

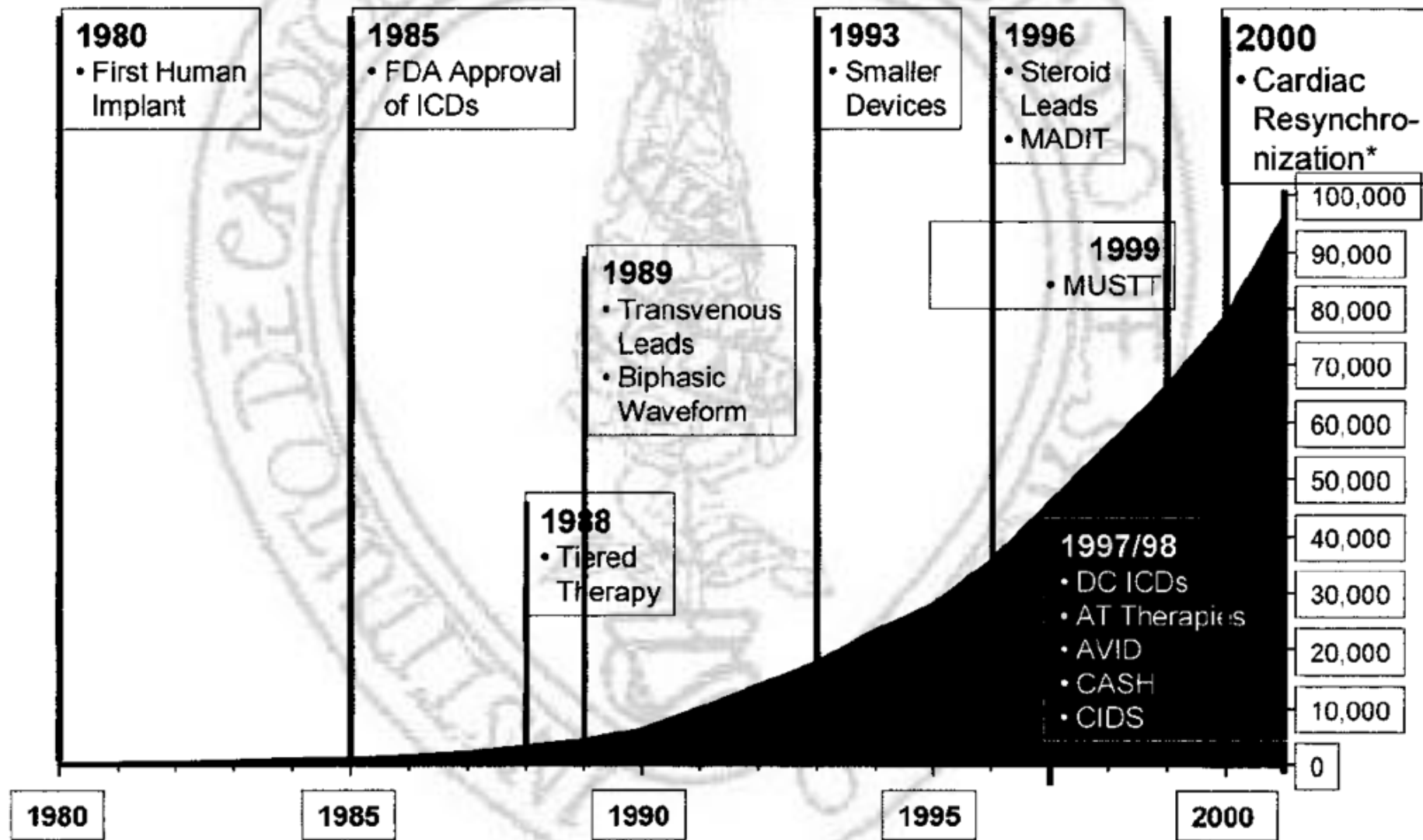
Aplicações do Eletrocardiograma de Alta Resolução e da Micro Alternância da onda T na prática cardiológica

Rogério Andalaft

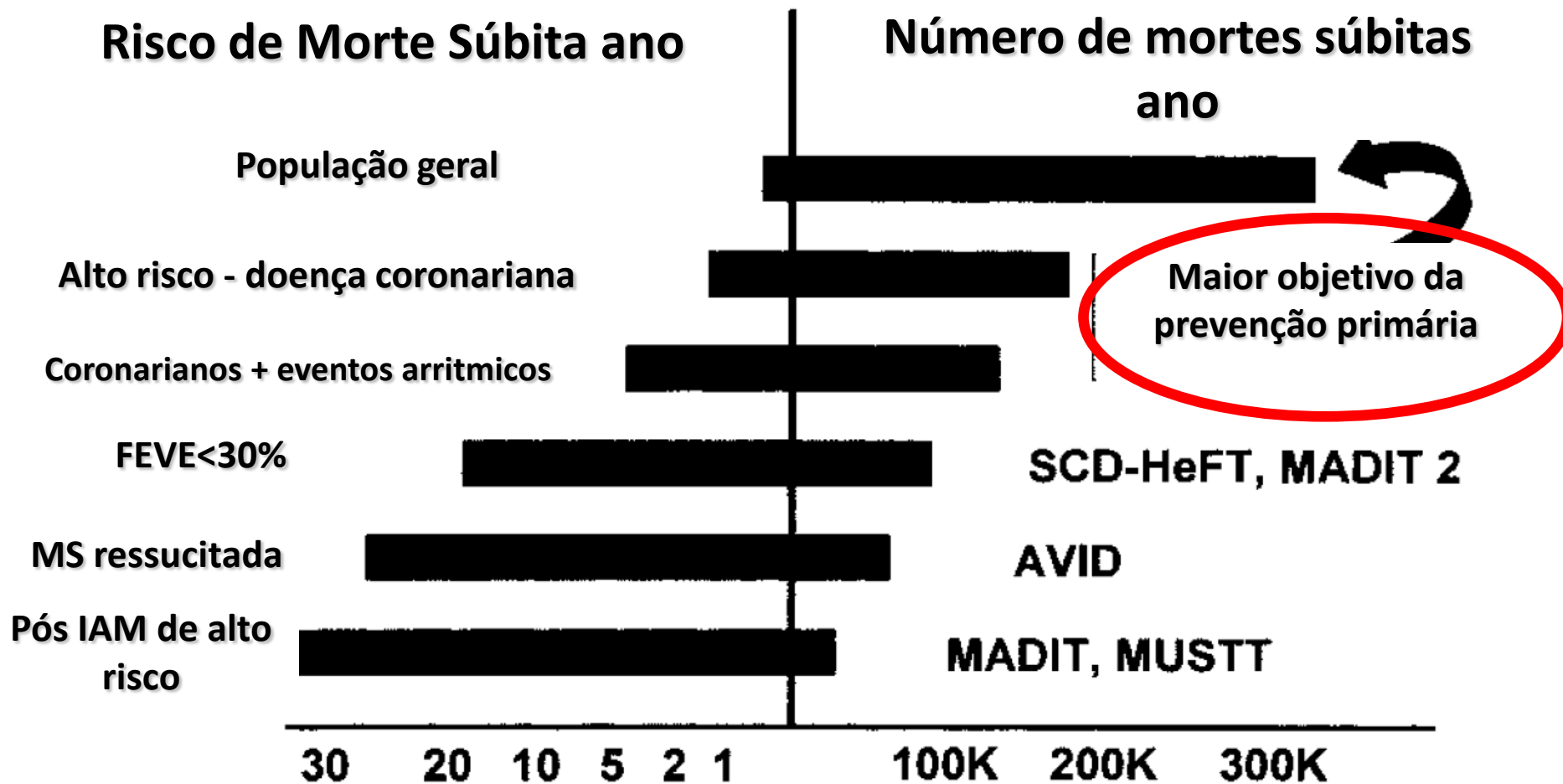


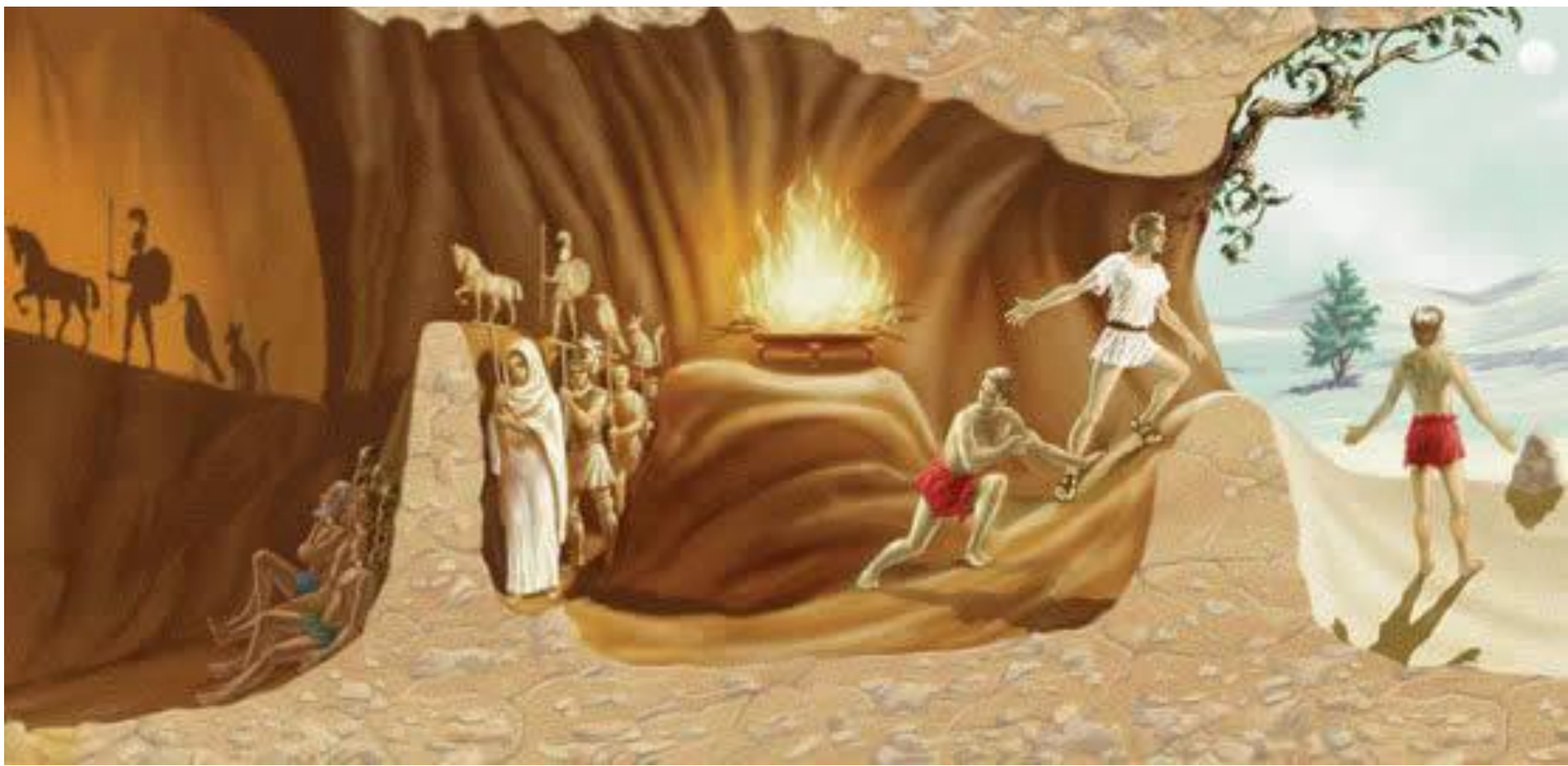
Seção Médica de Eletrofisiologia Clínica e Arritmias Cardíacas
Instituto Dante Pazzanese de Cardiologia

