La Contropulsazione Aortica

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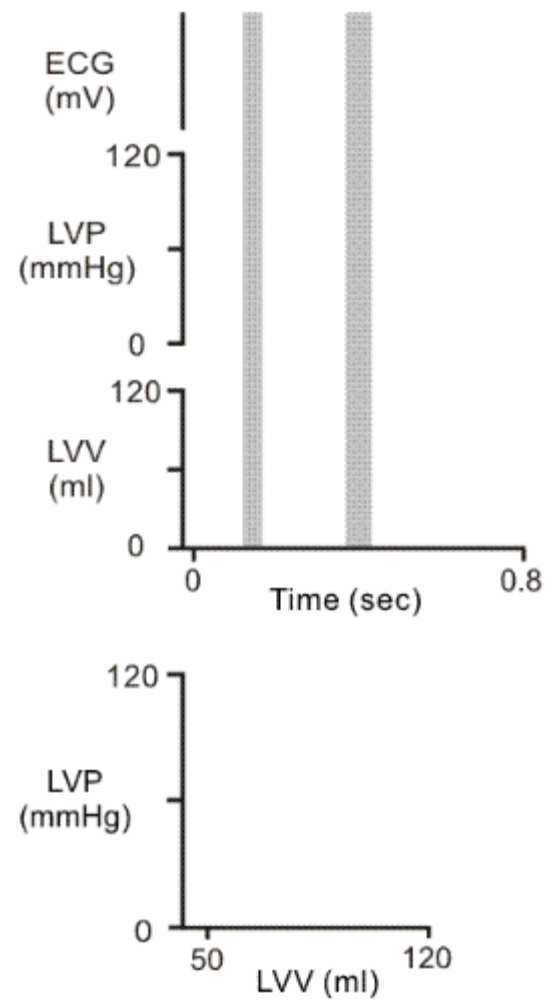
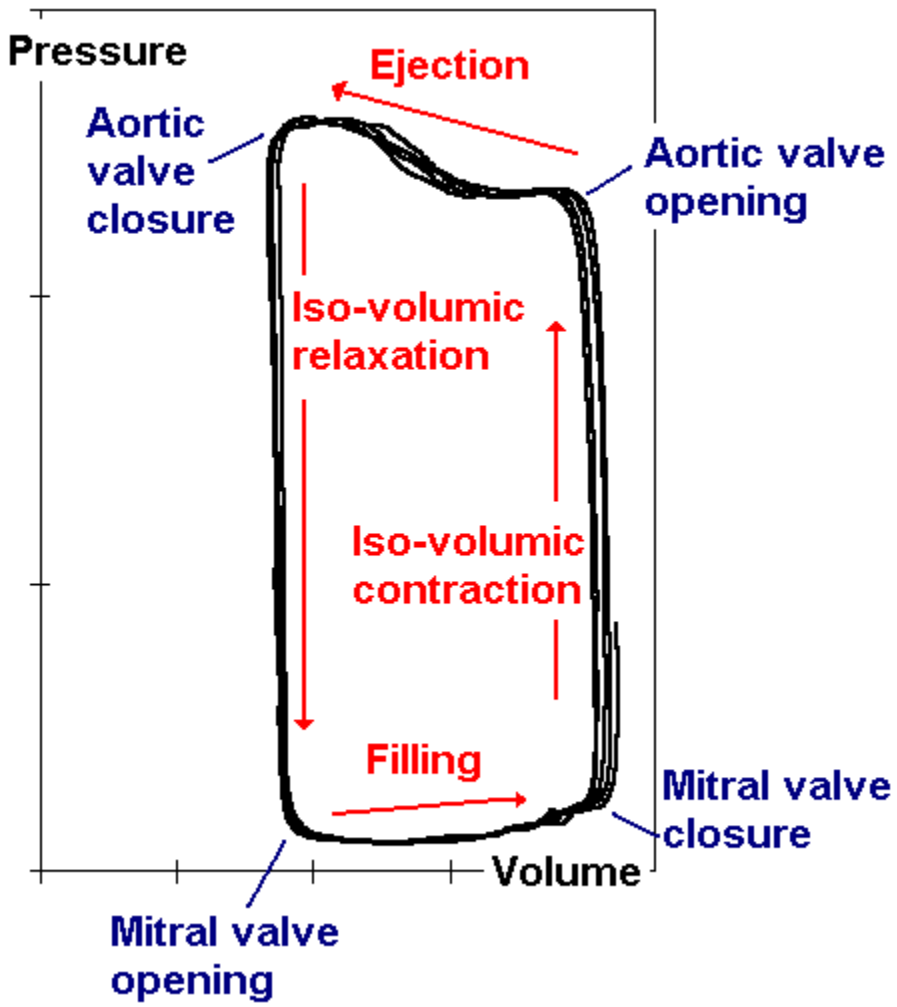
Principi della terapia IABP

- Fisiopatologia della contropulsazione aortica
- Metodologia
- Revisione della letteratura sulle indicazioni
- Linee guida
- Conclusioni

Fisiologia

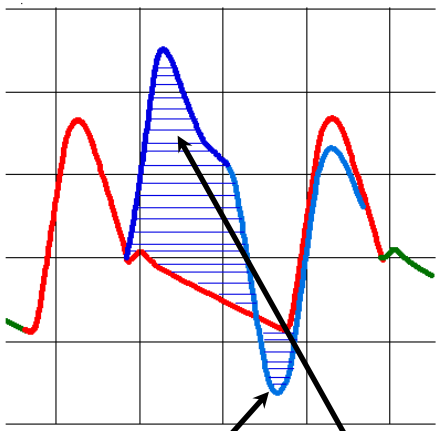
PV-Loop


ECG
(mV)
120
LVP
(mmHg)
0
120
LVV
(ml)
0
0
Time (sec)
0.8
120
LVP
(mmHg)
0
50
120
LVV (ml)


Pressure
Ejection
Aortic valve closure
Aortic valve opening
Iso-volumic relaxation
Iso-volumic contraction
Filling
Mitral valve closure
Volume
Mitral valve opening

