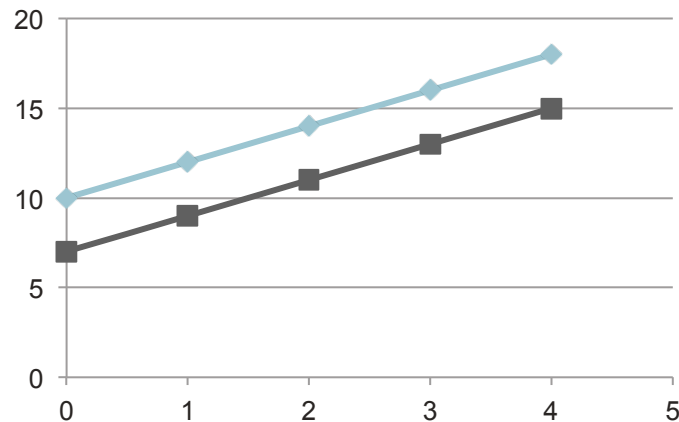
PV0 = 9 mmHg drops to 6 mmHg. E remains constant at 2 mmHg/liter



How improving workspace?

- If high PV0 easy to improve
 - NMB most effective, trendelenburg, IAP increase
- If low C difficult to improve
 - Flexing legs, higher IAP and NMB are less effective

NMB helps in both situations!



Case study

- **Woman; 26 years old;**
- **She has never been pregnant**
- **She had no comorbidities**
- **She has had a weight loss of 16 kg**
 - Her height was 172 cm
 - Last Christmas her weight was 132 kg
 - On the day of surgery she weighed 116 kg
 - Her BMI had dropped from 44.74 to 39.32
- **She had a cystic teratoma of the ovary**
- **She was scheduled for Lap gastric by-pass and adnexectomy**





GASTRIC BY-PASS AND ADNEXECTOMY

Alergias a medicación: No alergias conocidas
 Otras alergias:
 Precauciones: H.HIATO; Reversión BNM SUGAMMADEX



Resolución:
 30 minutos

Mostrar sólo filas con datos
 Mostrar subencabezados

General invasiva

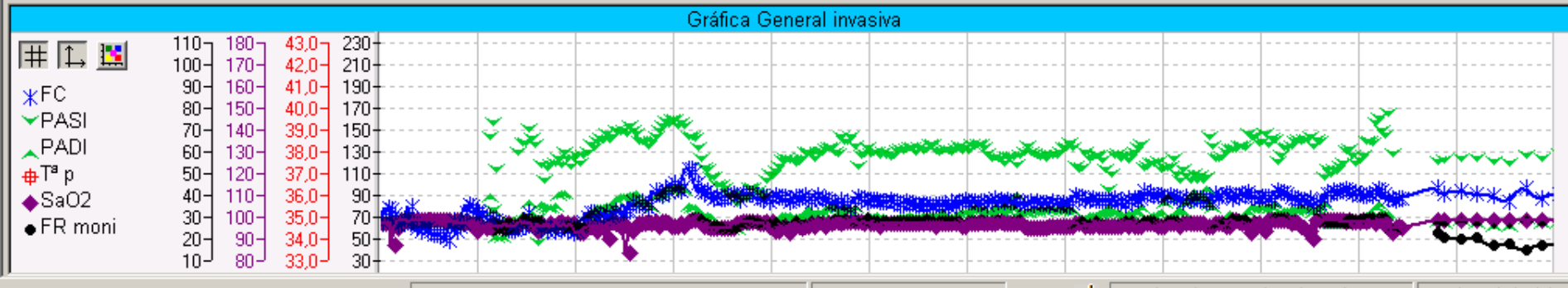
Anes (Anestesia)											An/Anes (Recuper..)	
13/02/2012												
09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	

Monitorización general invasiva

Variables en tiempo real	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30
FC	77	60	103	90	88	86	84	91	91	93	93	90
Ritmo ECG												
PASI		127	160	108	128	131	134	115	140	122	122	123
PADI		68	102	70	75	80	81	88	84	75	70	70
PAM cal		88	122	82	93	97	99	97	102	91	87	88