Evolução da Indicação de CDI na população USA

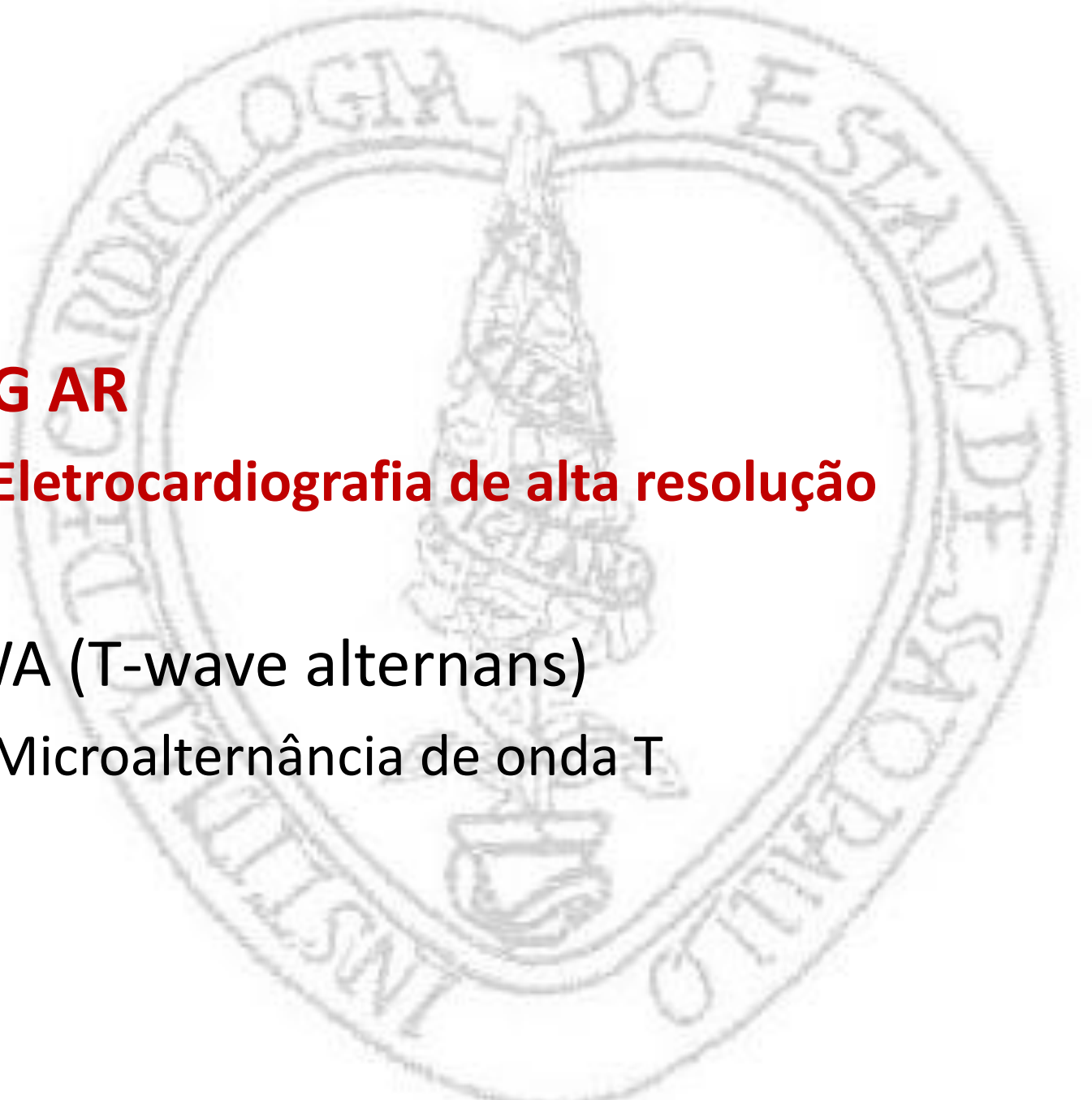


Morte cardíaca súbita

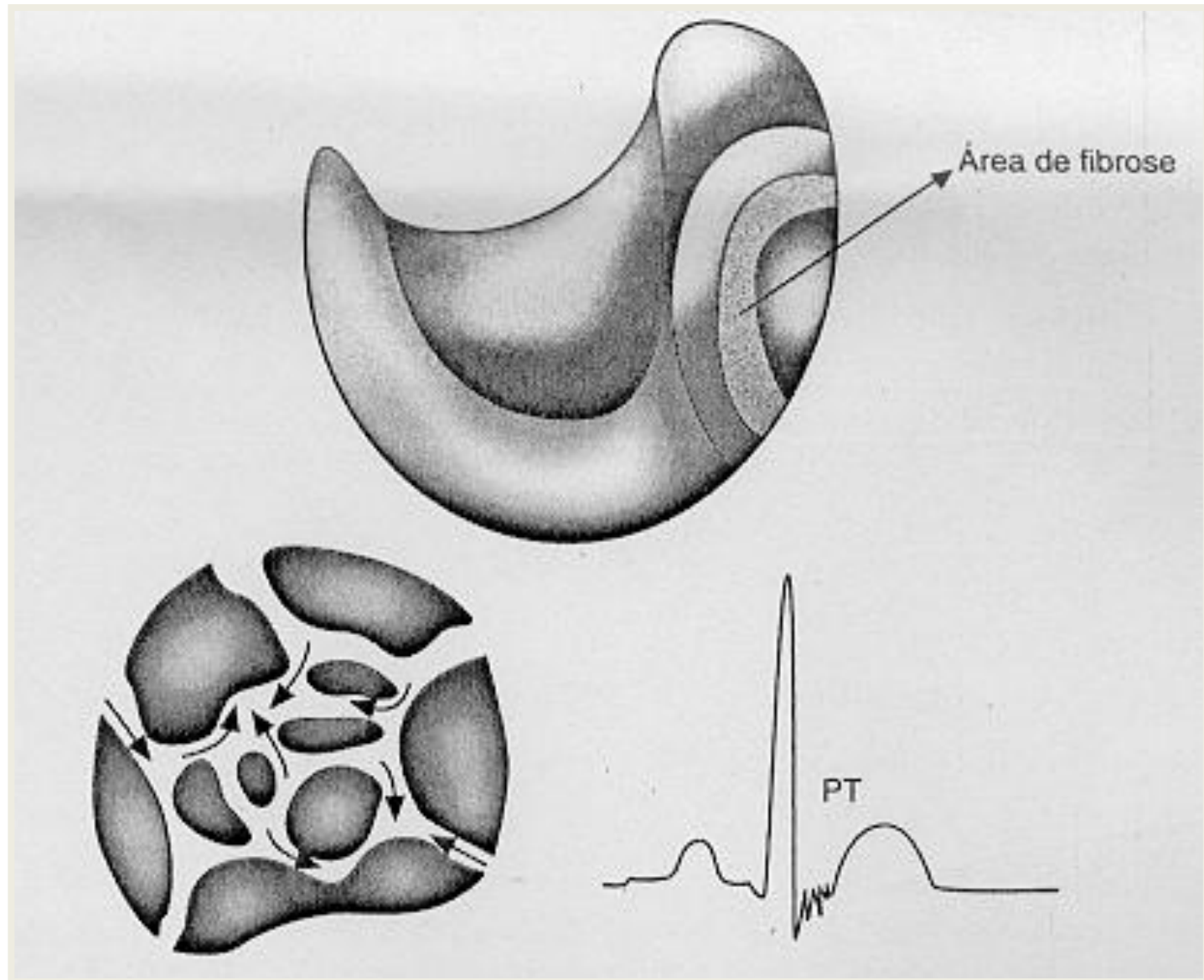




- 
- ECG AR
 - Eletrocardiografia de alta resolução
 - TWA (T-wave alternans)
 - Microalternância de onda T

- 
- **ECG AR**
 - Eletrocardiografia de alta resolução
 - TWA (T-wave alternans)
 - Microalternância de onda T

Áreas de Fibrose Entremeadas com Tecido Sadio



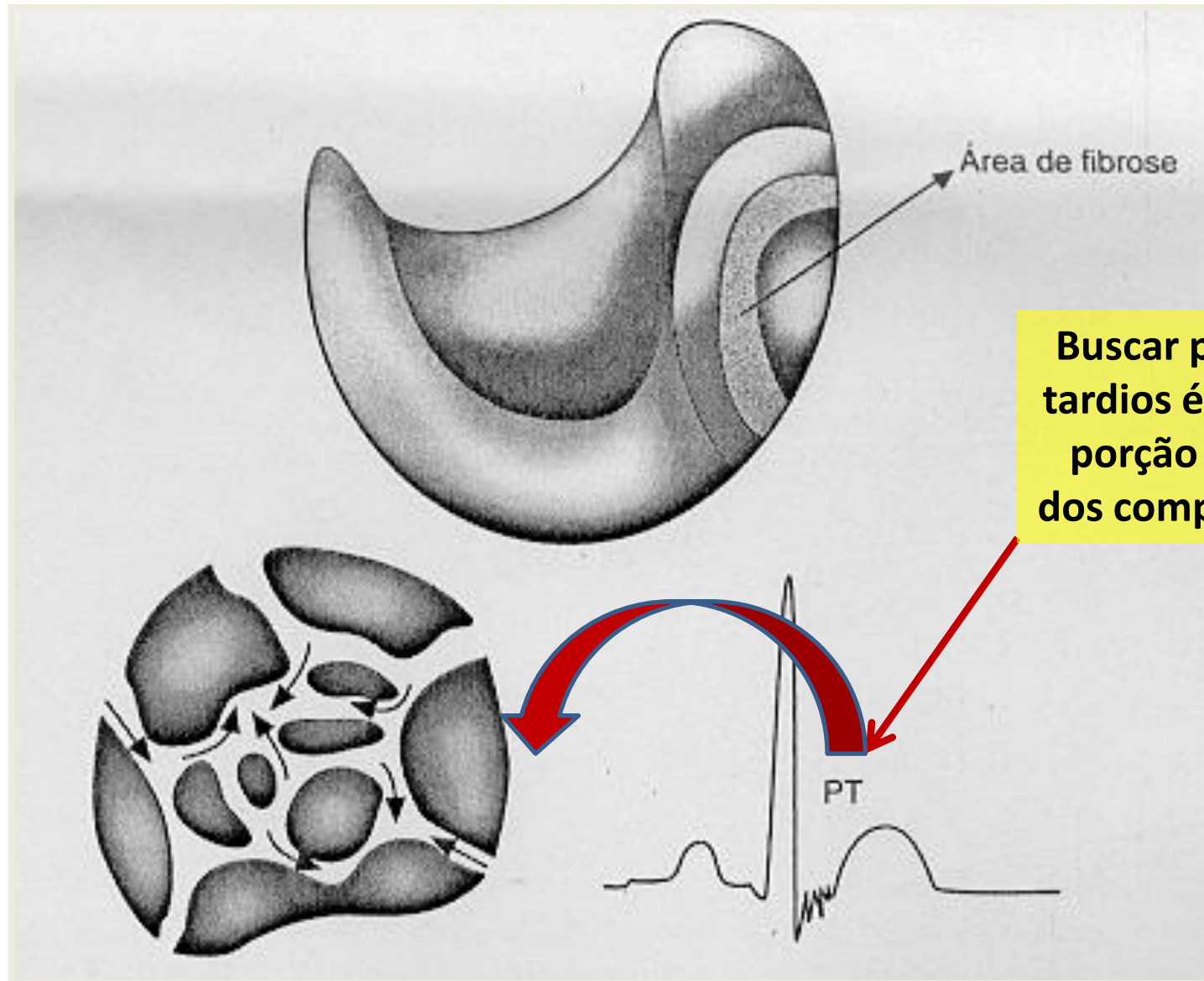
Aplicações do ECG-AR

- Auxiliar na Estratificação de risco pós IAM
- Auxiliar diagnóstico na Displasia arritmofênica de Ventrículo direito

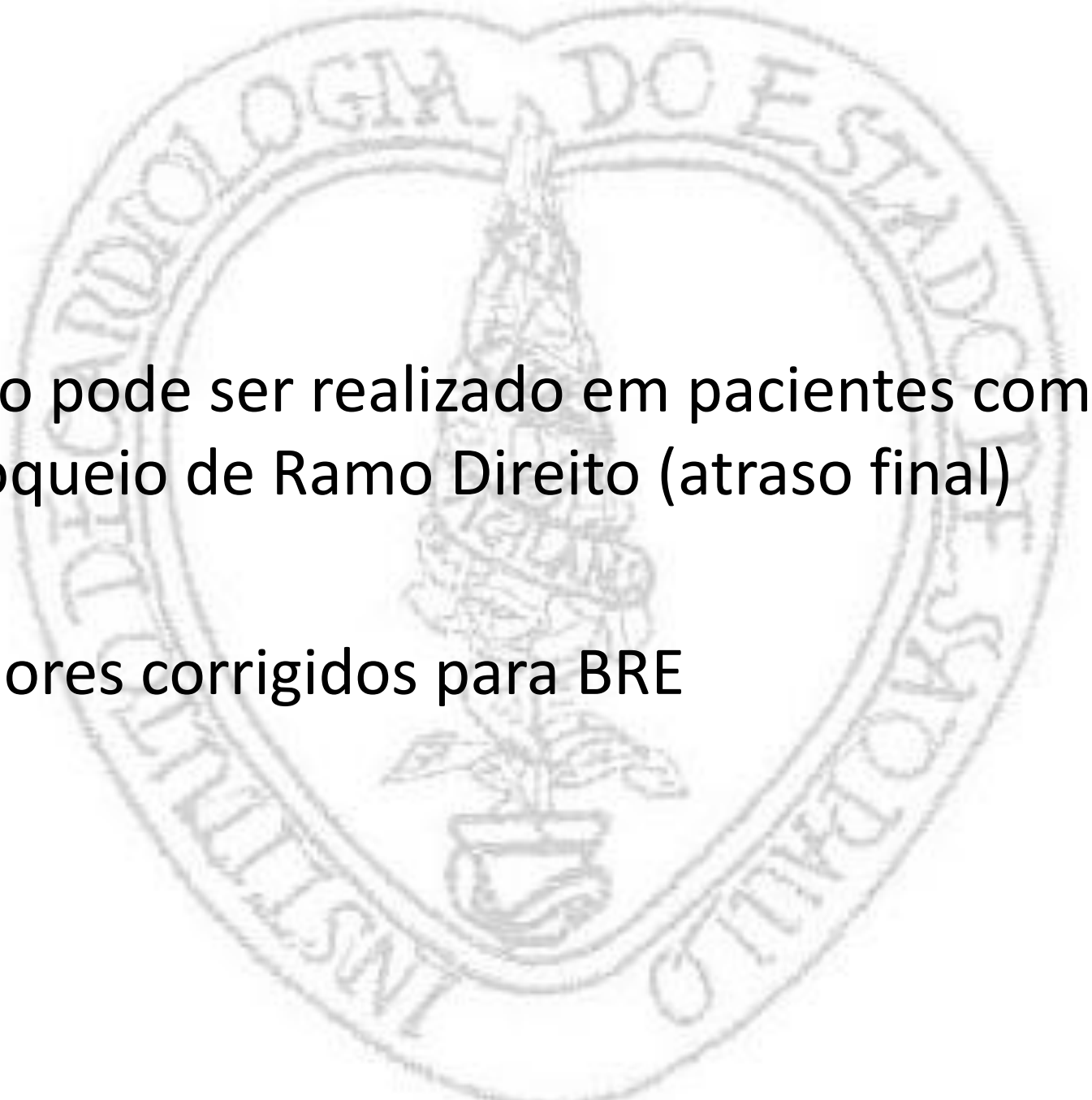
Três características para os complexos QRS normais

- Terminam rapidamente
- Terminam com potenciais de alta voltagem
- Tem poucos potenciais de baixa voltagem colaborando na sua formação

Áreas de Fibrose Entremeadas com Tecido Sadio



Buscar potenciais tardios é analisar a porção terminal dos complexos QRS

- 
- Não pode ser realizado em pacientes com Bloqueio de Ramo Direito (atraso final)
 - Valores corrigidos para BRE

Valores de normalidade

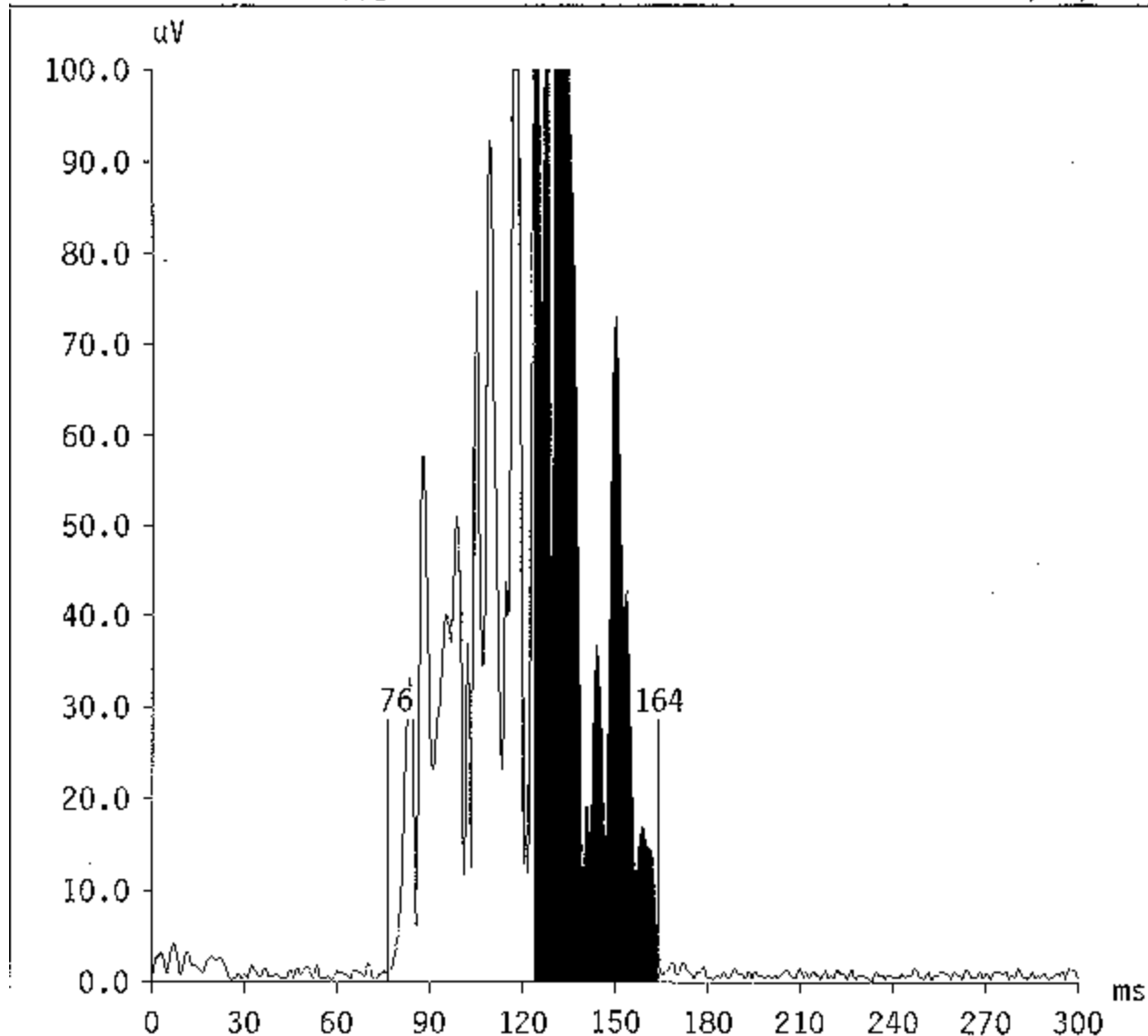
- Duração QRS < 114 ms
- RMS > 20 μ V (**R**oot **M**ean **S**quare)
- LAS < 38 ms (**L**ow **A**mplitude **S**ignal)