Effetti emodinamici

RIDUZIONE

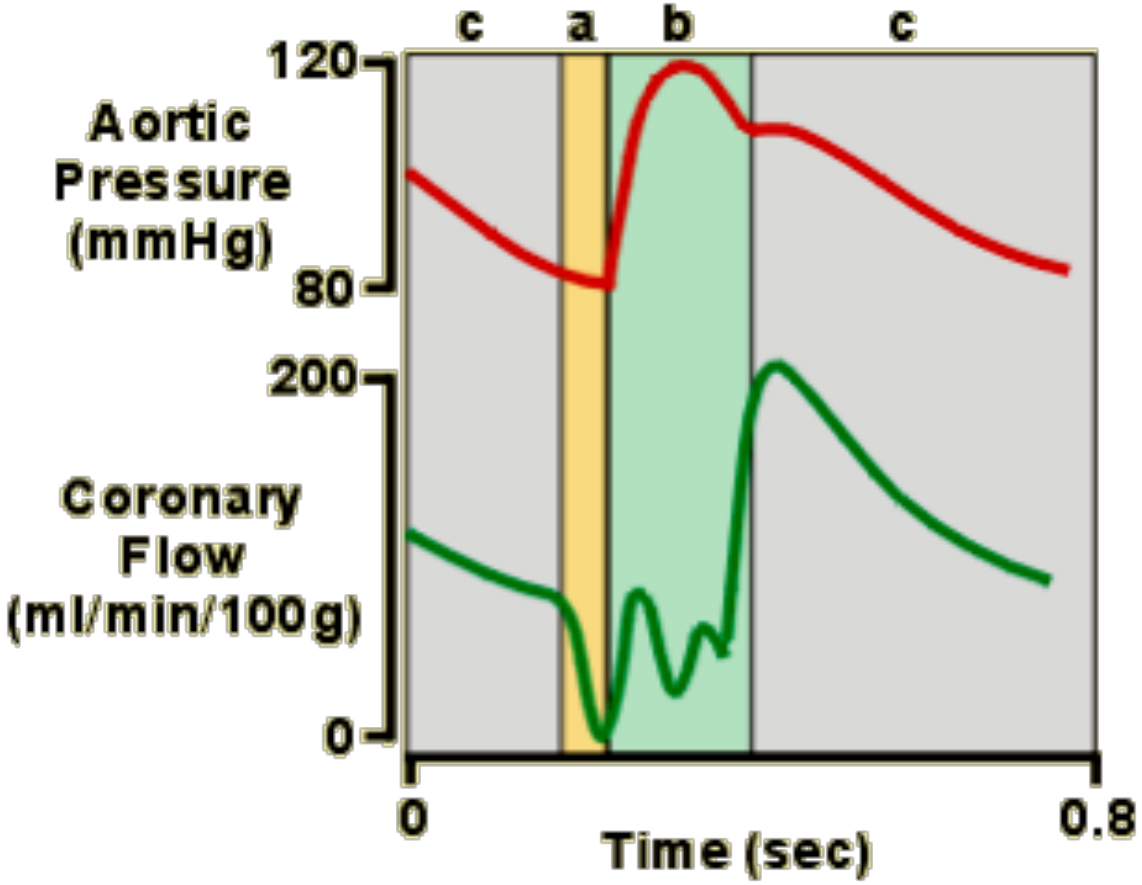


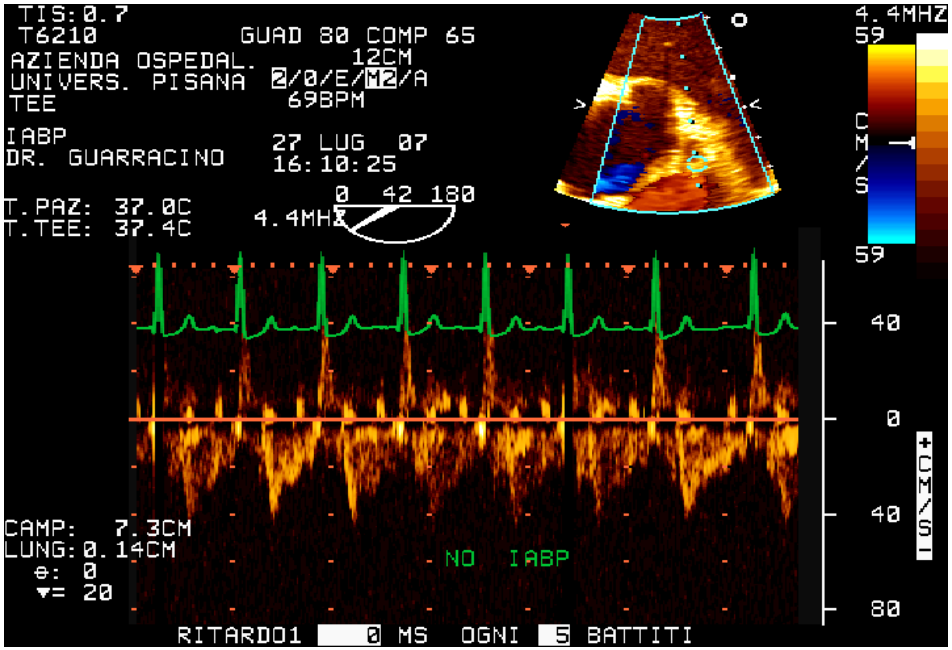
INCREMENTO

del post carico
del ventricolo SX
SGONFIAGGIO

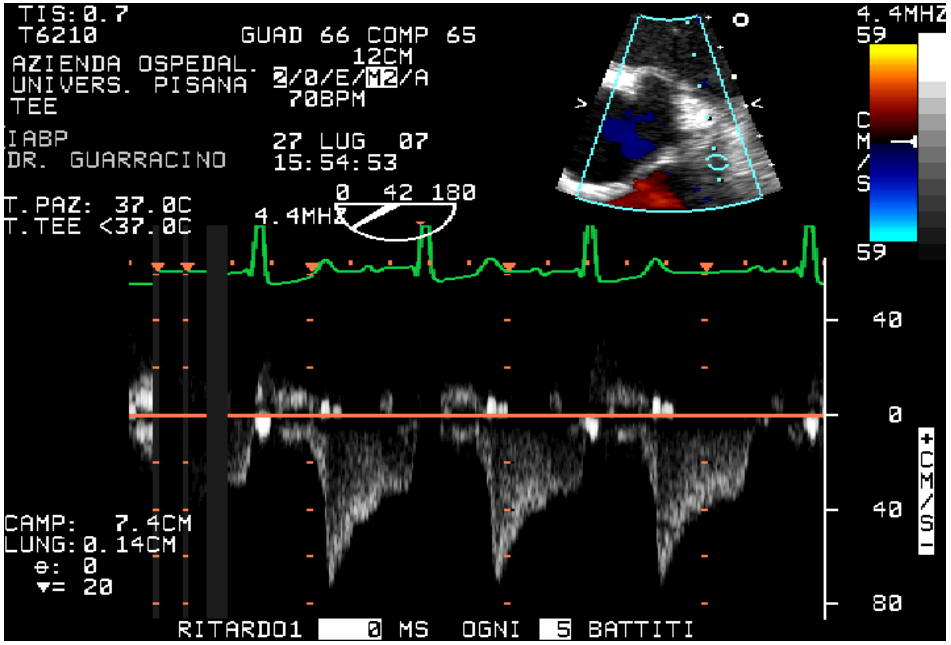
della pressione
diastolica media
GONFIAGGIO

Questione di timing…



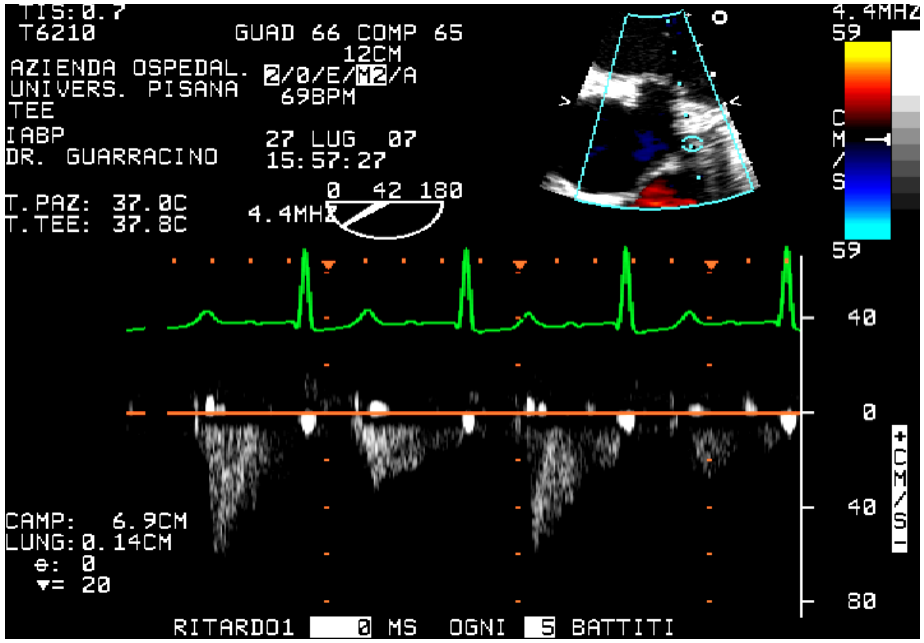


IABP OFF

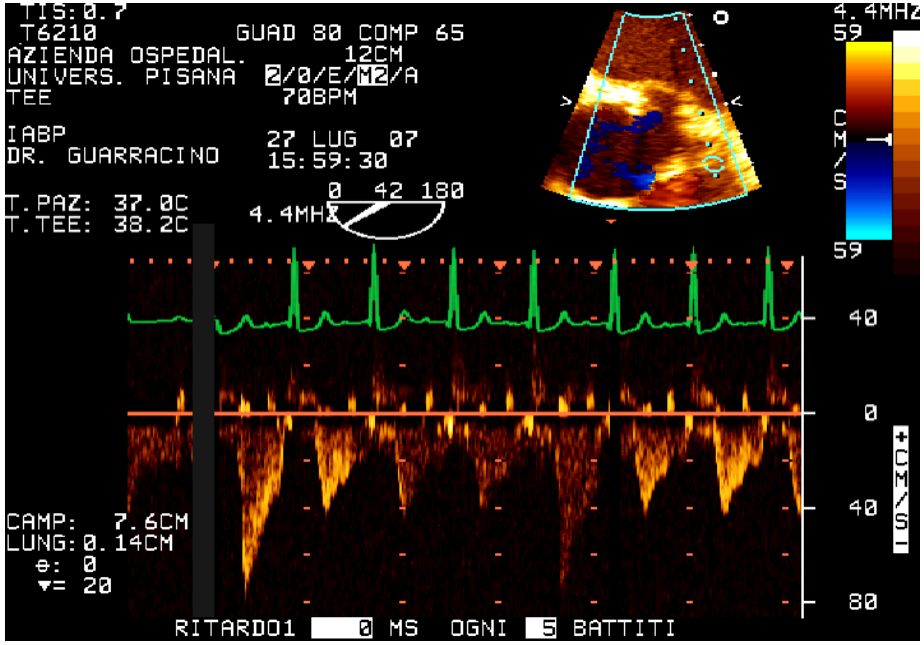


IABP ON

(1:1, 40cc)