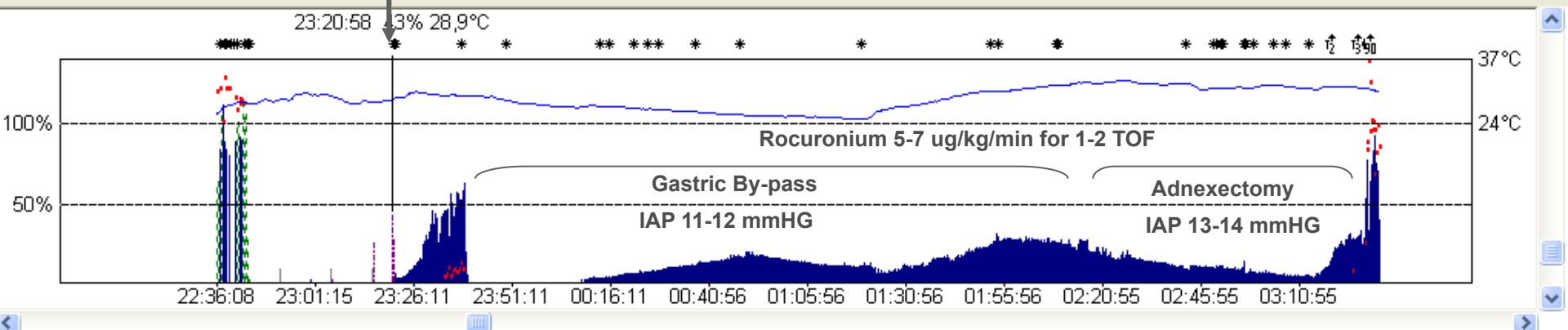
Fluidos E/S

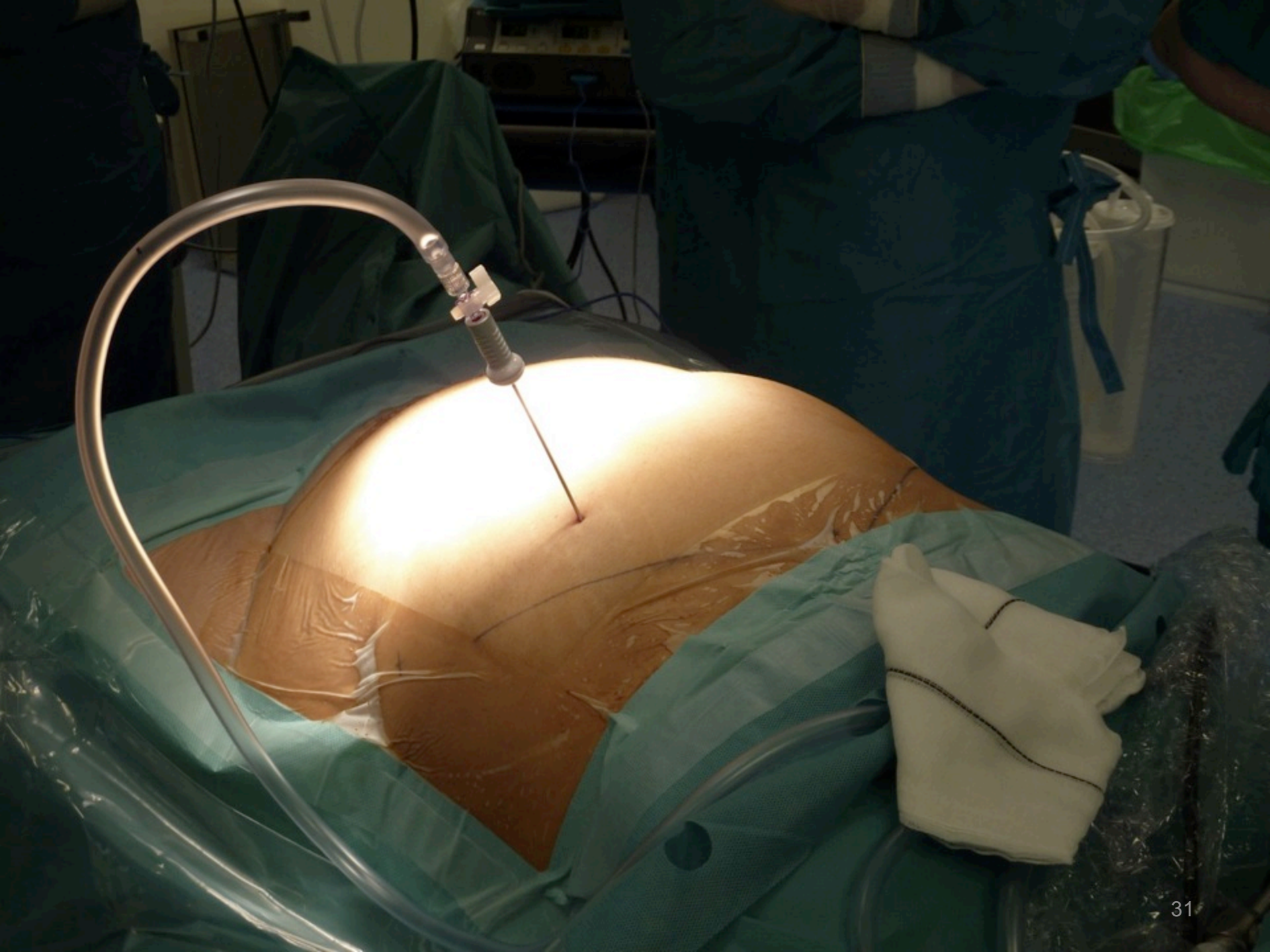
FLUIDOS +	09:00	09:30	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30
Dexketoprofeno 50 mg / Salino 0,9..									50			
Glucosalino 1/3 B05BB 500 mL a lo..												100
Ondansetron A04AA 4 mg / Salino 0,..									50			
Paracetamol N02BE 1 g / Solución p..									100			
Propofol 1% N01AX 0,5-5 mg/kg/h	7	7	6	6	6	6	6	6	6	6	6	X
Remifentanilo N01AH 0,01-1 mcg/k..	0,1	0,13	0,1	0,1	0,08	0,08	0,08	0,08	0,08	0,08	0,08	X
Remifentanilo N01AH 0,01-1 mcg/k..	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,026	0,035
Ringer Lactato B05BB 500 mL				500								X
Rocuronio M03AC 0-10 mcg/kg/min				3,6	5	5	5	6	6	6	X	