PREDICTOR Version 6.1

SAECG ANALYSIS

Date: 05/06/02

VECTOR



HAS.004

1/14/02 10:45a

Proto: BASIC

Type: BiSpec

Hi freq: 40

Total QRS

Dur: 87.5

RMS: 61.32

INT: 4.29

Terminal QRS

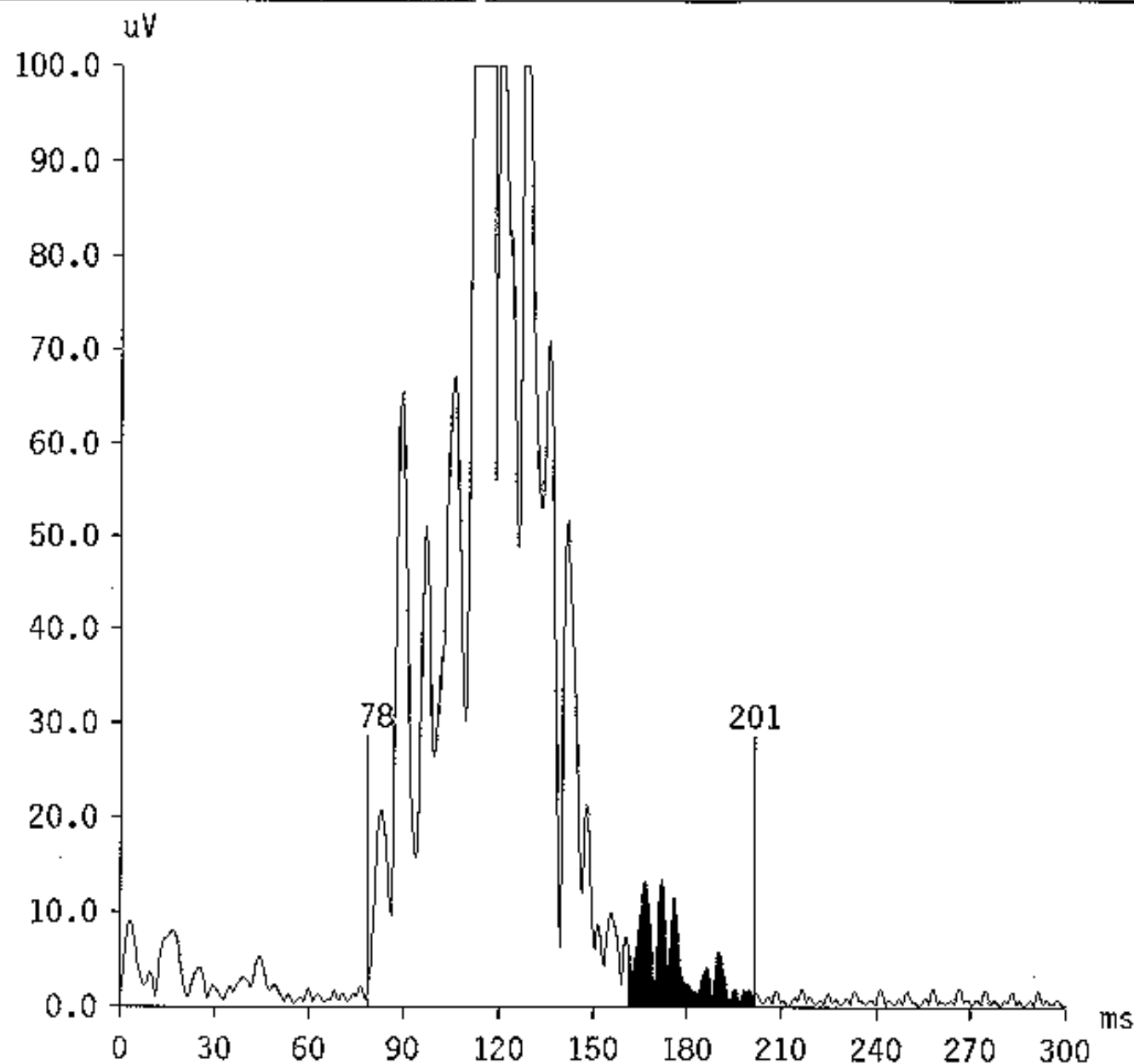
RMS: 73.93

MN: 57.34

LAS: 10.0

iQRSD: 87.5

Scale: 10.0



Proto: BASIC

Type: BiSpec

Hi freq: 40

Total QRS

Dur: 123.0

RMS: 73.19

INT: 5.09

Terminal QRS

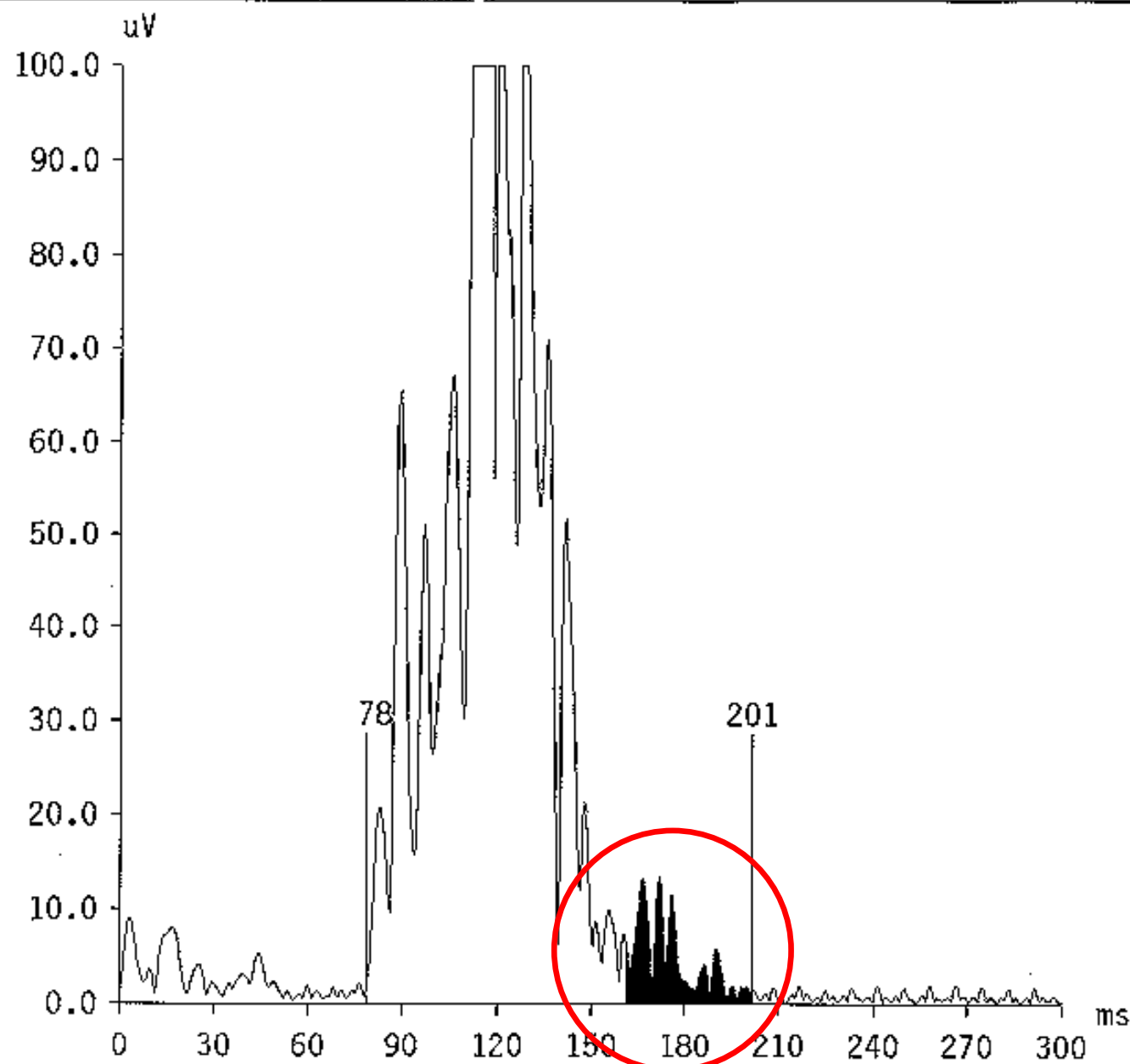
RMS: 5.30

MN: 4.22

LAS: 58.0

iQRSD: 123.0

Scale: 10.0



Proto: BASIC

Type: BiSpec

Hi freq: 40

Total QRS

Dur: 123.0

RMS: 73.19

INT: 5.09

Terminal QRS

RMS: 5.30

MN: 4.22

LAS: 58.0

iQRSD: 123.0

Scale: 10.0

STM
ANALYSIS

HAS.S04

1/11/02 11:18a

Proto: STMBASIC

 $\mu V^2/Hz$

5190.5

2595.2

0.0

216

166

116

ms

0

150 Hz

300

Prep: None

Lead: SUM

Scale: 192.7

PREDICTOR v6.0

SPECTRO-TEMPORAL MAPPING

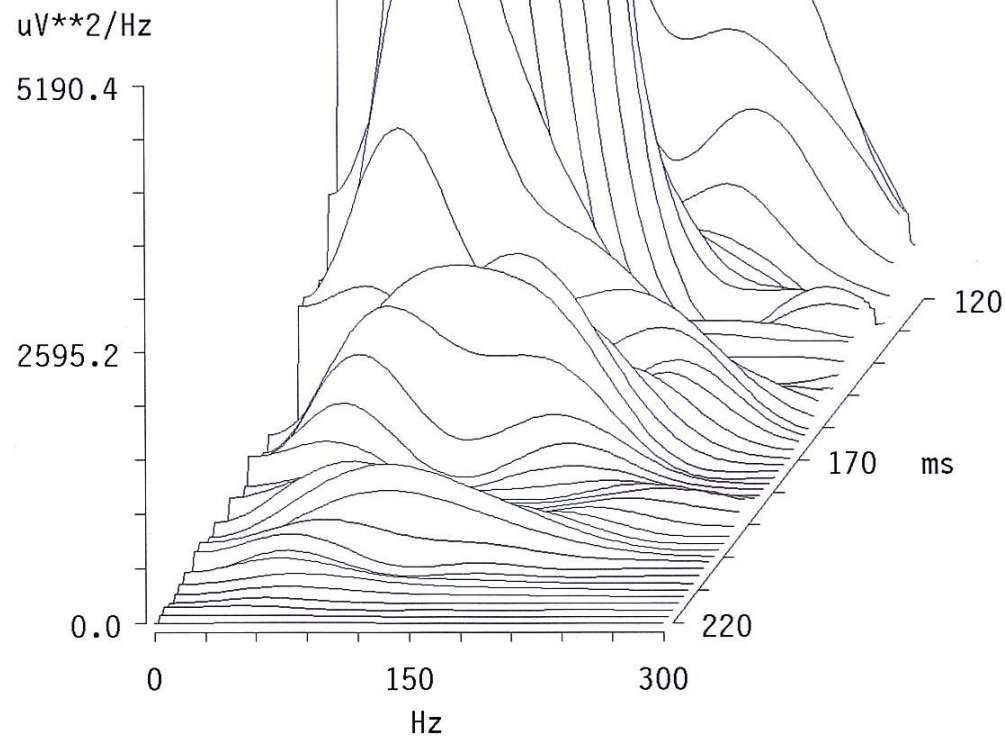
Date: 02/18/02

STM
ANALYSIS

MIOCA.S13

2/18/02 1:06p

Proto: STMBASIC



Prep: None

Lead: SUM

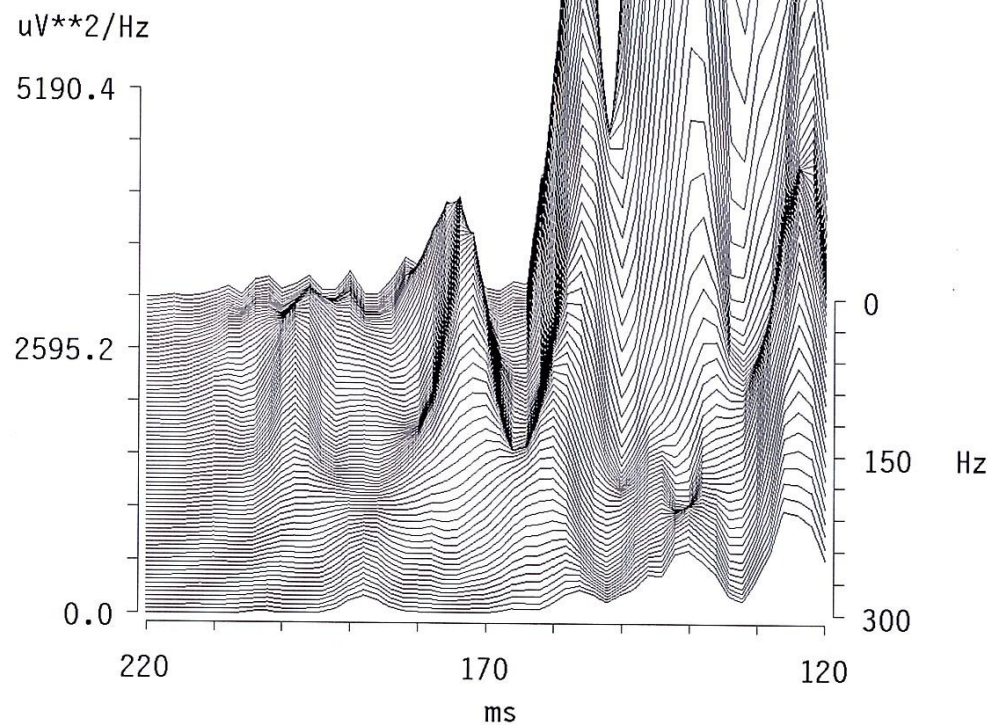
Scale: 192.7

STM
ANALYSIS

MIOCA.S13

2/18/02 1:06p

Proto: STMBASIC



Prep: None

Lead: SUM

Scale: 192.7

STM

ANALYSIS

MIOCA.S13

2/18/02 1:06p

Proto: STMBASIC

$\mu V^2/Hz$

5190.4

2595.2

0.0

0

150

300

Hz

120

170

220

ms

Prep:

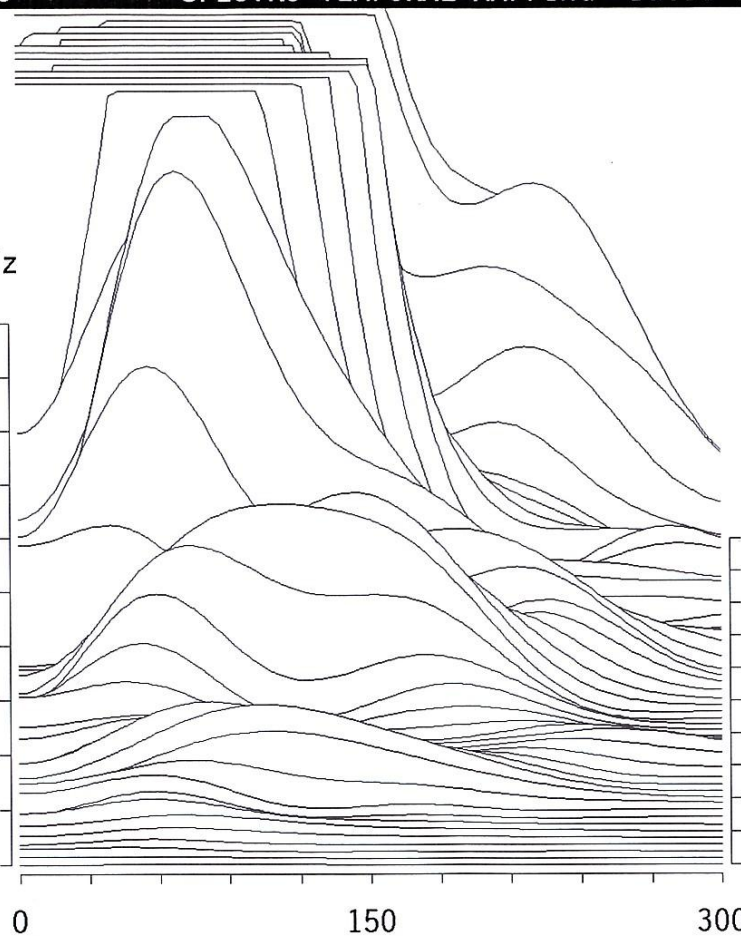
None

Lead:

SUM

Scale:

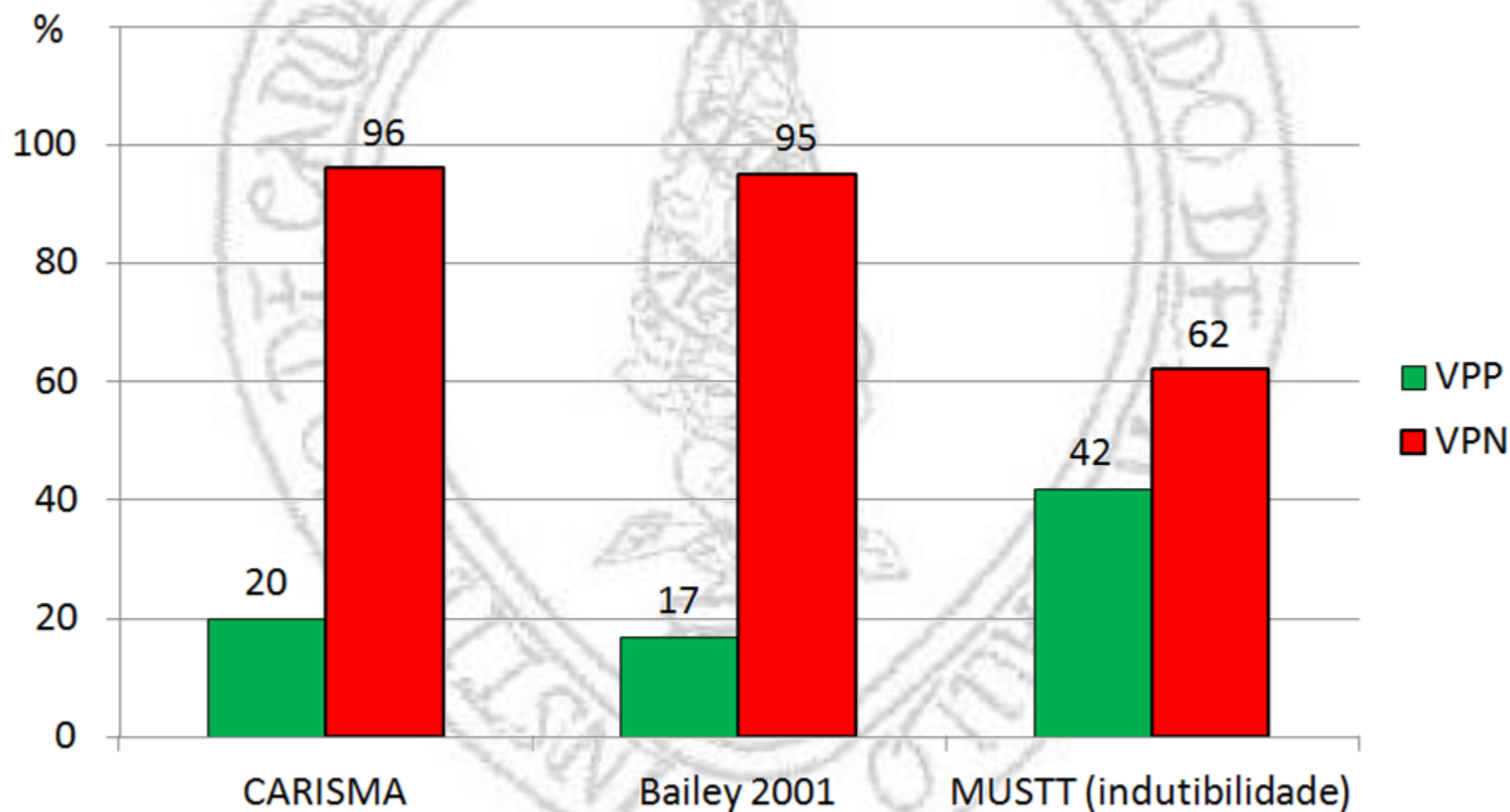
192.7



Aplicações do ECG-AR

- **Auxiliar na Estratificação de risco pós IAM**
- Auxiliar diagnóstico na Displasia arritmofênica de Ventrículo direito

Valores Preditivos do ECG em coronarianos e dilatados

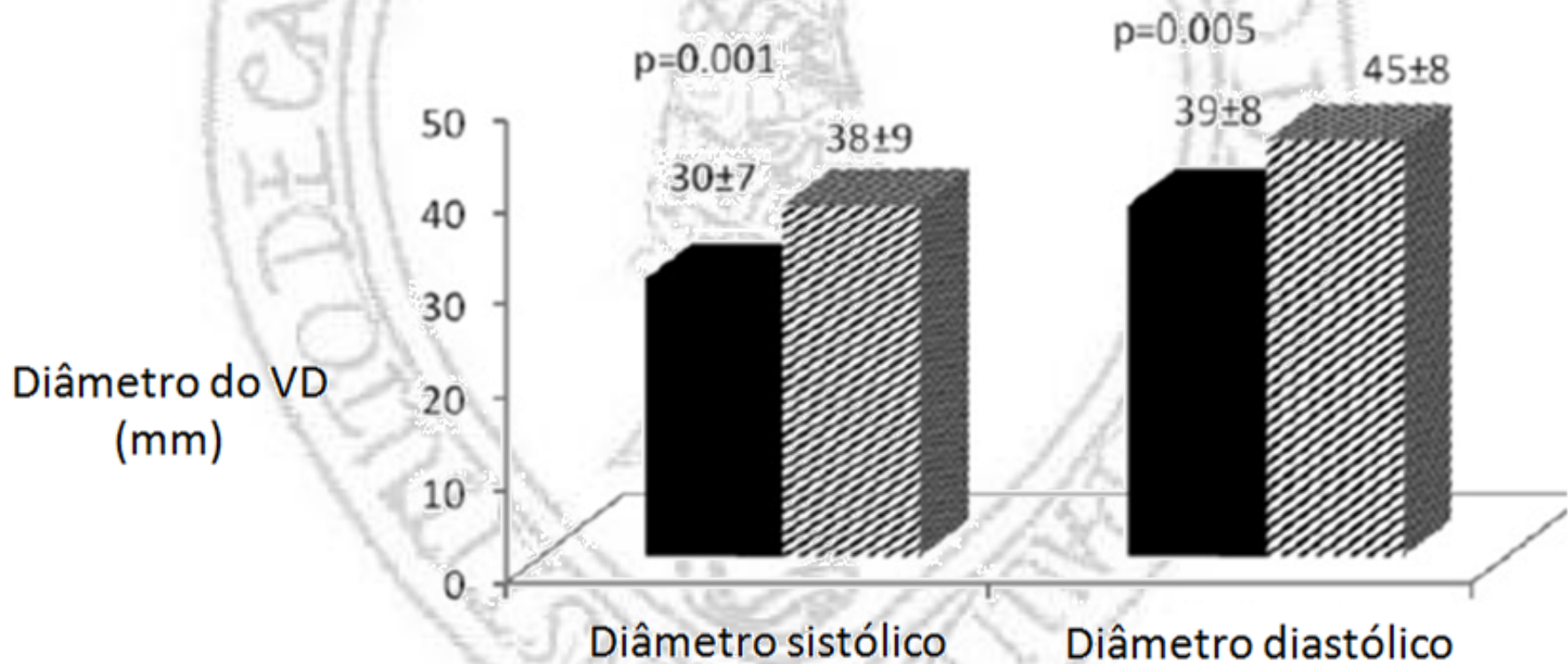


Aplicações do ECG-AR

- Auxiliar na Estratificação de risco pós IAM
- **Auxiliar diagnóstico na Displasia arritmofênica de Ventrículo direito**
 - **Critério menor**

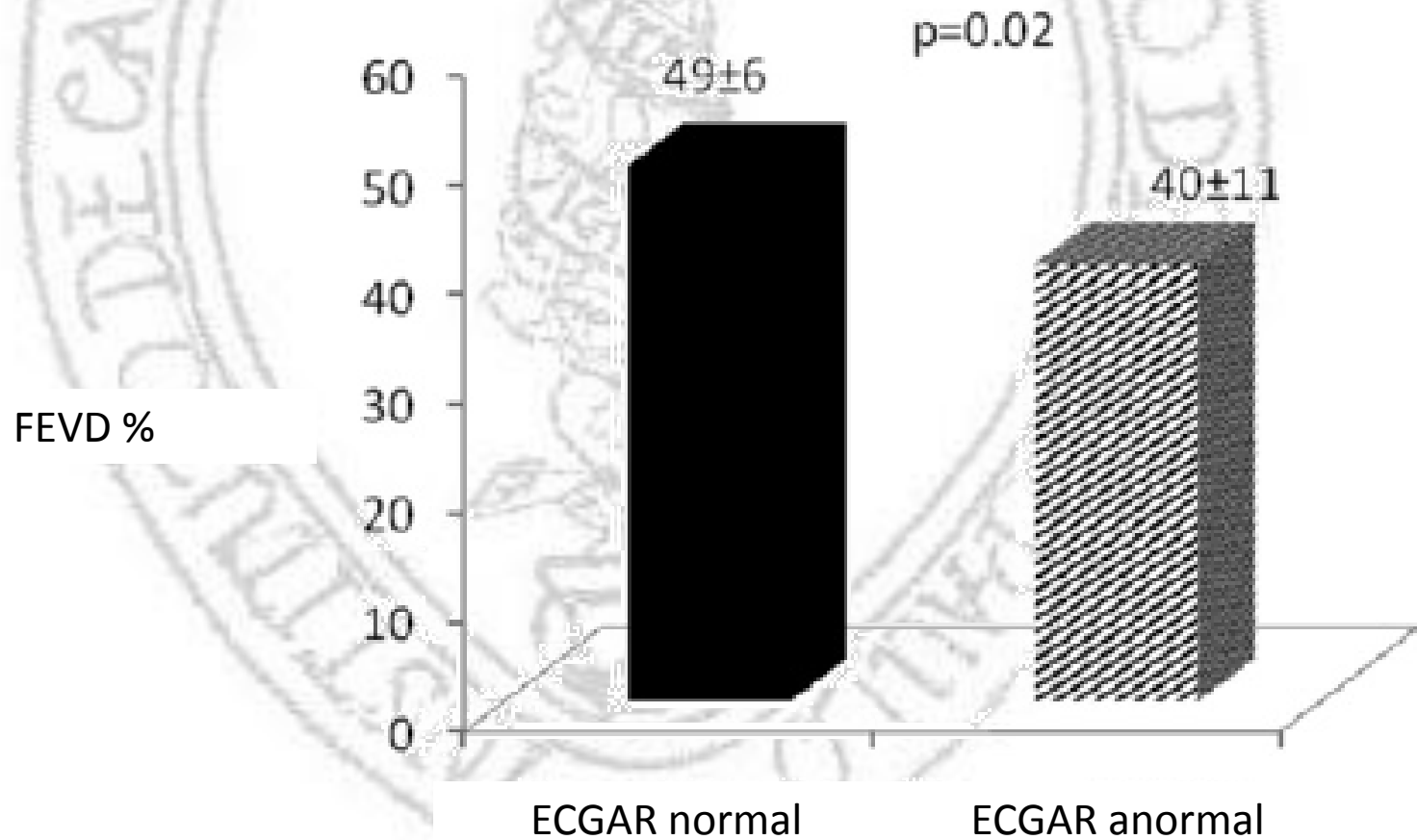
Value of the signal-averaged electrocardiogram in arrhythmogenic right ventricular cardiomyopathy/dysplasia

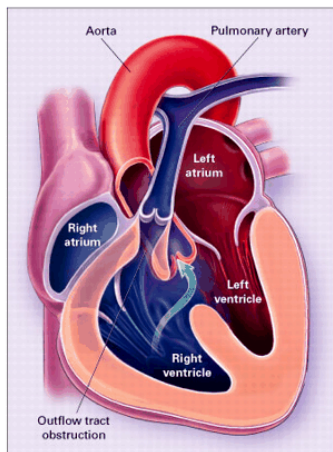
Ganesh S. Kamath, MD, MPH,* Wojciech Zareba, MD, PhD,[†] Jessica Delaney, MD,*
Jayanthi N. Koneru, MD,* William McKenna, MD,[‡] Kathleen Gear, RN,[§] Slava Polonsky, MS,[†]
Duane Sherrill, PhD,^{||} David Bluemke, MD, PhD,[¶] Frank Marcus, MD,[§] Jonathan S. Steinberg, MD, FHRS*



Value of the signal-averaged electrocardiogram in arrhythmogenic right ventricular cardiomyopathy/dysplasia

Ganesh S. Kamath, MD, MPH,^{*} Wojciech Zareba, MD, PhD,[†] Jessica Delaney, MD,^{*} Jayanthi N. Koneru, MD,^{*} William McKenna, MD,[‡] Kathleen Gear, RN,[§] Slava Polonsky, MS,[†] Duane Sherrill, PhD,^{||} David Bluemke, MD, PhD,[¶] Frank Marcus, MD,[§] Jonathan S. Steinberg, MD, FHRS^{*}