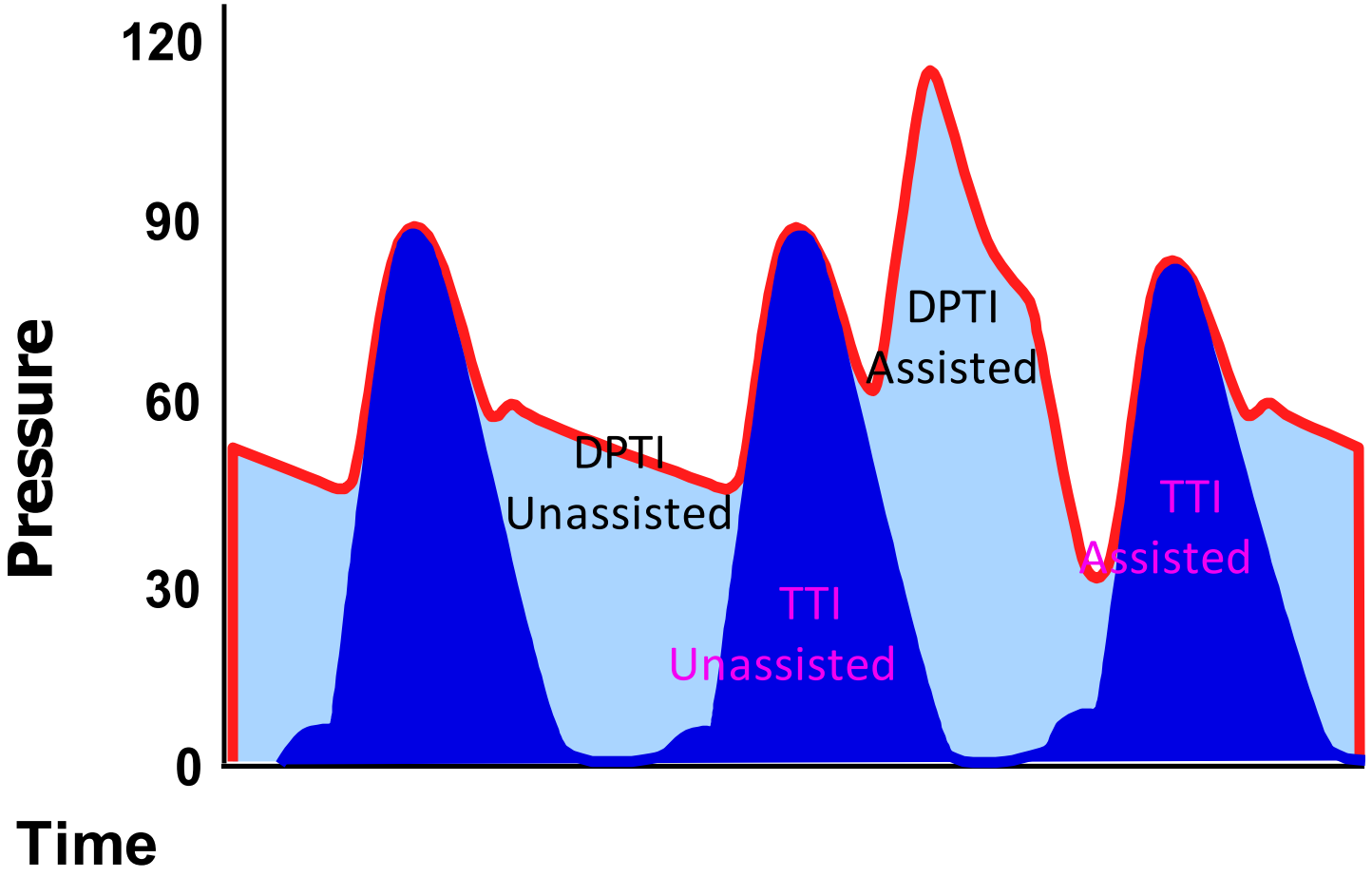
IABP 1:2, 40cc



IABP 1:4, 40cc

Endocardial Viability Ratio

(Diastolic Pressure Time index / Tension Time Index)



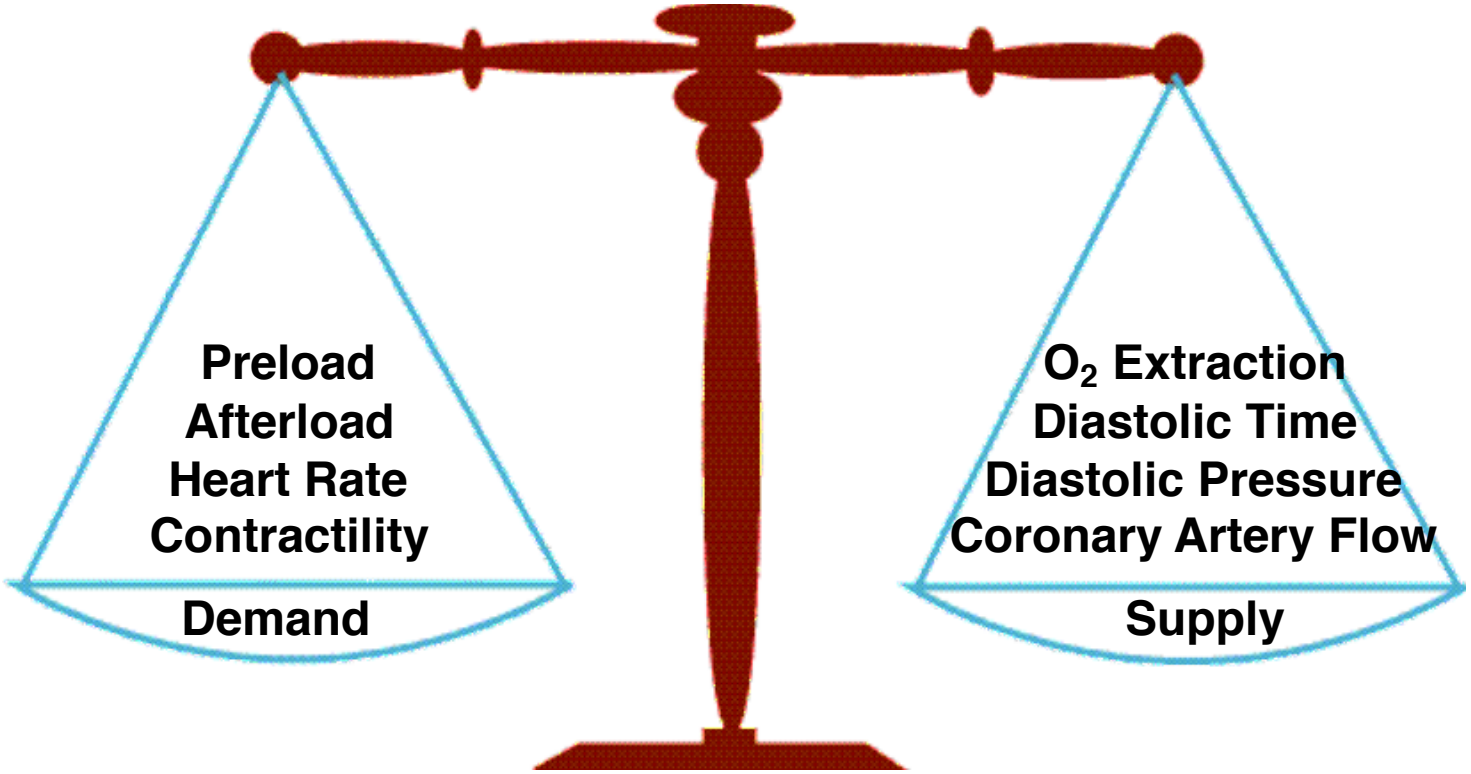
IABP Improves EVR

IABP in Acute Heart Failure

- Intra-aortic balloon pumping (IABP) has been well established in the last five decades.
  - Balance Oxygen Supply/Demand via Volume displacement and LV Pressure unloading
    - Afterload reduction
    - Diastolic augmentation

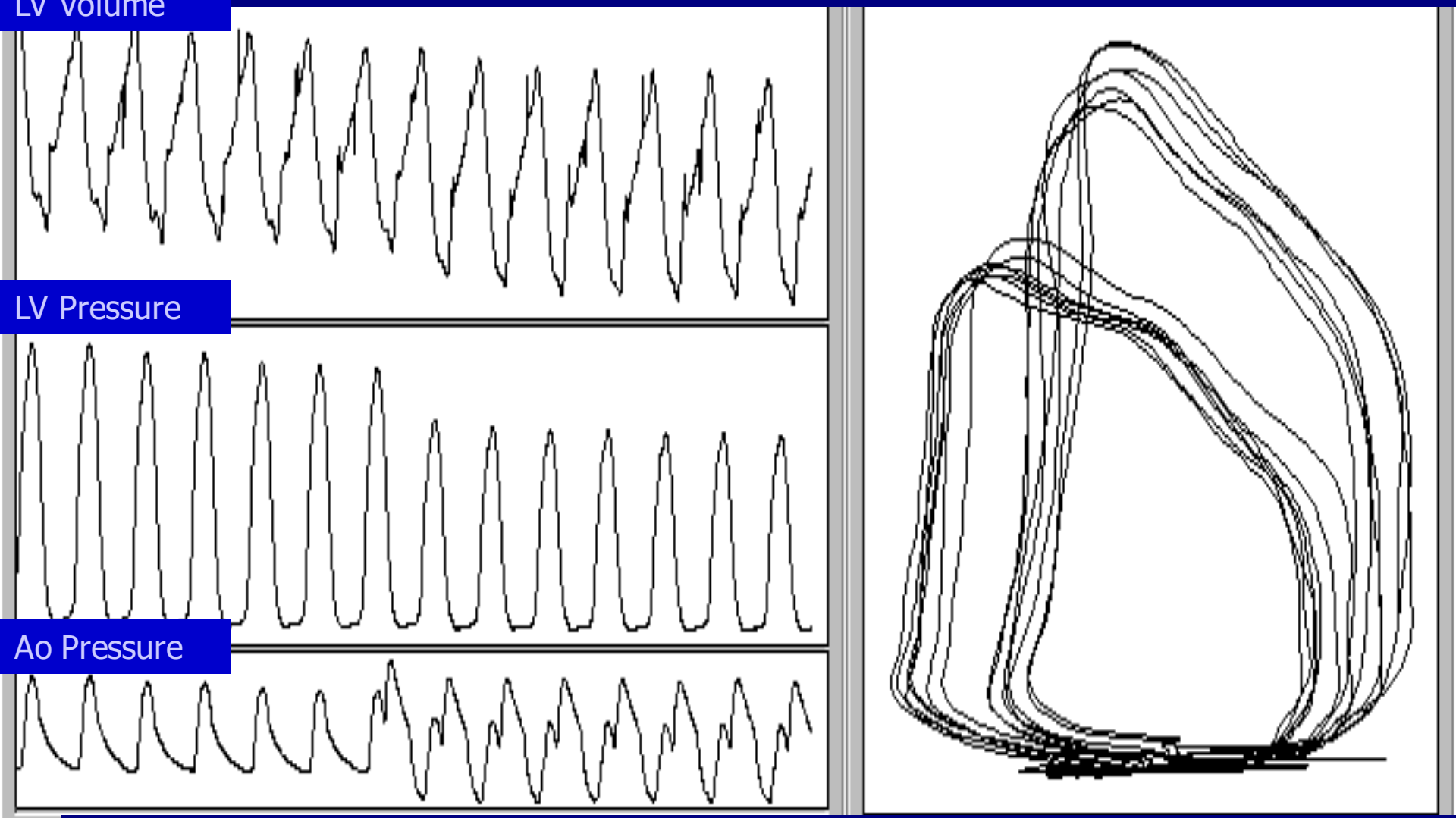
- The IABP shifts the balance of oxygen supply and demand to the left (reduces demand), indicating that the left ventricle (LV) can maintain contractility at a lower level of oxygen availability, due to the reduction in cardiac work.
- Physiologic data (PV Loops) and hemodynamic data show improved LV function with IABP therapy
- However, clinical evidence on the impact of IABP on outcomes, specifically mortality is conflicting