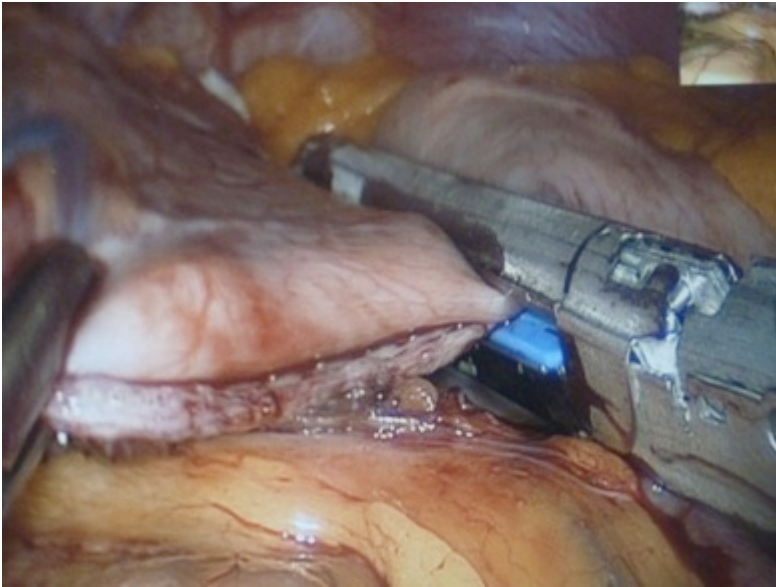
Time	?!* Mode	Tw1	Tw2	Tw3	Tw4	TOF	CNT	Temp	Stim	T	Sens.	CAL [Curr.]	TOF alarm	Comments
04/02/2005		%	%	%	%	%		°C	mA	µs		- [mA]		
23:20:45	PTC pre pulse 10	0						28,7	60,00	200	151	2 [<20]		
23:20:46	PTC pre pulse 11	0						28,7	60,00	200	151	2 [<20]		
23:20:47	PTC pre pulse 12	0						28,7	60,00	200	151	2 [<20]		
23:20:48	PTC pre pulse 13	0						28,8	60,00	200	151	2 [<20]		
23:20:48	PTC pre pulse 14	0						28,8	60,00	200	151	2 [<20]		
23:20:49	PTC pre pulse 15	0						28,8	60,00	200	151	2 [<20]		
23:20:50	PTC 5 sec. Tetanic							28,8	60,00	200	151	2 [<20]		
23:20:58	PTC 1	43					1	28,9	60,00	200	151	2 [<20]		
23:21:00	PTC 2	28					2	28,9	60,00	200	151	2 [<20]		

Volume **Pressure**
 0.5 L 7 mmHg
 1.5 L 10 mmHg
 2.5 L 12 mmHg
 3.5 L 15 mmHg
 PV0 5-6 mmHg
 E 2-3 mmHg/L





Gastric by-pass



Adnexectomy



Sugammadex and Rocuronium Bromide Indications and Safety Information

Therapeutic Indications for BRIDION® (sugammadex)¹

Indications

BRIDION is indicated for the reversal of neuromuscular blockade induced by rocuronium or vecuronium.

In children and adolescents (aged 2-17 years), BRIDION is recommended only for routine reversal of moderate rocuronium-induced neuromuscular blockade.

There are no data to recommend BRIDION for immediate reversal following vecuronium-induced blockade.

Dosage and Administration

BRIDION should be administered only by, or under the supervision of, an anaesthetist. Neuromuscular monitoring is recommended during recovery of neuromuscular blockade. Ventilatory support is mandatory for patients until adequate spontaneous respiration is restored following reversal. Even if recovery from neuromuscular blockade is complete, other medicinal products used in the peri- and postoperative period could depress respiratory function and, therefore, ventilatory support might still be required.

If neuromuscular blockade is required within 24 hours of BRIDION administration, a nonsteroidal neuromuscular blocking agent should be used instead of rocuronium or vecuronium.

Selected Safety Information About BRIDION[®] (sugammadex)¹ (*continued*)

Contraindications

BRIDION is contraindicated in patients hypersensitive to sugammadex or any of its excipients.

Precautions and Drug Interactions

BRIDION is not recommended in patients with severe renal impairment (including patients requiring dialysis [CrCl <30 mL/min]). Studies in patients with hepatic impairment have not been conducted and, therefore, patients with severe hepatic impairment should be treated with great caution.

Caution should be exercised when administering BRIDION to pregnant women as no clinical data on exposed pregnancies are available.

BRIDION has not been investigated in patients receiving rocuronium or vecuronium in the ICU setting.

Side Effects

The most commonly reported adverse reactions were dysgeusia (metal or bitter taste) and anesthetic complications (eg, movement, coughing, grimacing, or suckling on the endotracheal tube). In patients treated with BRIDION, a few cases of awareness were reported. The relationship to BRIDION was uncertain. Drug hypersensitivity reactions: Hypersensitivity reactions, including anaphylaxis, have occurred in some patients and volunteers. In clinical trials of surgical patients these reactions were reported uncommonly and for postmarketing reports the frequency is unknown. These reactions varied from isolated skin reactions to serious systemic reactions (ie, anaphylaxis, anaphylactic shock) and have occurred in patients with no prior exposure to sugammadex. Symptoms associated with these reactions can include: flushing, urticaria, erythematous rash, (severe) hypotension, tachycardia and swelling of tongue and pharynx. Clinicians should be prepared for the possibility of allergic reactions and take the necessary precautions.