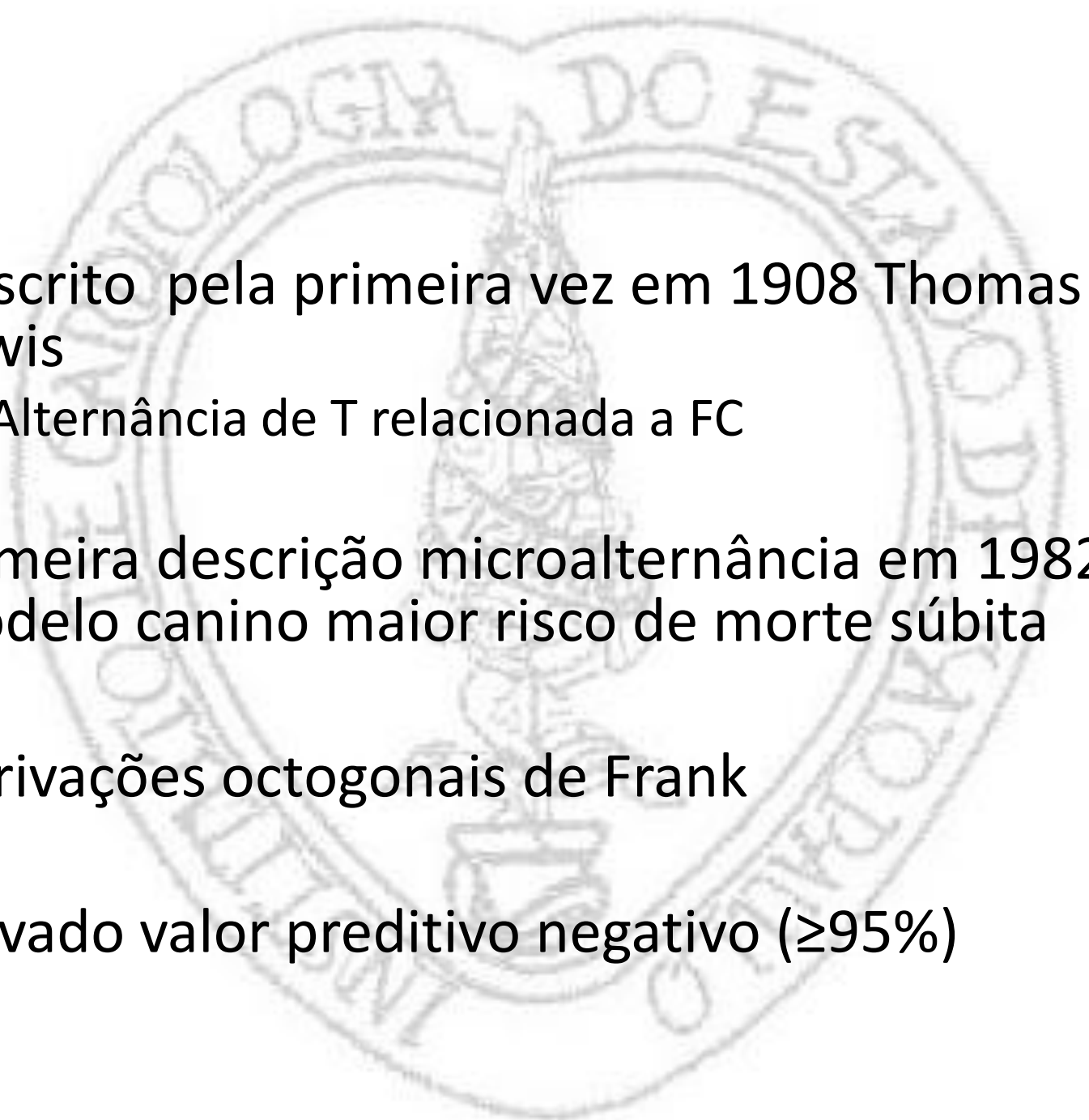




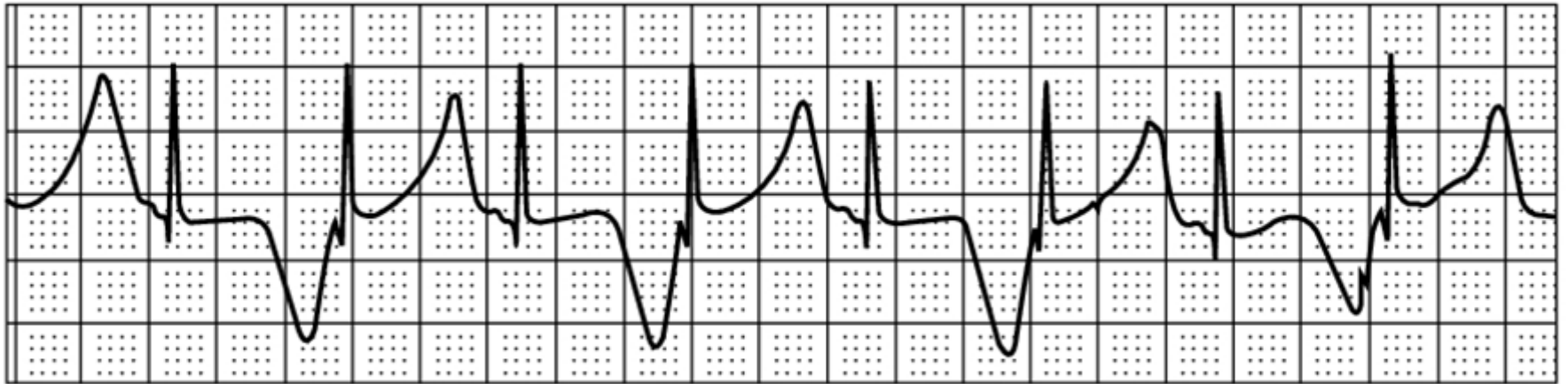
Parâmetros a serem analisados no ECG-AR e cut off utilizados

	Sensibilidade %	Especificidade %	Valor preditivo Positivo %	Valor preditivo Negativo %
QRS $\geq$ 148ms	80	54	28	92
LAS $\geq$ 32,5 ms	100	72	45	100
RMS $\leq$ 23,0 μV	100	72	45	100
Relação VD/VE >1	100	68	41	100

- 
- ECG AR
 - Eletrocardiografia de alta resolução
 - **TWA (T-wave alternans)**
 - **Microalternância de onda T**

- 
- Descrito pela primeira vez em 1908 Thomas Lewis
 - Alternância de T relacionada a FC
 - Primeira descrição microalternância em 1982 em modelo canino maior risco de morte súbita
 - Derivações octogonais de Frank
 - Elevado valor preditivo negativo ($\geq 95\%$)

Macroalternância de onda T



Plano Horizontal (PH)

The diagram illustrates the Horizontal Plane (PH) with a top-down view of a head. A vertical line represents the midline, with 'Posterior' at the top and 'Anterior' at the bottom. A horizontal line represents the transverse plane, with 'Direita' (Right) on the left and 'Esquerda' (Left) on the right. Angles are marked: 180° on the left, 0° on the right, and 90° at the bottom. A blue 'X' is placed at the 0° position. A blue 'Z' is placed below the 'Anterior' label. A small sketch of a head is shown in the bottom right corner.

Posterior

180°

Direita

0°

Esquerda

180°

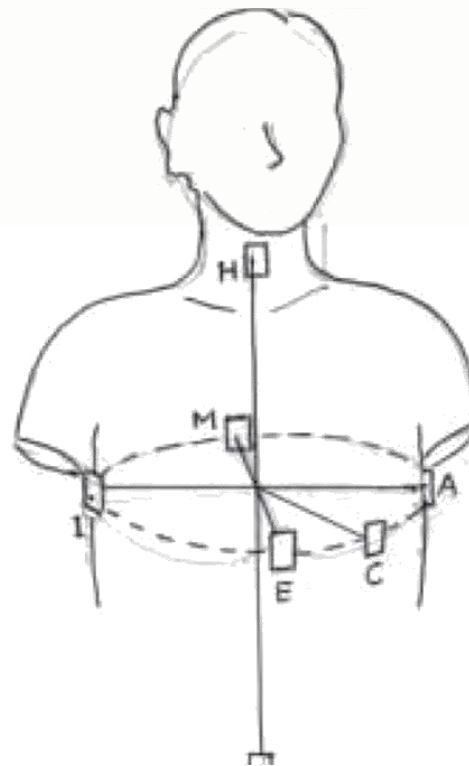
90°

Anterior

Z

Plano Frontal (PF)

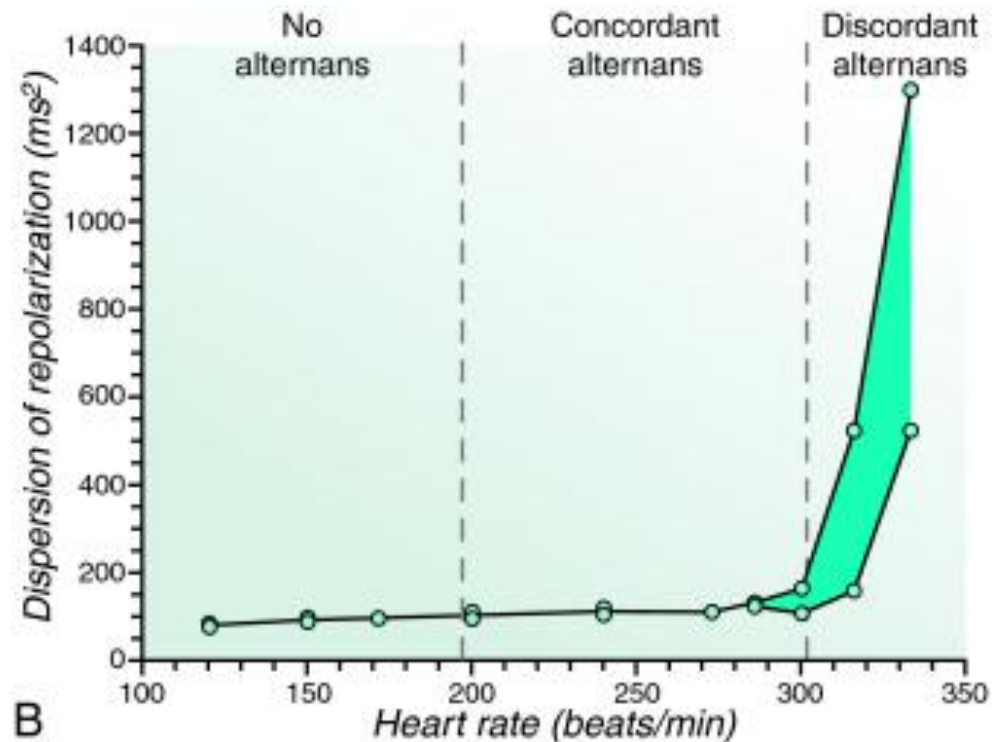
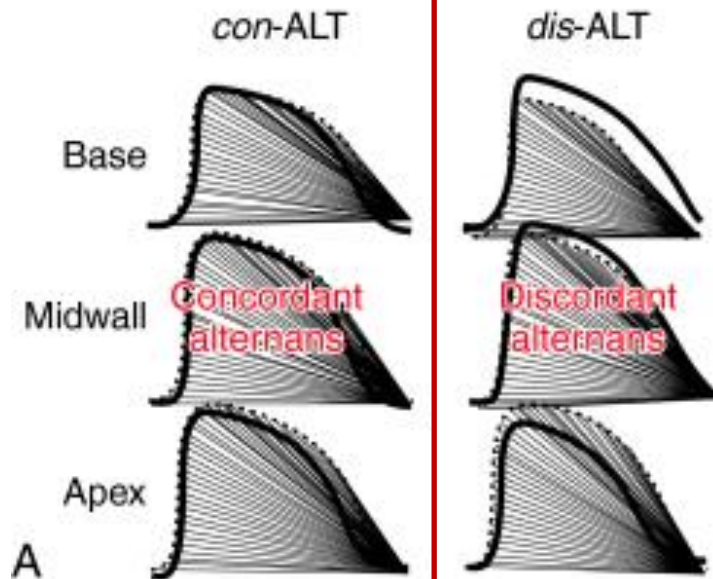
The diagram illustrates the Frontal Plane (PF) with a vertical line and a horizontal line intersecting at the center. The vertical line is labeled 'Superior' at the top and 'Inferior' at the bottom, with a '90°' angle marked at the intersection. The horizontal line is labeled 'Direita' (Right) on the left and 'Esquerda' (Left) on the right, with '180°' and '0°' angles marked at the ends. A blue 'X' is placed at the right end of the horizontal line, and a blue 'Y' is placed at the bottom of the vertical line.



Aumento da FC aumenta a discordância entre os potenciais

Potenciais concordantes

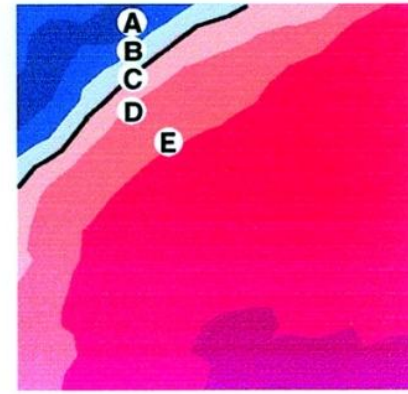
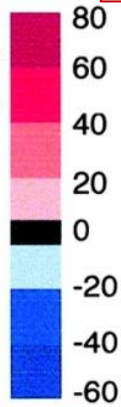
Potenciais discordantes



Concordante

Discordante

LOCAL REPOLARIZATION
ALTERNANS (ms)