Myocardial Oxygen Balance



The IABP shifts the balance of oxygen supply and demand to the left (reduces demand), indicating that the left ventricle (LV) can maintain contractility at a lower level of oxygen availability, due to the reduction in cardiac work.

PV LOOPS WITH IABP OFF TO ON



NYHA class III patient, EF20%, undergoing LV Aneurysmectomy + CABG

Results: Effect of IABP Timing on LV

- Correctly timed IABP
  - Immediate/predictable LV impact in all patients within 3 to 4 beats of IABP
  - Reduction in aortic impedance increases the length of ejection, increasing SV/EF and reducing LVESV/LVESP
    - Change is LVESV preceded change in LVESP
  - ↑SV/EF 14% ($p < 0.0001$) on a beat to beat basis
  - CO by 13% ($p<0.001$) within first 10 minutes of pump initiation
  - Reduction in dyssynchrony of 2% ($p < 0.02$) due to afterload reduction
- Early inflation: Greatest compromise to LV performance
  - Regurgitant flow ↑LVESV/LVESP, causing premature AVC
  - ↓ SV by 20% ($p < .0001$)
    - This loss is cumulative and not compensated by future beats
- Late deflation: Two part effect
  - ↑Aortic impedance (LV afterload) in early systole by delay in AVO
    - ↑SW 16% $p < .0001$
  - ↓ Afterload (LVESP/LVESV) in late systole
    - ↑ SV by 18% ($p < .0001$)
    - In the presence of mechanical defects, SV was increased by 30%
  - Overall ↑ in SV/SW/MVO2

Gestione del paziente contropulsato

Sincronismo e temporizzazione

SINCRONISMO  **TEMPORIZZAZIONE**

- Controllare il sincronismo con il segnale ECG (o di pressione arteriosa). La mancanza di un sincronismo stabile e affidabile determina sempre una scorretta temporizzazione del contropulsatore (gonfiaggio precoce, gonfiaggio ritardato, sgonfiaggio precoce, sgonfiaggio ritardato,temporizzazione errante).
- Pertanto, in accordo con le istruzioni dell'apparecchio in uso è opportuno verificare periodicamente la corretta temporizzazione della terapia e procedere ad effettuare le correzioni se necessario.
- Una temporizzazione non corretta riduce la qualità della terapia e può in alcuni casi compromette la funzionalità cardiaca.

Sincronismo e Temporizzazione

Sincronismo:

Segnale/evento fisiologico che consente al contropulsatore di identificare l'inizio del ciclo cardiaco.

Segnali:

- ECG
- AP
- PACE MAKER

Algoritmi:

- ECG (complesso QRS)
- ECG (solo fronte di salita)
- Filtro ESIS (modalità di riduzione disturbi)
- Picco o pendenza segnale AP

Temporizzazione:

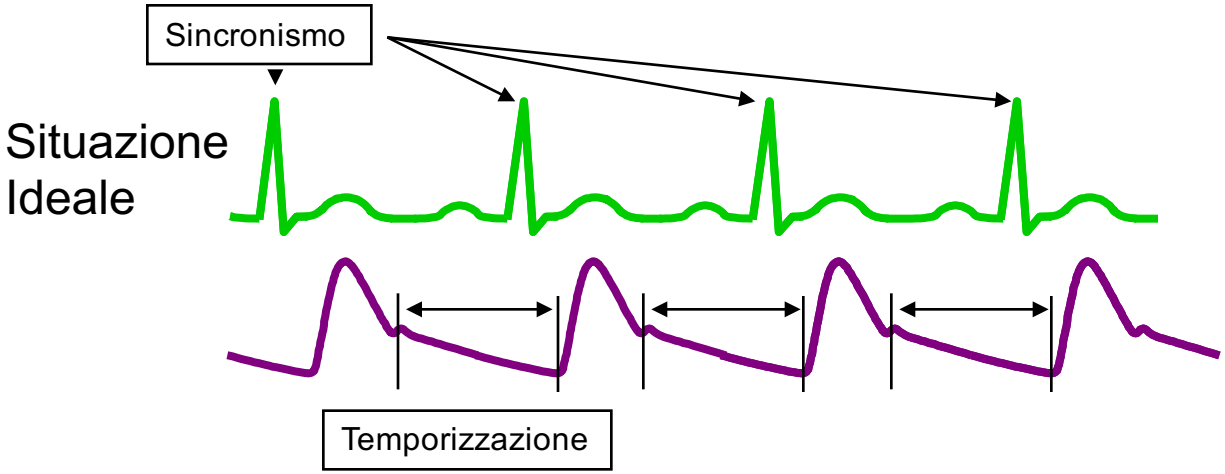
Insieme di eventi e algoritmi che consentono di individuare la diastole all'interno del ciclo cardiaco

Eventi:

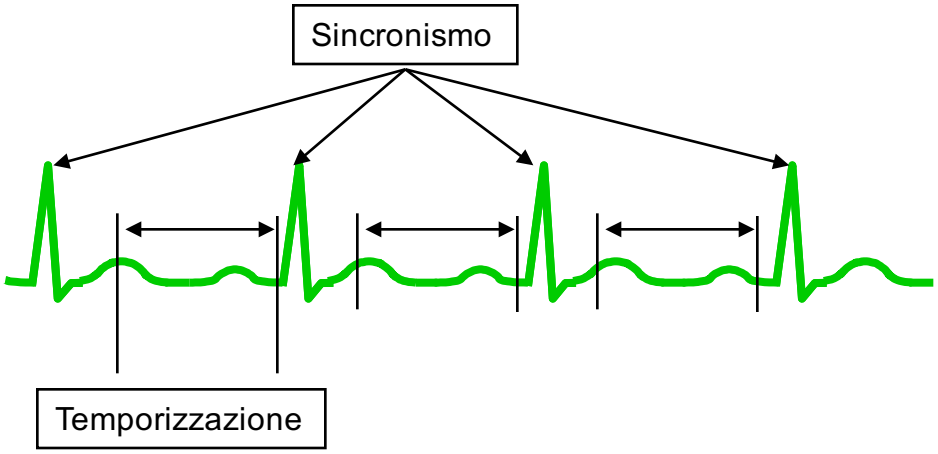
- Incisura dicrota
- Onda R e intervallo RR
- Picco di pressione
- Onda di flusso

Algoritmi:

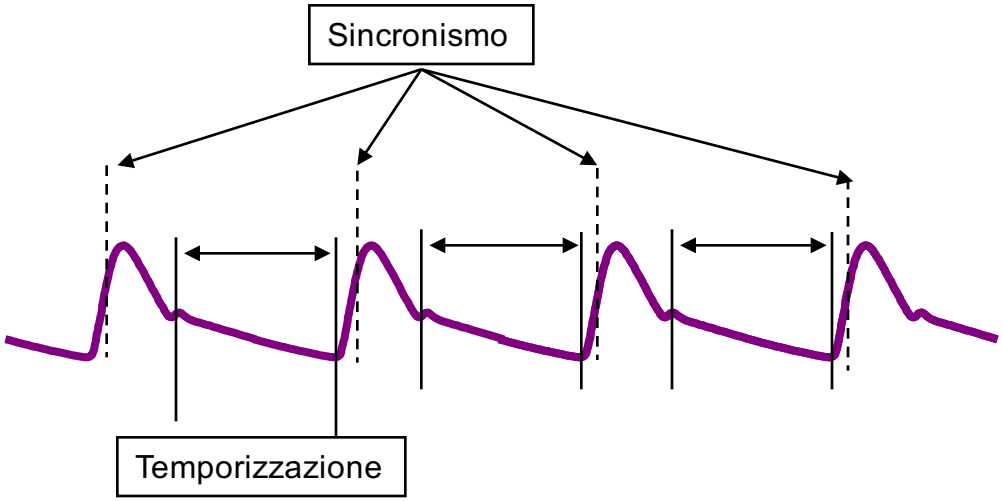
- Predittivi (calcoli statistici)
- Weissler (Tabella di riferimento)
- Real time (Onda R come segnale di sgonfiaggio)
- WAVE (Brevetto Onda di flusso per gonfiaggio)