Selected Safety Information About BRIDION[®] (sugammadex)¹ (*continued*)

In a trial of patients with a history of pulmonary complications, bronchospasm was reported in 2 patients and a causal relationship could not be fully excluded.

Volunteer studies have demonstrated a slight (17% to 22%) and transient (≤ 30 minutes) prolongation of the PT/aPTT with BRIDION; however, clinical studies have demonstrated no clinically relevant effect on peri- or postoperative bleeding complications with BRIDION alone or in combination with anticoagulants. As BRIDION has demonstrated an in vitro pharmacodynamic interaction with anticoagulants, caution should be exercised in patients on anticoagulation for a pre-existing or comorbid condition. This pharmacodynamic interaction is not clinically relevant for patients receiving routine postoperative prophylactic anticoagulation.

Although formal interaction studies have not been conducted, no drug interactions were observed in clinical trials. Preclinical data suggest that clinically significant drug interactions are unlikely with the possible exceptions of toremifene, fusidic acid, and hormonal contraceptives.

Therapeutic Indications for ESMERON[®] (rocuronium bromide)¹

Indications

ESMERON is indicated as an adjunct to general anesthesia to facilitate tracheal intubation during routine and rapid sequence induction, and to provide skeletal muscle relaxation during surgery. ESMERON is also indicated as an adjunct in the intensive care unit (ICU) to facilitate intubation and mechanical ventilation.

For the pediatric population: ESMERON is indicated as an adjunct to general anesthesia to facilitate tracheal intubation during routine induction and to provide skeletal muscle relaxation during surgery in pediatric patients from term newborn infants to adolescents.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹

Contraindications

Hypersensitivity to rocuronium or to the bromide ion or to any of the excipients.

Warnings and Precautions

Since ESMERON causes paralysis of the respiratory muscles, ventilatory support is mandatory for patients treated with this drug until adequate spontaneous respiration is restored. As with all neuromuscular blocking agents, it is important to anticipate intubation difficulties, particularly when used as part of a rapid sequence induction technique. In case of intubation difficulties resulting in a clinical need for immediate reversal of a rocuronium induced neuromuscular block, the use of sugammadex should be considered.

As with other neuromuscular blocking agents, residual curarization has been reported for ESMERON. In order to prevent complications resulting from residual curarization, it is recommended to extubate only after the patient has recovered sufficiently from neuromuscular block. Other factors that could cause residual curarization after extubation in the postoperative phase (eg, drug interactions or patient condition) should also be considered. If not used as part of standard clinical practice, the use of sugammadex or another reversal agent should be considered, especially in those cases where residual curarization is more likely to occur.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹ *(continued)*

Anaphylactic reactions can occur following the administration of neuromuscular blocking agents. Precautions for treating such reactions should always be taken. Particularly in the case of previous anaphylactic reactions to neuromuscular blocking agents, special precautions should be taken since allergic cross-reactivity to neuromuscular blocking agents has been reported.

In general, following long-term use of neuromuscular blocking agents in the ICU, prolonged paralysis and/or skeletal muscle weakness has been noted. In order to help preclude possible prolongation of neuromuscular block and/or overdose it is strongly recommended that neuromuscular transmission is monitored throughout the use of neuromuscular blocking agents. In addition, patients should receive adequate analgesia and sedation. Furthermore, neuromuscular blocking agents should be titrated to effect in the individual patients by or under supervision of experienced clinicians who are familiar with their actions and with appropriate neuromuscular monitoring techniques.