A



B



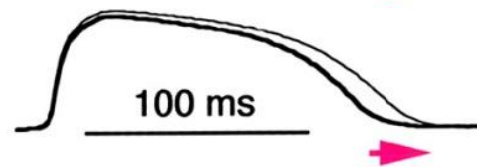
C



D

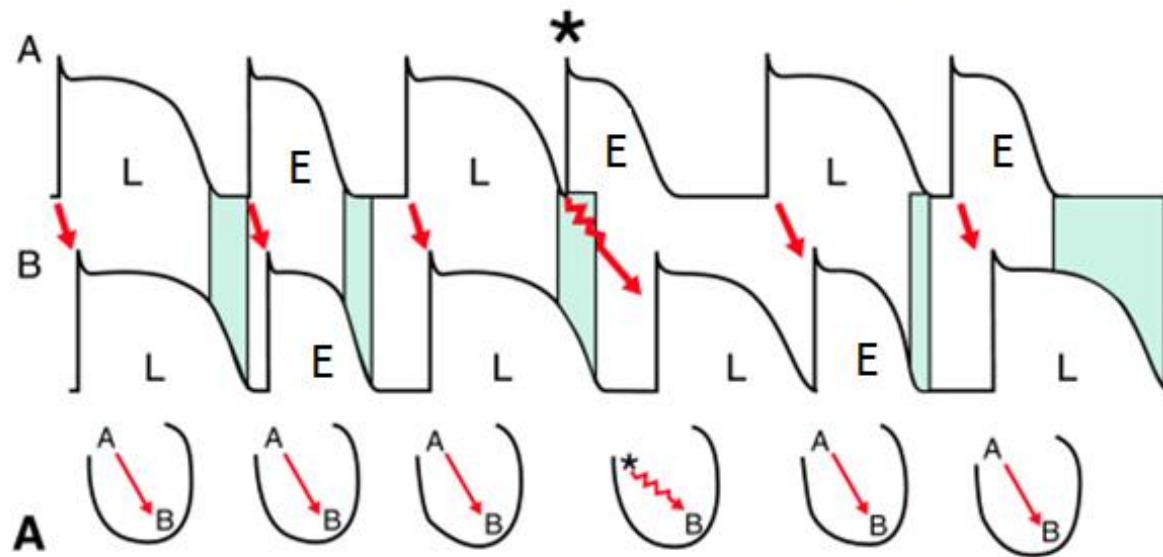


E



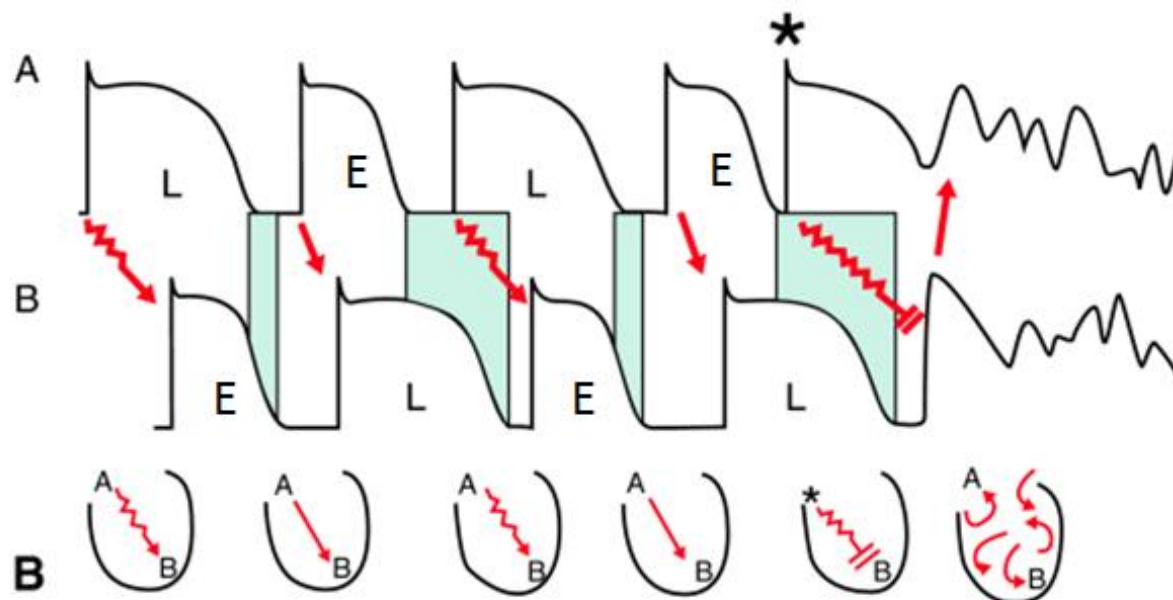
Concordante

Discordante



Discordante

FV →



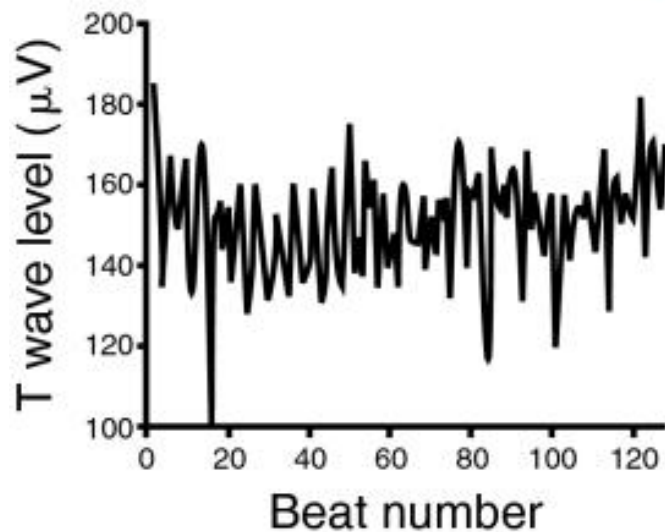
- Métodos para elevar a FC

- Estimulação atrial
- Bicicleta
- Inclinação

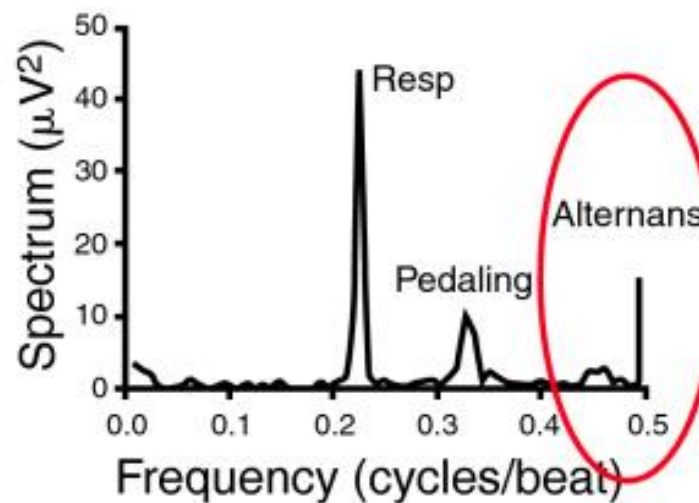
- Limitações

- Dificuldade de subir a FC acima 105
- 25% de casos indeterminados
- Ação medicamentos (betabloqueadores e amiodarona)
- Grande densidade de ectopias atriais e ventriculares

ECG (128 beats)



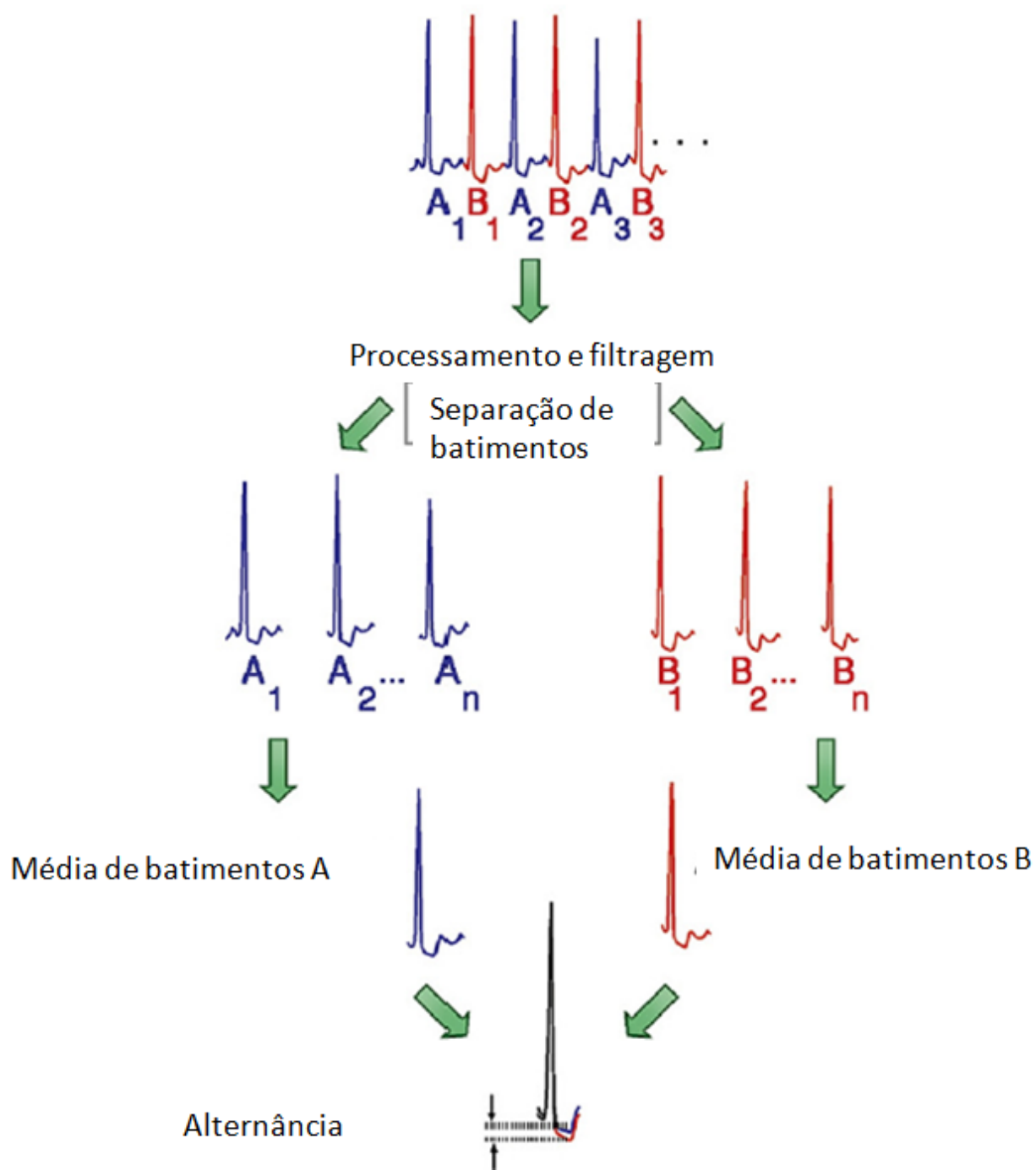
Time series



Spectrum

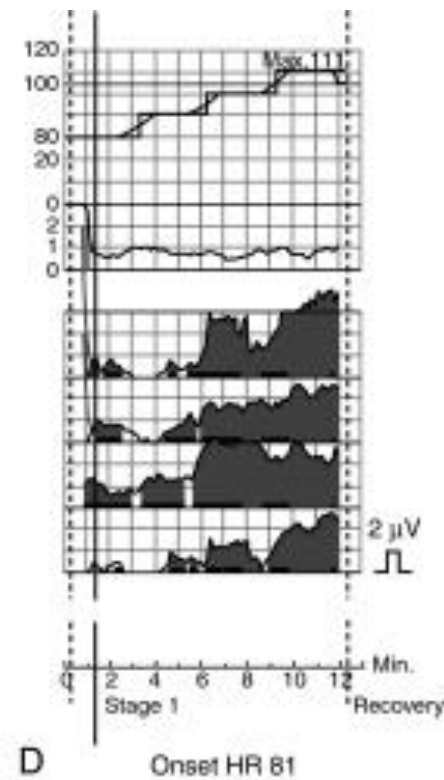
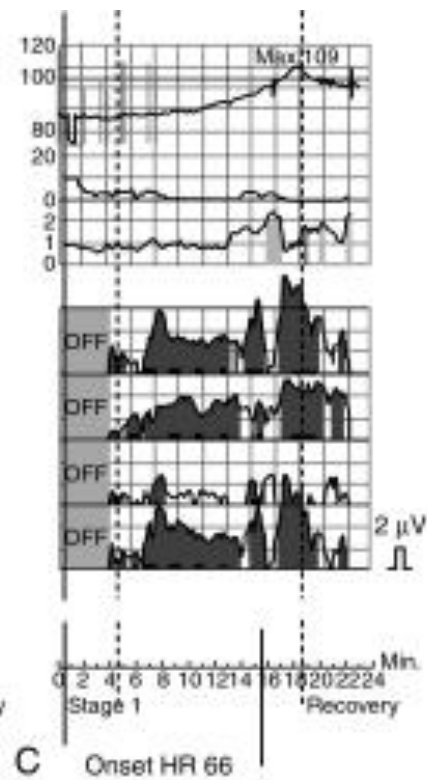
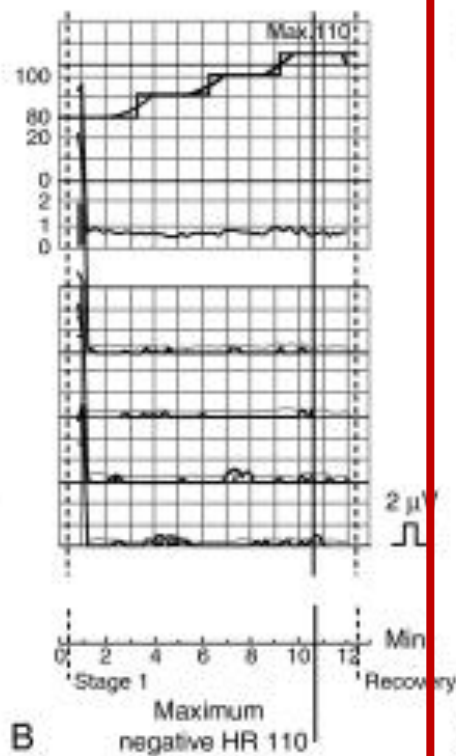
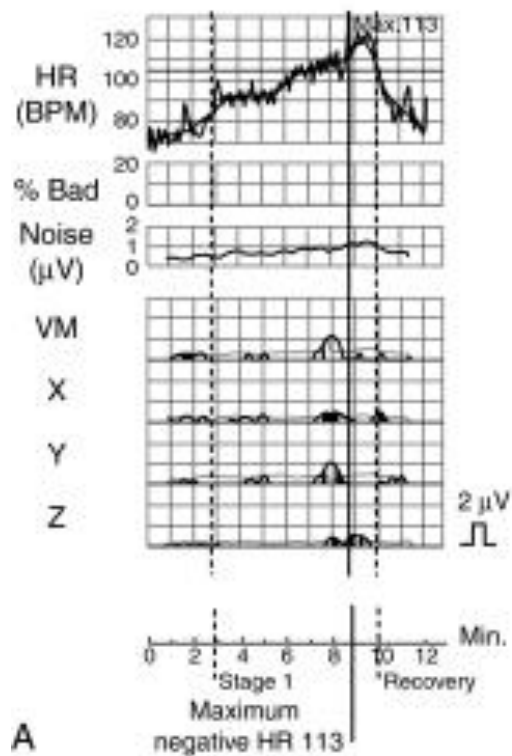