Sincronismo e Temporizzazione



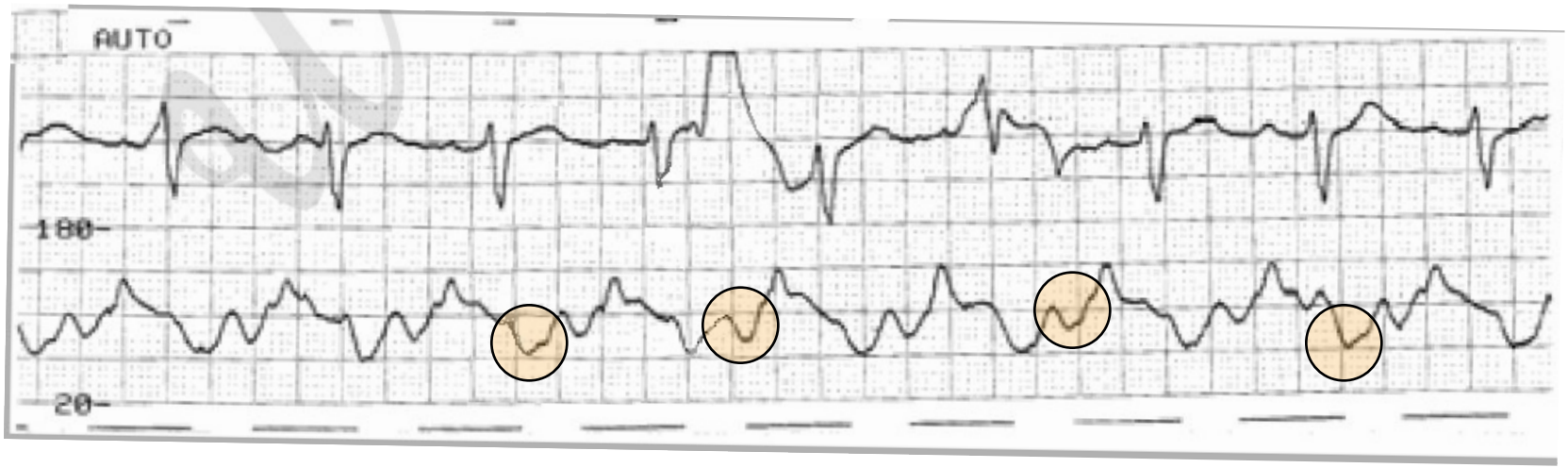
In questa situazione il sincronismo è perfetto ma la temporizzazione è approssimativa. Non si conosce esattamente inizio e fine diastole meccanica



In questa situazione il sincronismo è ritardato gestirà il battito seguente la temporizzazione è possibile solo se il ritmo è sinusale

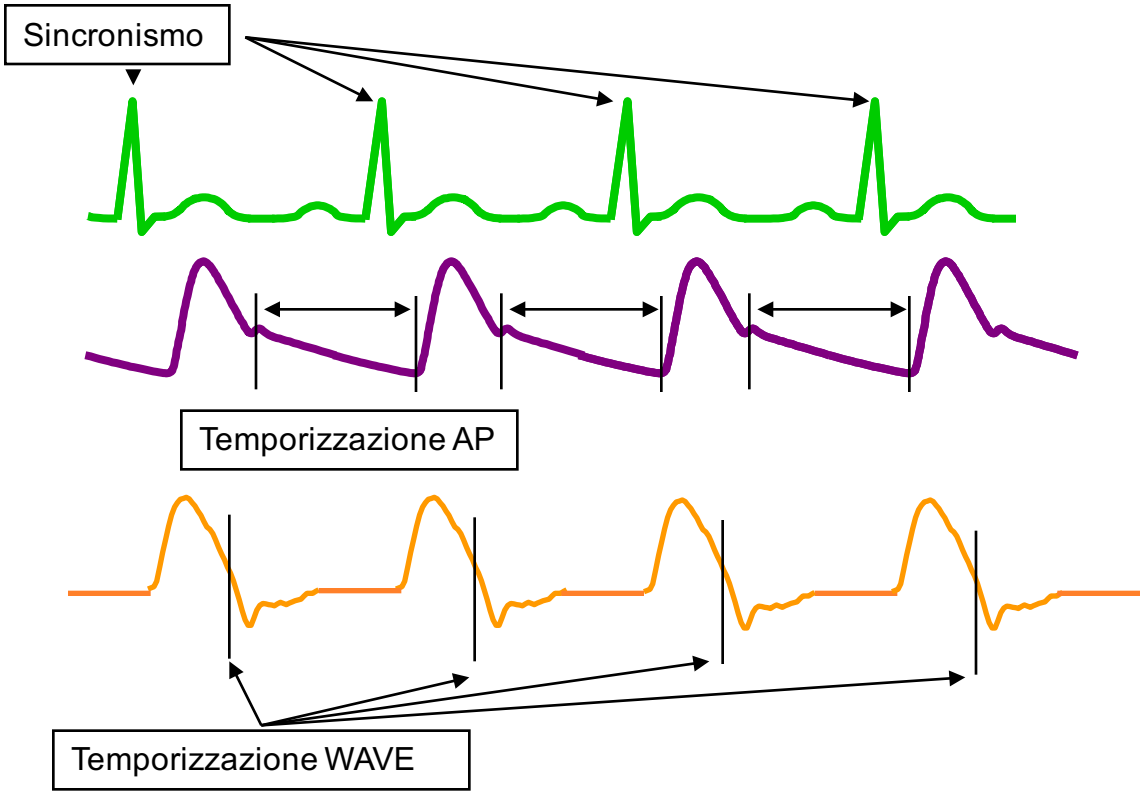
Ecco i risultati...

- Apparentemente la terapia sembra corretta
- Ma ad un controllo più attento???



La considerazione più importante da fare è sul tempo in cui si deve agire. Se il paziente ha una Frq. di 60 bpm. il ciclo sistole diastole avviene in un secondo, un piccolo errore in percentuale diventa un grande errore

Nuovo modo di temporizzare la terapia



L'aggiunta di un ulteriore punto di riferimento nel ciclo cardiaco preso sull'onda di flusso aortico aumenta la precisione della temporizzazione, particolarmente in condizioni di aritmia

Questione di timing…

Gonfiaggio ritardato | **Temporizzazione OK** | Sgonfiaggio anticipato

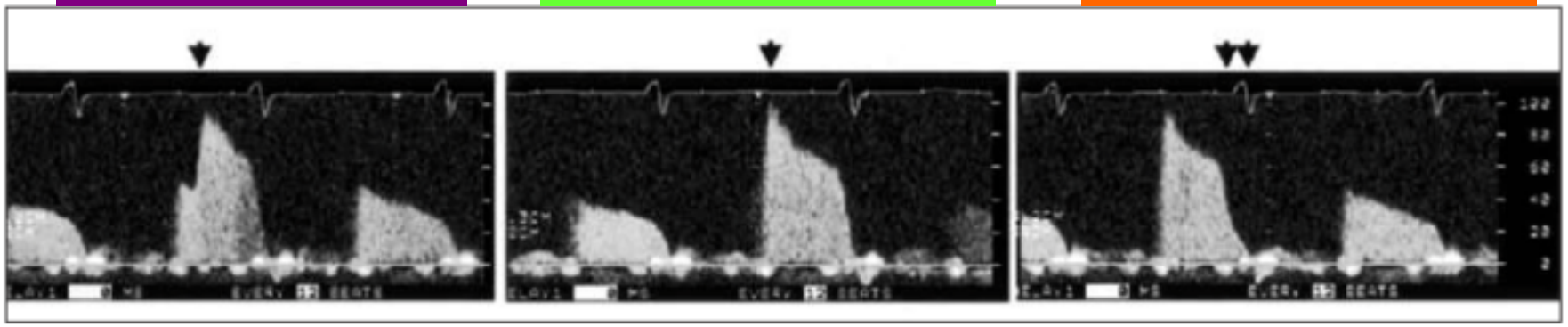


Figura 79: Aggiustamento della temporizzazione durante registrazione del flusso coronarico (tratto da M. Takeuchi, Y. Nohtomi, H. Yoshitani et al. "Enhanced Coronary Flow Velocity During Intra-Aortic Balloon Pumping Assessed by Transthoracic Doppler Echocardiography" J Am Coll Cardiol 2004; 43: pp. 368 –76):
A) Gonfiaggio ritardato: è possibile identificare un'incisura tra il flusso di decelerazione diastolica e il flusso corrispondente al picco diastolico generato dal contropulsatore (indicato dalla freccia)
B) Temporizzazione ottimale: l'incremento del flusso diastolico coincide con il fronte di salita del flusso di accelerazione diastolica (indicato dalla freccia)
C) Sgonfiaggio anticipato: il profilo del flusso coronarico termina molto prima dell'onda R sull'elettrocardiogramma (indicato dalla freccia)

La letteratura

Meta-analysis of Mixed Trials: IABP Effect on Mortality

TABLE 2. *Meta-analysis: Effect of IABP on mortality in patients with infarction-related cardiogenic shock, depending on the type of reperfusion therapy (23)*

	Study	IABP	No IABP	Odds ratio	Effect of IABP on mortality
No reperfusion	1 trial	M:24/34	M:15/15	–0.29 (–0.47 to –0.12)	–29%
Thrombolysis	7 trials	M:1415/2878	M:2890/4320	–0.18 (–0.20 to –0.16)	–18%
PCI	2 trials	M:1049/2234	M:427/1048	0.006 (0.003 to 0.10)	6%
Overall	10 trials	M:2488/5146	M:3332/5383	–0.11 (–0.13 to –0.09)	–11%

M, mortality.