Myopathy after long-term administration of other nondepolarizing neuromuscular blocking agents in the ICU in combination with corticosteroid therapy has been reported regularly. Therefore, for patients receiving both neuromuscular blocking agents and corticosteroids, the period of use of the neuromuscular blocking agent should be limited as much as possible.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹ (*continued*)

If suxamethonium is used for intubation, the administration of ESMERON should be delayed until the patient has clinically recovered from the neuromuscular block induced by suxamethonium.

The following conditions may influence the pharmacokinetics and/or pharmacodynamics of ESMERON: hepatic and/or biliary tract disease and renal failure; prolonged circulation time; neuromuscular disease, hypothermia, obesity, burns.

Conditions that may increase the effects of ESMERON: hypokalaemia (eg, after severe vomiting, diarrhea and diuretic therapy), hypermagnesemia, hypocalcemia (after massive transfusions), hypoproteinemia, dehydration, acidosis, hypercapnia, cachexia.

Drug Interactions

The following drugs have been shown to influence the magnitude and/or duration of action of ESMERON. Increased effect: halogenated volatile anesthetics, after intubation with suxamethonium, long-term concomitant use of corticosteroids may result in prolonged duration of neuromuscular block or myopathy; other drugs—some antibiotics (aminoglycoside, lincosamide and polypeptide antibiotics, acylamino-penicillin antibiotics), diuretics, quinidine and quinine, magnesium salts, calcium channel blocking agents, lithium salts, local anesthetics (lidocaine i.v., bupivacaine epidural), and acute administration of phenytoin or β -blocking agents.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹ *(continued)*

Recurarization has been reported after postoperative administration of: aminoglycoside, lincosamide, polypeptide and acylamino-penicillin antibiotics, quinidine, quinine, and magnesium salts.

Decreased effect: prior chronic administration of phenytoin or carbamazepine, protease inhibitors (gabexate, ulinastatin)

Variable effect: administration of other nondepolarizing neuromuscular blocking agents in combination with ESMERON may produce attenuation or potentiation of the neuromuscular block, depending on the order of administration and the neuromuscular blocking agent used. Suxamethonium given after the administration of ESMERON may produce potentiation or attenuation of the neuromuscular blocking effect of ESMERON. ESMERON combined with lidocaine may result in a quicker onset of action of lidocaine.

Pediatric patients

No formal interaction studies have been performed. The above mentioned interactions for adults and their special warnings and precautions for use should also be taken into account for pediatric patients.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹ (*continued*)

Adverse Events

The most commonly occurring adverse drug reactions include injection site pain/reaction, changes in vital signs and prolonged neuromuscular block. The most frequently reported serious adverse drug reactions during postmarketing surveillance are anaphylactic and anaphylactoid reactions and associated symptoms.

Although very rare, severe anaphylactic reactions to neuromuscular blocking agents, including ESMERON, have been reported. Anaphylactic/anaphylactoid reactions are: bronchospasm, cardiovascular changes (eg, hypotension, tachycardia, circulatory collapse–shock), and cutaneous changes (eg, angioedema, urticaria). These reactions have, in some cases, been fatal. Due to the possible severity of these reactions, one should always assume they may occur and take the necessary precautions. Since neuromuscular blocking agents are known to be capable of inducing histamine release both locally at the site of injection and systemically, the possible occurrence of itching and erythematous reactions at the site of injection and/or generalized histaminoid (anaphylactoid) reactions should always be taken into consideration when administering these drugs. In clinical studies only a slight increase in mean plasma histamine levels has been observed following rapid bolus administration of rocuronium bromide 0.3-0.9 mg.kg⁻¹.

Selected Safety Information About ESMERON[®] (rocuronium bromide)¹ (*continued*)

Pediatric patients

A meta-analysis of 11 clinical studies in pediatric patients (N=704) with rocuronium bromide (up to 1 mg/kg) showed that tachycardia was identified as adverse drug reaction with a frequency of 1.4%.

For additional safety information, please consult the Summary of Product Characteristics.