Modified Moving Average



Negativo

Positivo



Esforço

Pace atrial

Esforço

Pace atrial

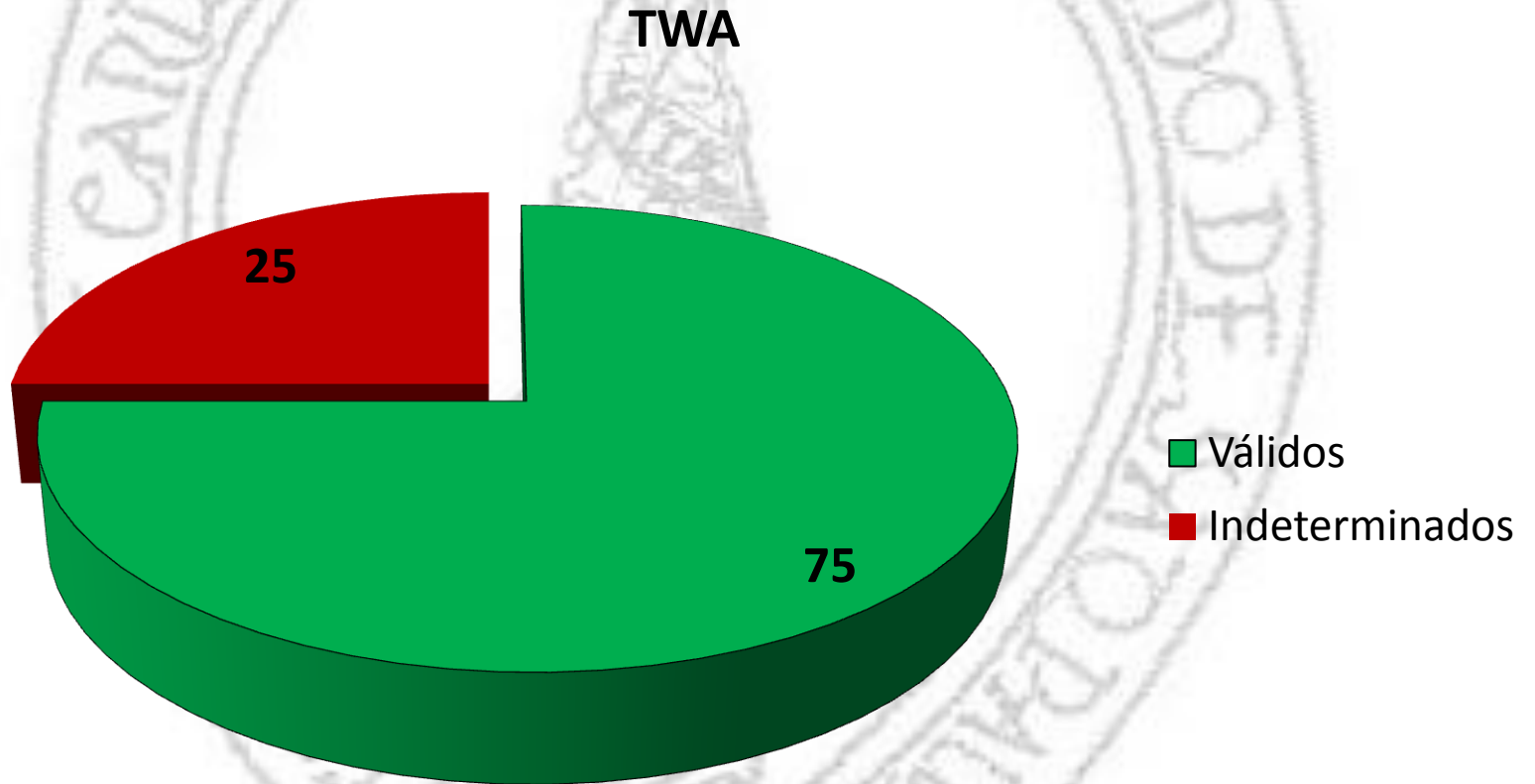
Outras limitações

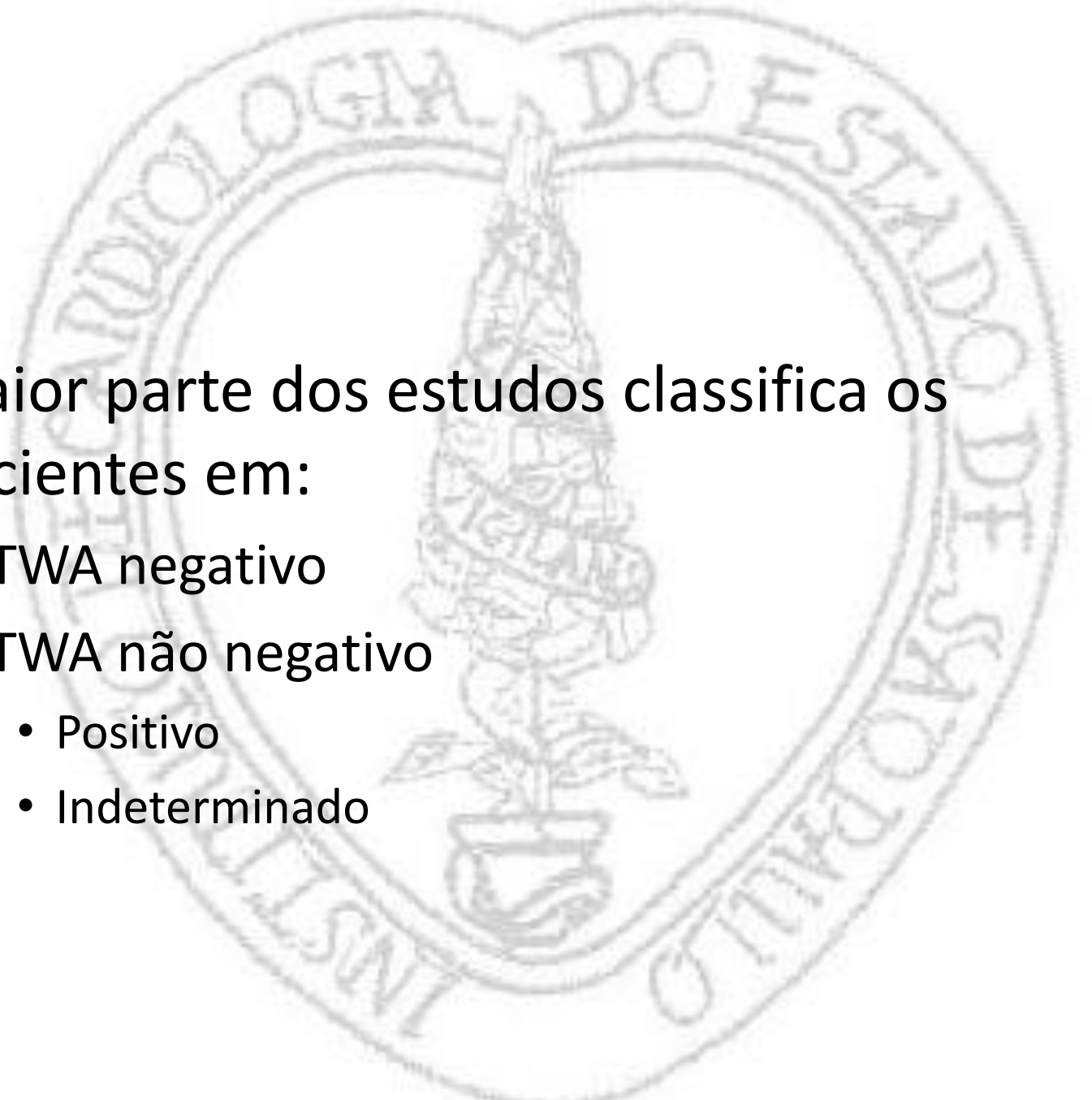
- FR deve estar inferior a 30 ipm para FC 120 bpm ou seja 0,25 por ciclo
- Ausência de arritmia sinusal maior que 30 bpm de irregularização

Classificação

- **Positivo:**
 - Alternância que inicia com $FC \leq 110$ bpm
 - Alternância sustentada
 - Presente em toda a gravação independente da FC
- **Negativo:**
 - Atinge $FC \geq 105$ bpm sem alternância
- **Indeterminado**

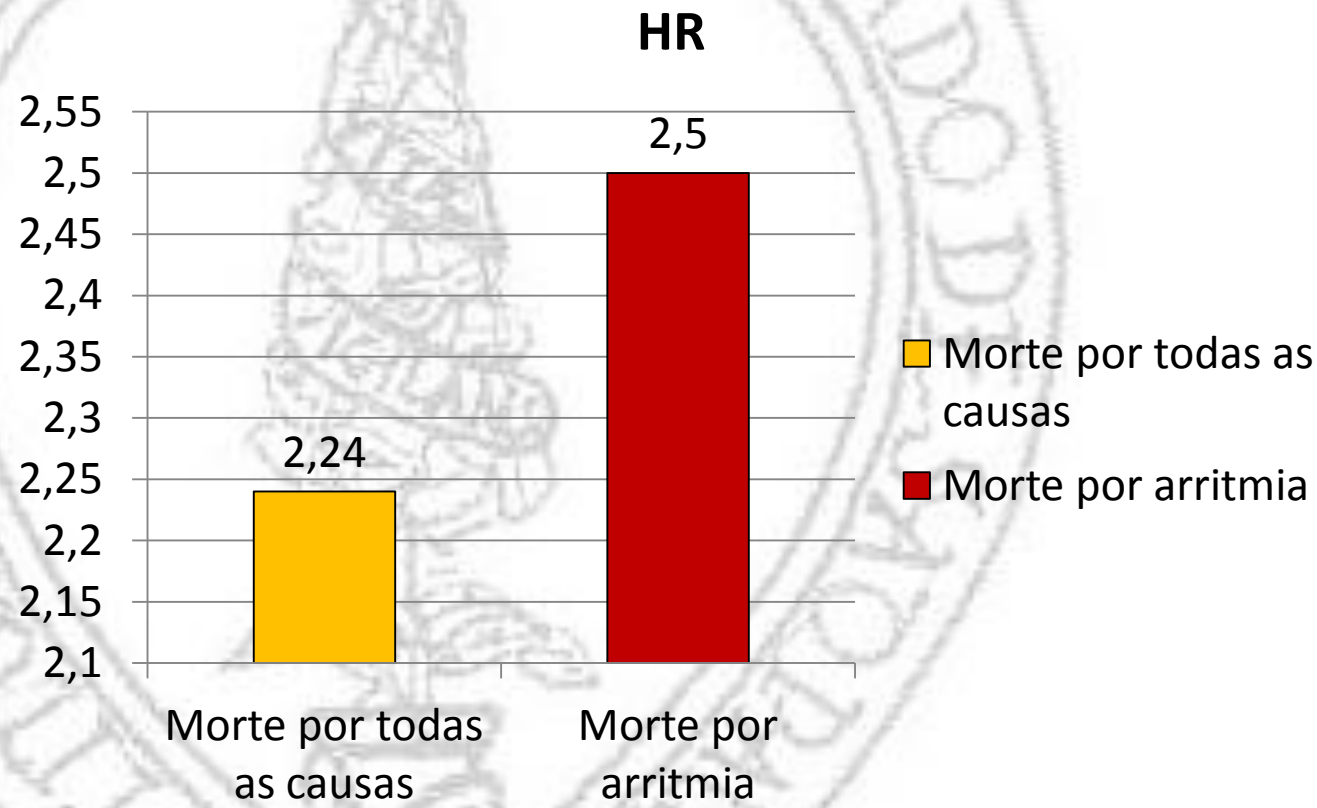
Formas de resultados



- 
- Maior parte dos estudos classifica os pacientes em:
 - TWA negativo
 - TWA não negativo
 - Positivo
 - Indeterminado

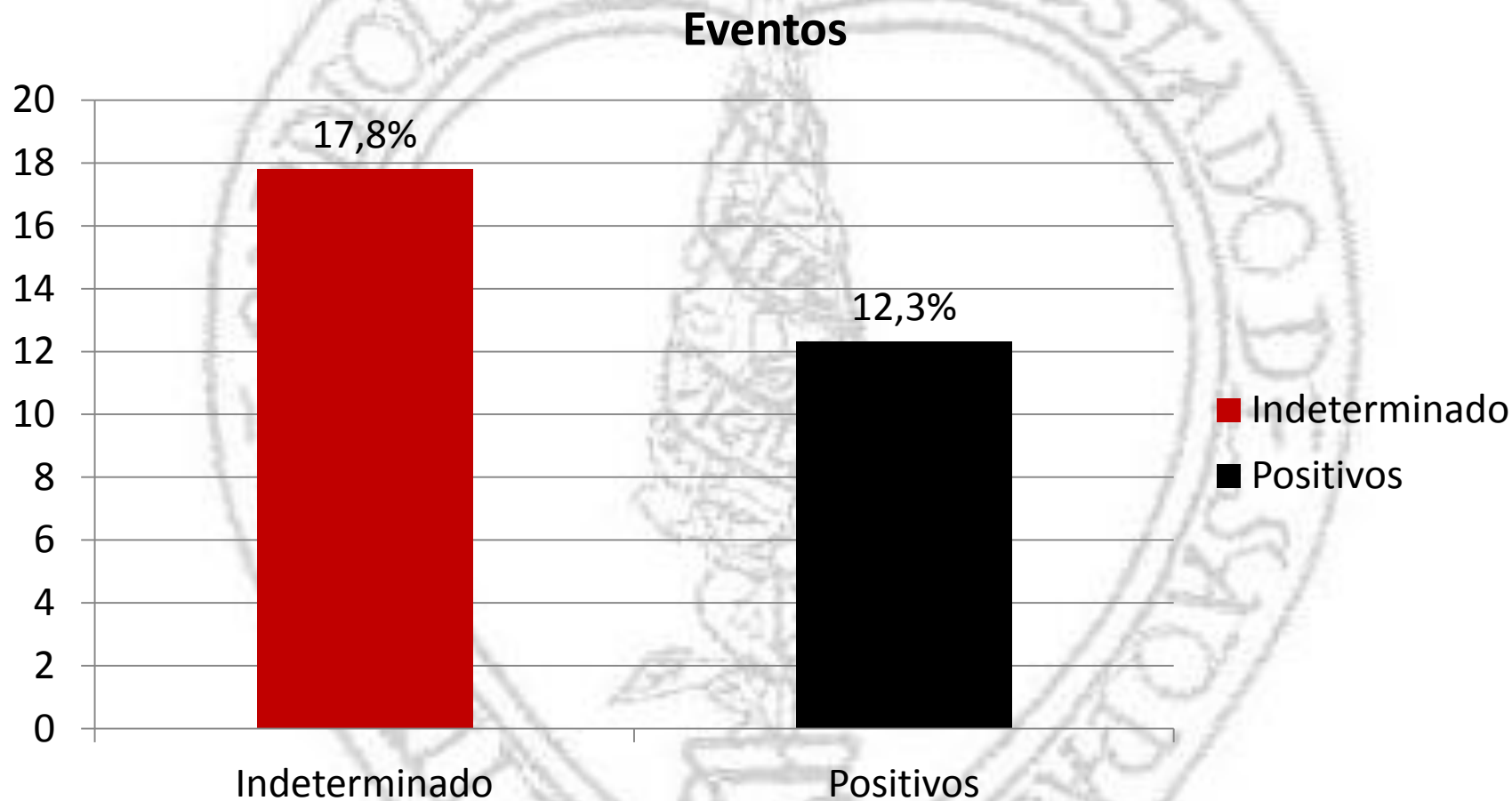
- Chow

- 768 pacientes
- FEVE ≤ 35%
- isquemicos

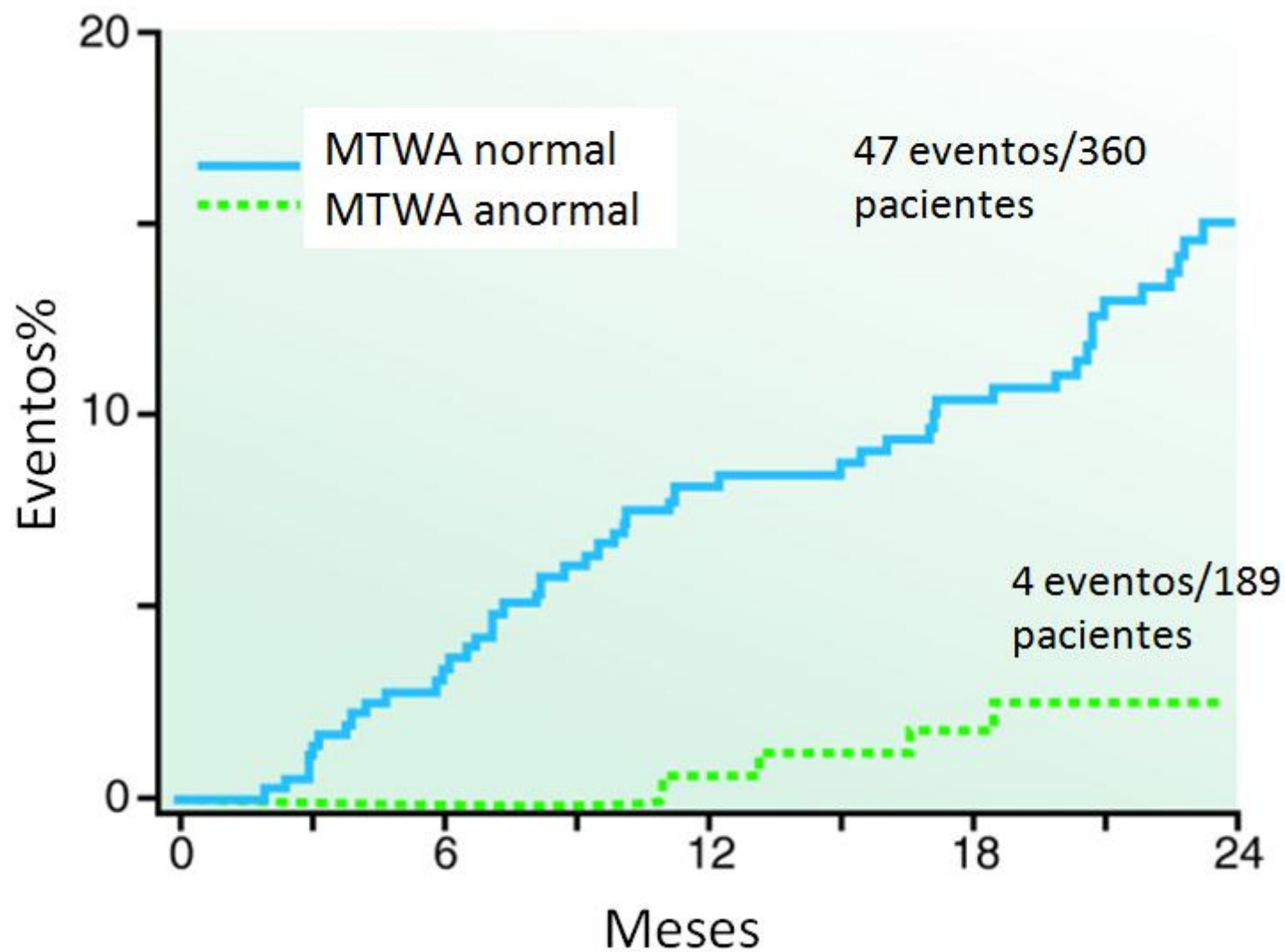


48.. Chow T, Kereiakes D, Bartone C, et al: [Prognostic utility of microvolt T-wave alternans in risk stratification of patients with ischemic cardiomyopathy.](#) *J Am Coll Cardiol* 2006; 47:1820-1827.