- **Buerke et al (2012) Performed a meta-analysis to determine the effect of IABP on mortality by type of re-perfusion therapy, including RCT's, registry and single center studies**
- **IABP reduced mortality in the following categories:**
  - **No reperfusion (29% reduction)**
  - **Thrombolytic therapy (18% reduction)**
  - **Overall (11% reduction)**
- **IABP increased mortality in PCI (6 % increase)**

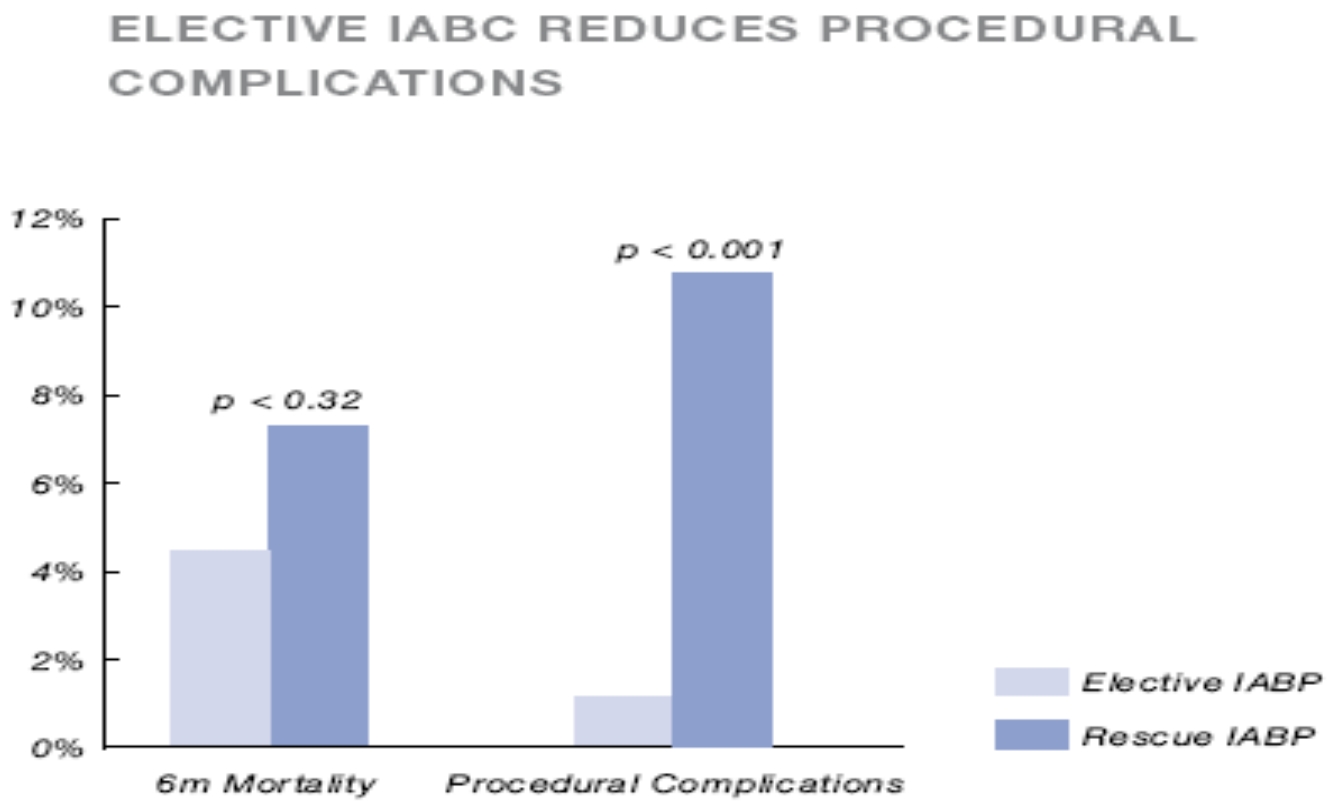
IABP Reduces Mortality in Cardiogenic Shock (Meta-analysis)

- Bahekar, A. (2012) Cardiovascular Outcomes using Intra-aortic Balloon Pump in High-Risk Acute Myocardial Infarction with or without Cardiogenic Shock: A Meta-analysis. J. Cardiovasc Pharmacol Therap; 17(1): 44-56.
- Background:
- To review existing literature to analyze whether the use of the IABP offers any cardiac benefit to patients with AMI and the complications associated with IABP.
- Method:
- We analyzed 16 studies which included primary endpoints, including; In-hospital mortality, re-infarction and recurrent ischemia and secondary endpoints, including; incidence of severe or moderate bleeding during hospitalization.
- Results:
- There was no significant difference in-hospital mortality, re-infarction rates of recurrent ischemia in the IABP or non-IABP groups. However, in the analysis of studies restricted to patients with AMI, complicated by Cardiogenic Shock (SBP < 90 mmHg) there was a significant reduction in mortality with IABP use.
- IABP is associated with increased rates of both moderate and severe bleeding.
- CONCLUSIONS:
- IABP in patients with AMI complicated by Cardiogenic Shock, IABP reduces mortality. The authors recommend that more conservative strategy for the use of IABP in patients with AMI. Patients with moderate hypotension (SBP 90 to 100mmHg) showed no benefit. Mortality reduction was seen in patients with SBP < 90mmHg and indicates that sicker patients may experience greater benefit from the IABP. IABP should be used judiciously and reserved for sicker patients and those in cardiogenic shock.

IABP IS ASSOCIATED REDUCTION IN MORTALITY FOR PATIENTS IN CARDIOGENIC SHOCK

BCIS-1

- Balloon Pump Assisted Coronary Intervention Study, 2009
- Trend toward reduced mortality at 6 months
- Significant reduction in Procedural Complications related to IABP



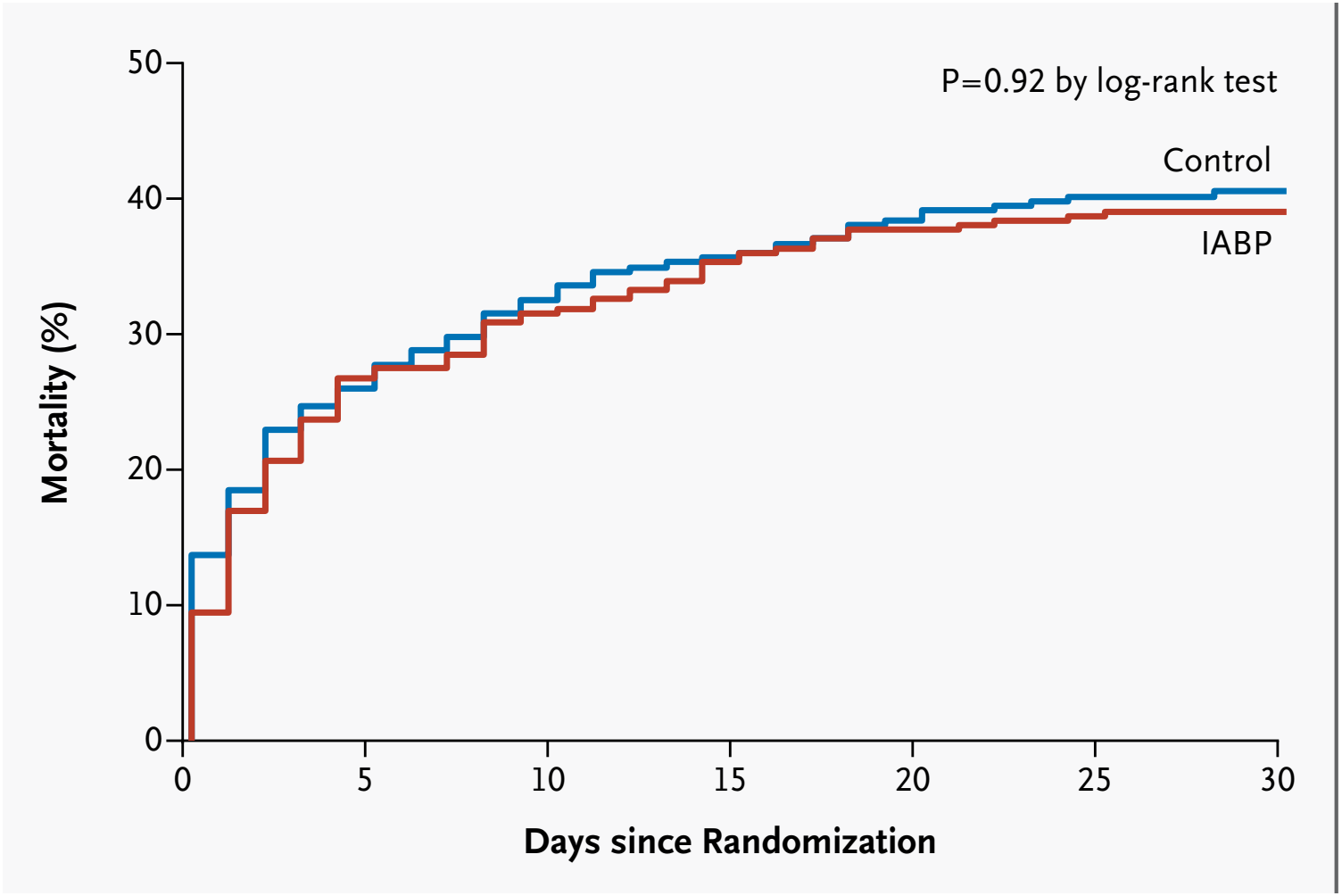
Perera et al

Primary outcome

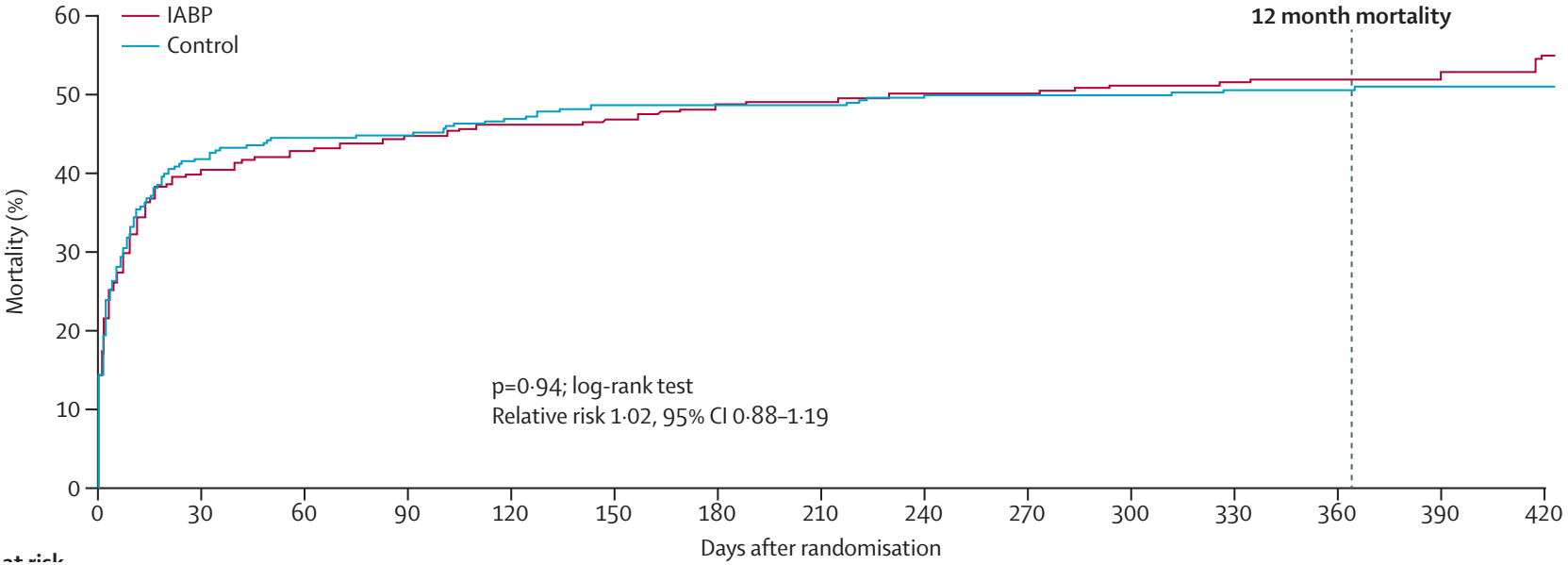
CRISP am counterpulsation reduces infarct size pre pci in acute myocardial infarction

	All (N=337)	IABC (N=161)	SOC (N=176)	P Value
Primary endpoint				
Infarct size (% LV), modified ITT all patients with CMR data				**0.060**
N	275	133	142	
Mean	39.8	42.1	37.5	
Median	38.8	42.8	36.2	
Infarct size (% LV), modified ITT patients prox. LAD and TIMI flow 0/1				**0.110**
N	192	93	99	
Mean	44.4	46.7	42.3	
Median	42.1	45.1	38.6	

Co-primary endpoint: 2-sided p=0.025

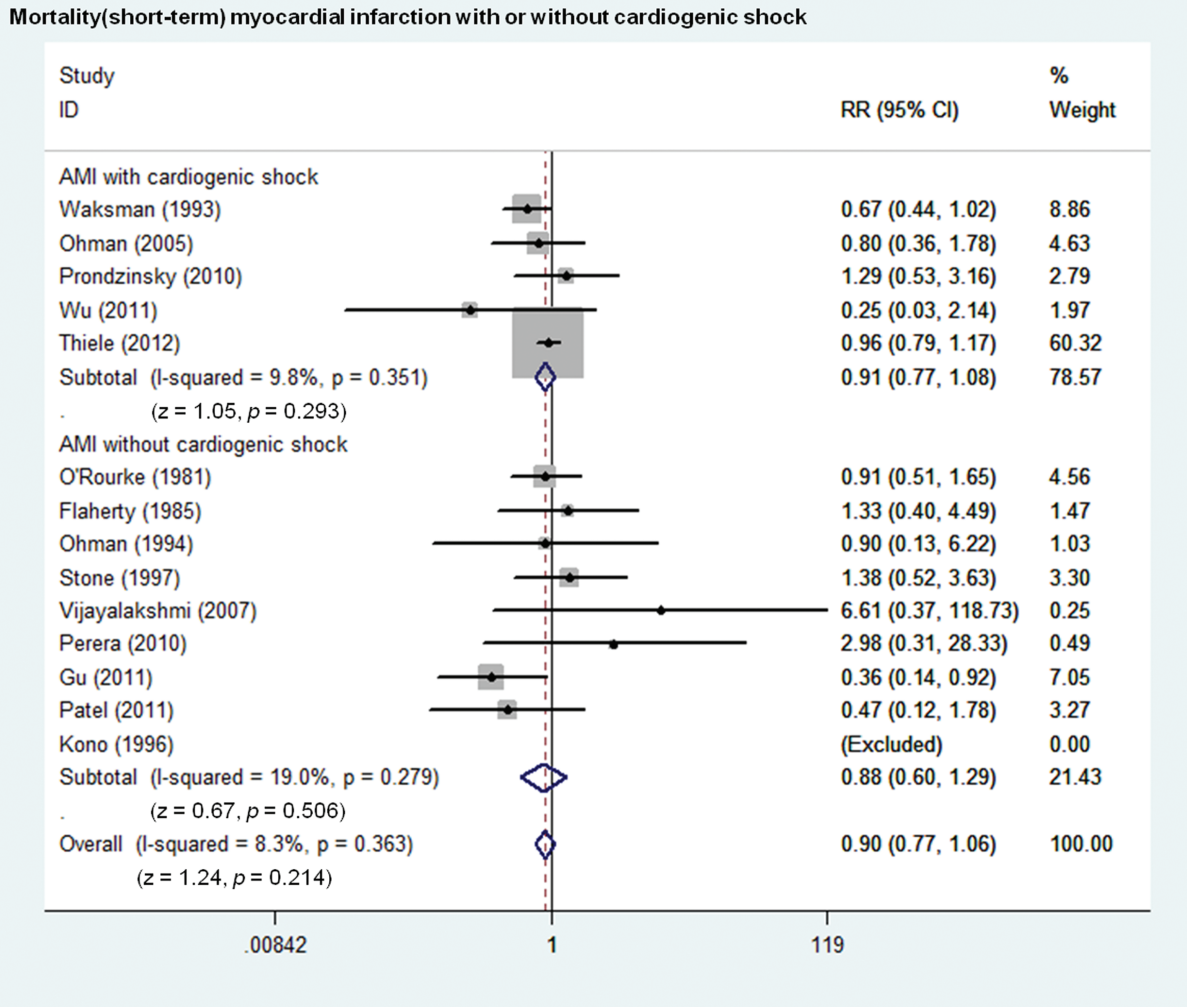


IABP - Shock II Trial – Risultati a 30 giorni



IABP - Shock II Trial a 12 mesi

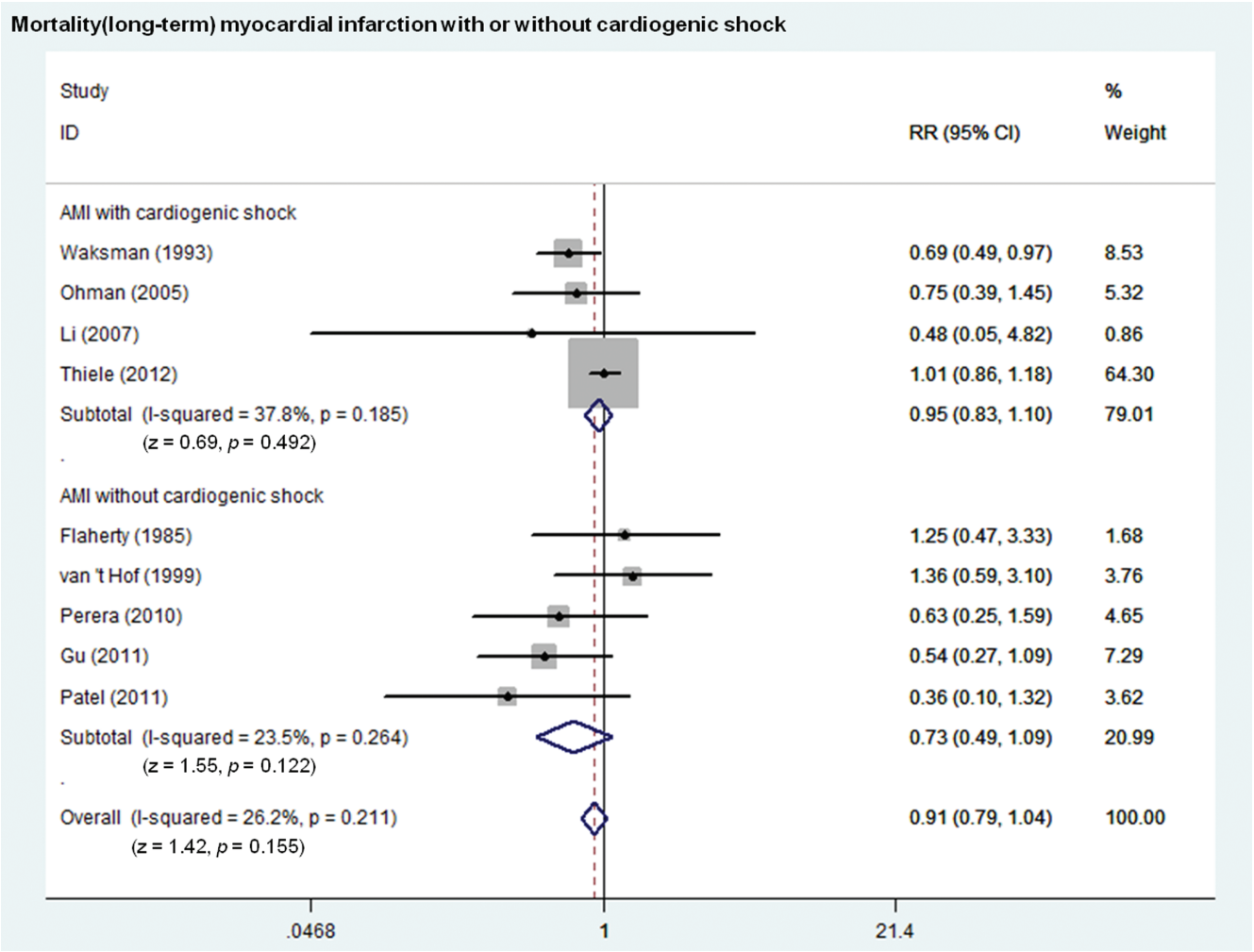
Meta-Analysis of Prospective RCT's for IABP in Shock: Short term mortality AMI and IABP



NO SIGNIFICANT REDUCTION IN SHORT OR LONG TERM MORTALITY FOR PATIENTS IN CARDIOGENIC SHOCK WITH IABP

Su et al (2015, Lancet)

Meta-Analysis of Prospective RCT's for IABP in Shock: Long term mortality AMI and IABP



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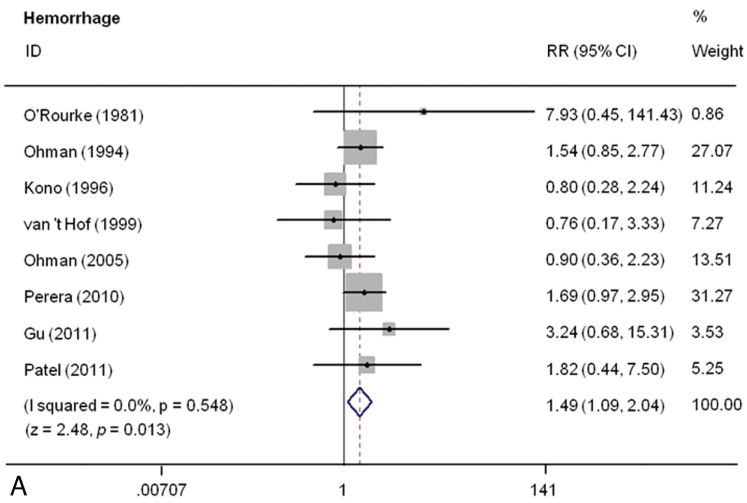

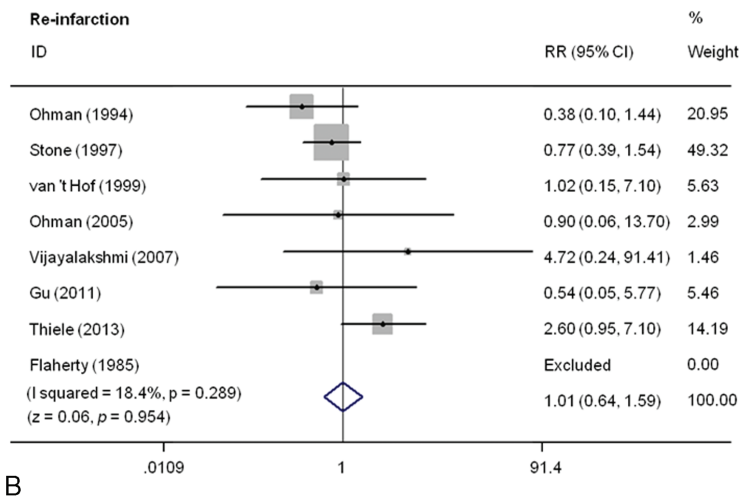

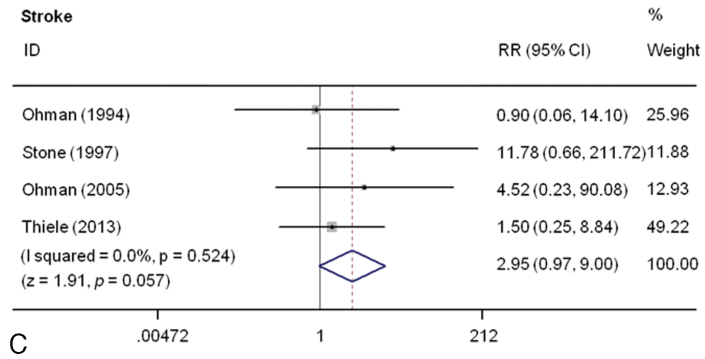

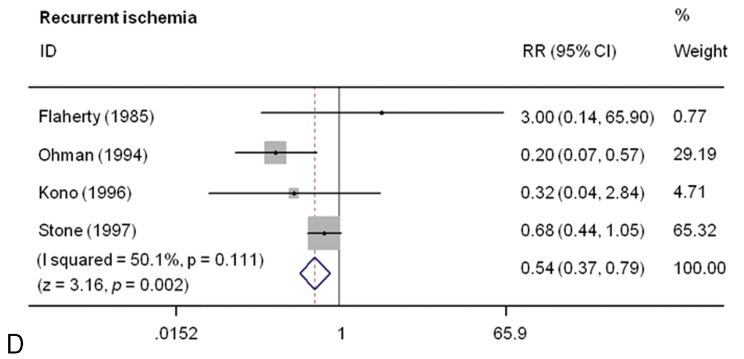

Su et al (2015, Lancet)

Linee Guida

Linee Guida ESC – STEMI 2012

Treatment of cardiogenic shock (Killip class IV)		
Oxygen/mechanical respiratory support is indicated according to blood gasses.	I	C
Urgent echocardiography/Doppler must be performed to detect mechanical complications, assess systolic function and loading conditions.	I	C
High-risk patients must be transferred early to tertiary centres.	I	C
Emergency revascularization with either PCI or CABG in suitable patients must be considered.	I	B
Fibrinolysis should be considered if revascularization is unavailable.	IIa	C
Intra-aortic balloon pumping may be considered.	IIb	B

LG ESC – Rivascolarizzazione 2014

(acute HF in the setting of ACS)

IABP insertion should be considered in patients with haemodynamic instability/cardiogenic shock due to mechanical complications.	IIa	C
Patients with mechanical complication after acute myocardial infarction require immediate discussion by the Heart Team.	I	C
Short-term mechanical circulatory support in ACS patients with cardiogenic shock may be considered.	IIb	C
Percutaneous repair of VSD may be considered after discussion by the Heart Team.	IIb	C
Routine use of IABP in patients with cardiogenic shock is not recommended.	III	A

LG ACC/AHA 2013

CLASS IIa

1. The use of intra-aortic balloon pump (IABP) counterpulsation can be useful for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy (455–459). (*Level of Evidence: B*)

Conclusioni