Risco de morte ou TVS para exames não negativos



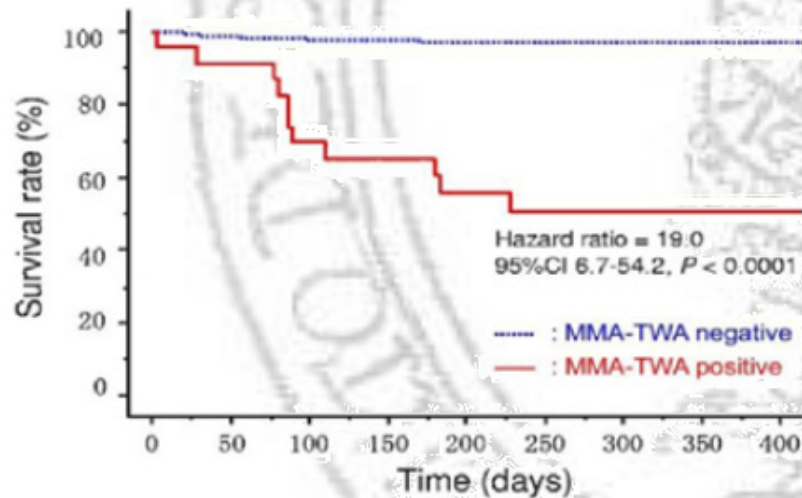
Kaufman E, Bloomfield D, Steinman R, et al: "Indeterminate" microvolt T-wave alternans tests predict high risk of death or sustained ventricular arrhythmias in patients with left ventricular dysfunction. *J Am Coll Cardiol* 2006; 48:1399-1404.



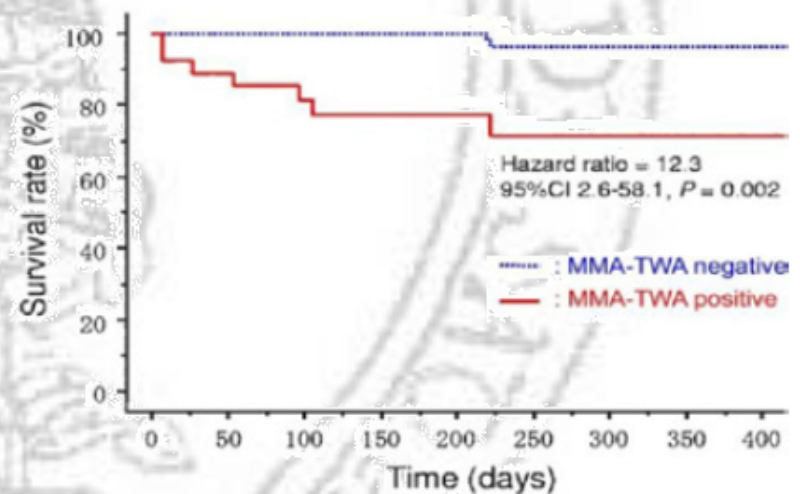
Bloomfield D, Bigger J, Steinman R, et al: Microvolt T-wave alternans and the risk of death or sustained ventricular arrhythmias in patients with left ventricular dysfunction. J Am Coll Cardiol 47:456-463, 2006

Sakaki K, Ikeda T, Miwa Y, et al. Time-domain T-wave alternans measured from Holter electrocardiograms predicts cardiac mortality in patients with left ventricular dysfunction: a prospective study. *Heart Rhythm* 2009;6:332-7.

Isquêmicos



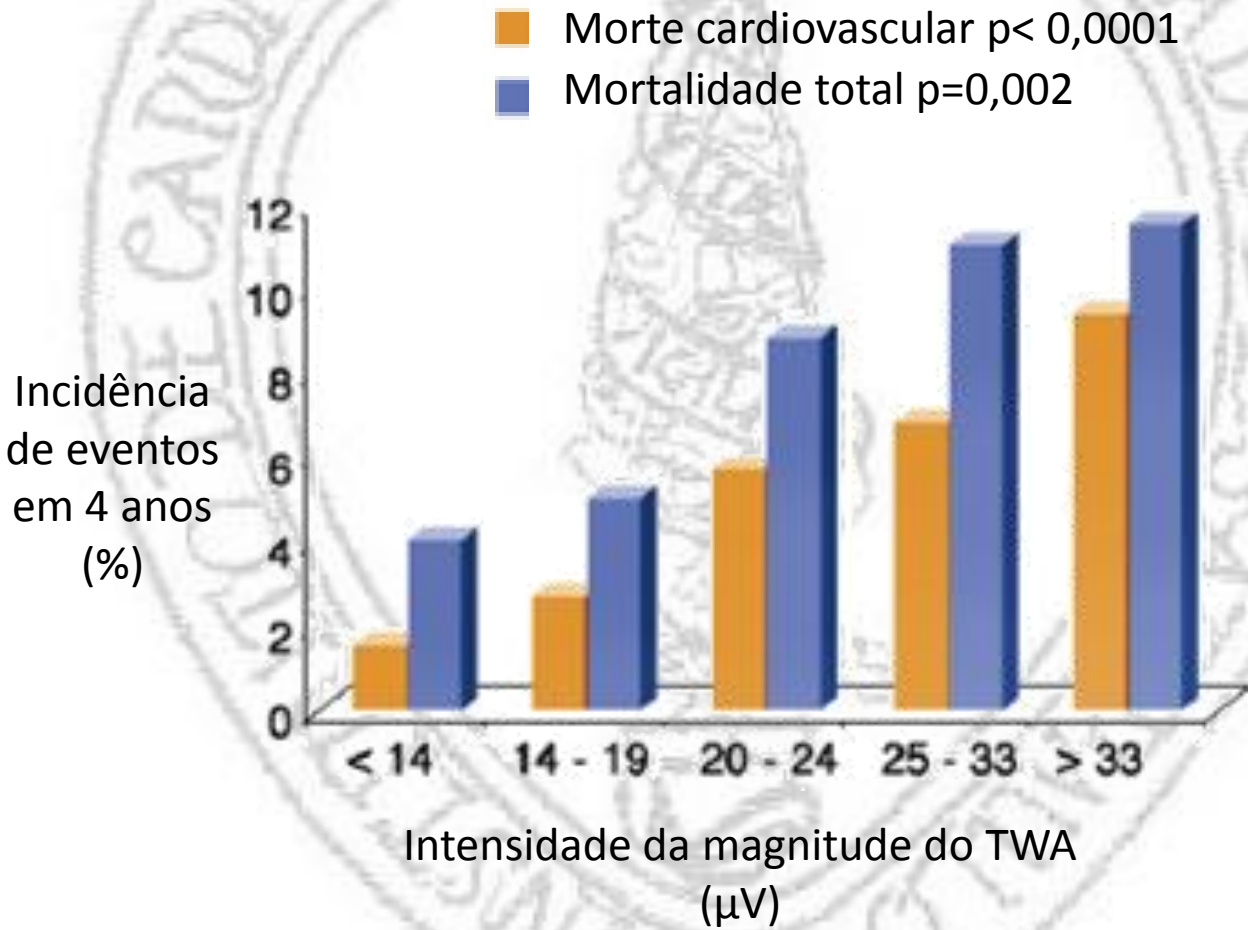
Não Isquêmicos



TWA positivo

Nieminen T, Lehtimäki T, Viik J, et al. T-wave alternans predicts mortality in a population undergoing a clinically indicated exercise test. Eur Heart J 2007;28:2332-7.

Slawnych MP, Nieminen T, Kahonen M, et al. Post-exercise assessment of cardiac repolarization alternans in patients with coronary artery disease using the modified moving average method. J Am Coll Cardiol 2009;53:1130-7.

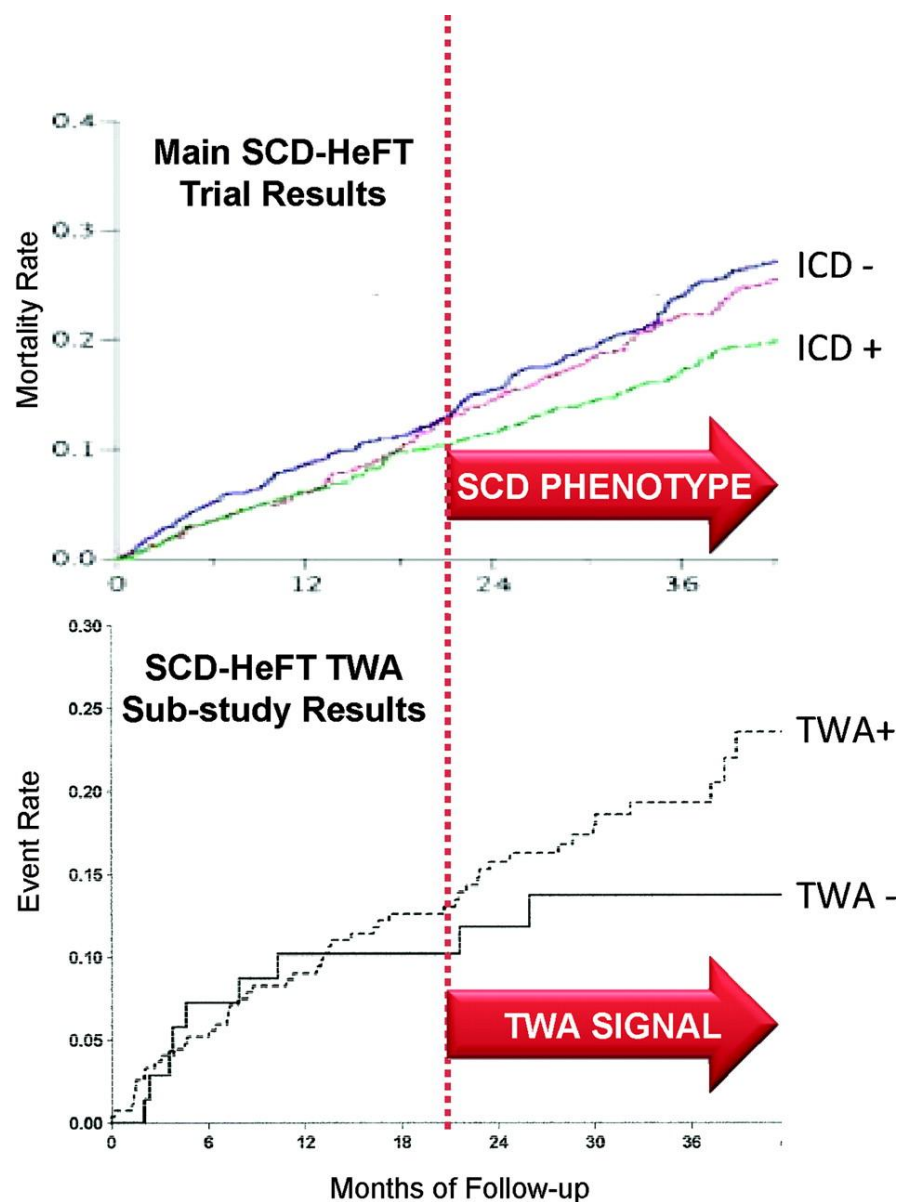


Gold MR, Ip JH, Costantini O, et al. Role of microvolt T-wave alternans in assessment of arrhythmia vulnerability among patients with heart failure and systolic dysfunction: Primary results from the T-wave Alternans Sudden Cardiac Death in Heart Failure Trial substudy. *Circulation* 2008;118:2022–8.

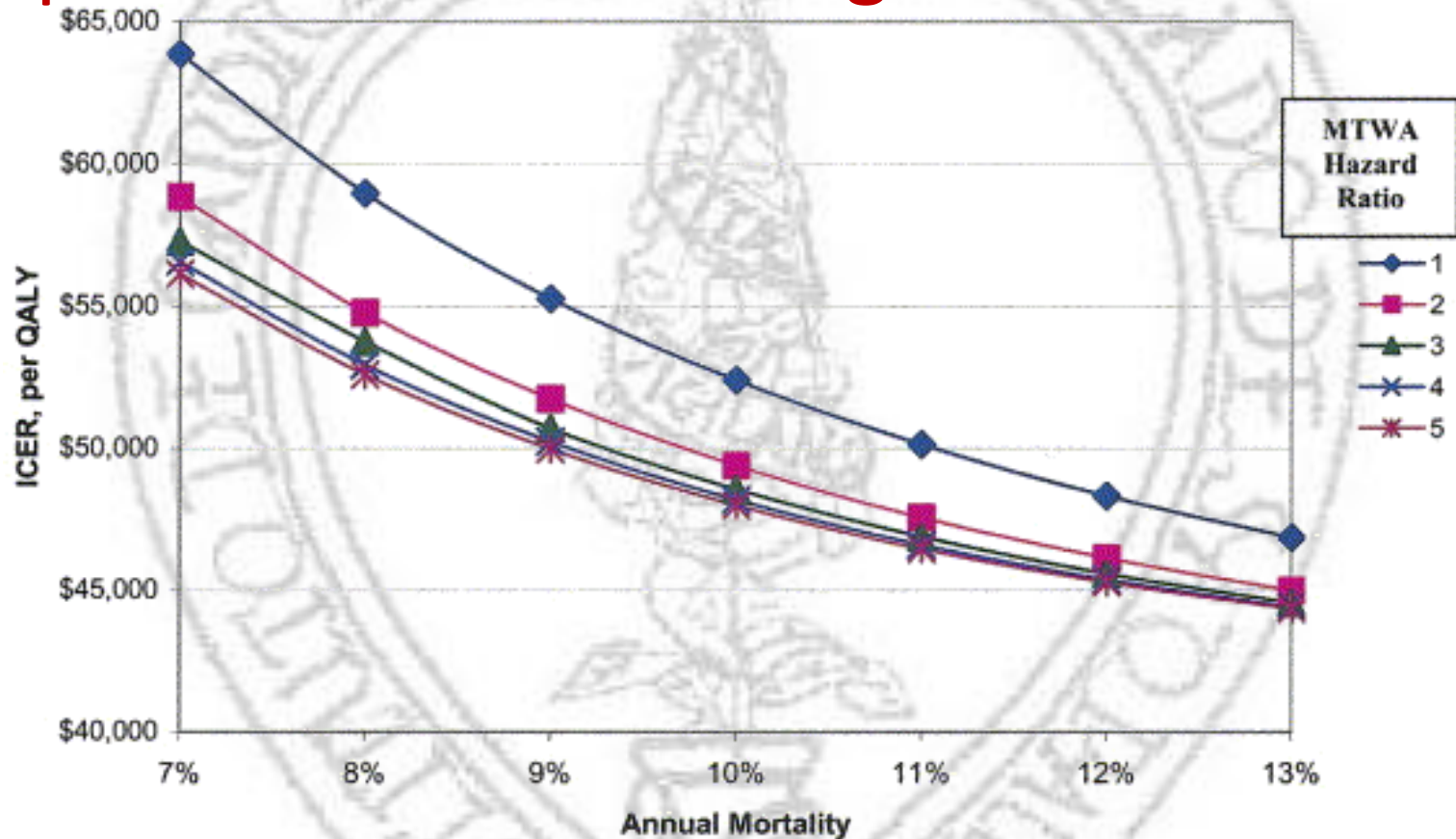
Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION



T-Wave Alternans in the Sudden Cardiac Death in Heart Failure Trial Population: Signal or Noise?
David S. Rosenbaum

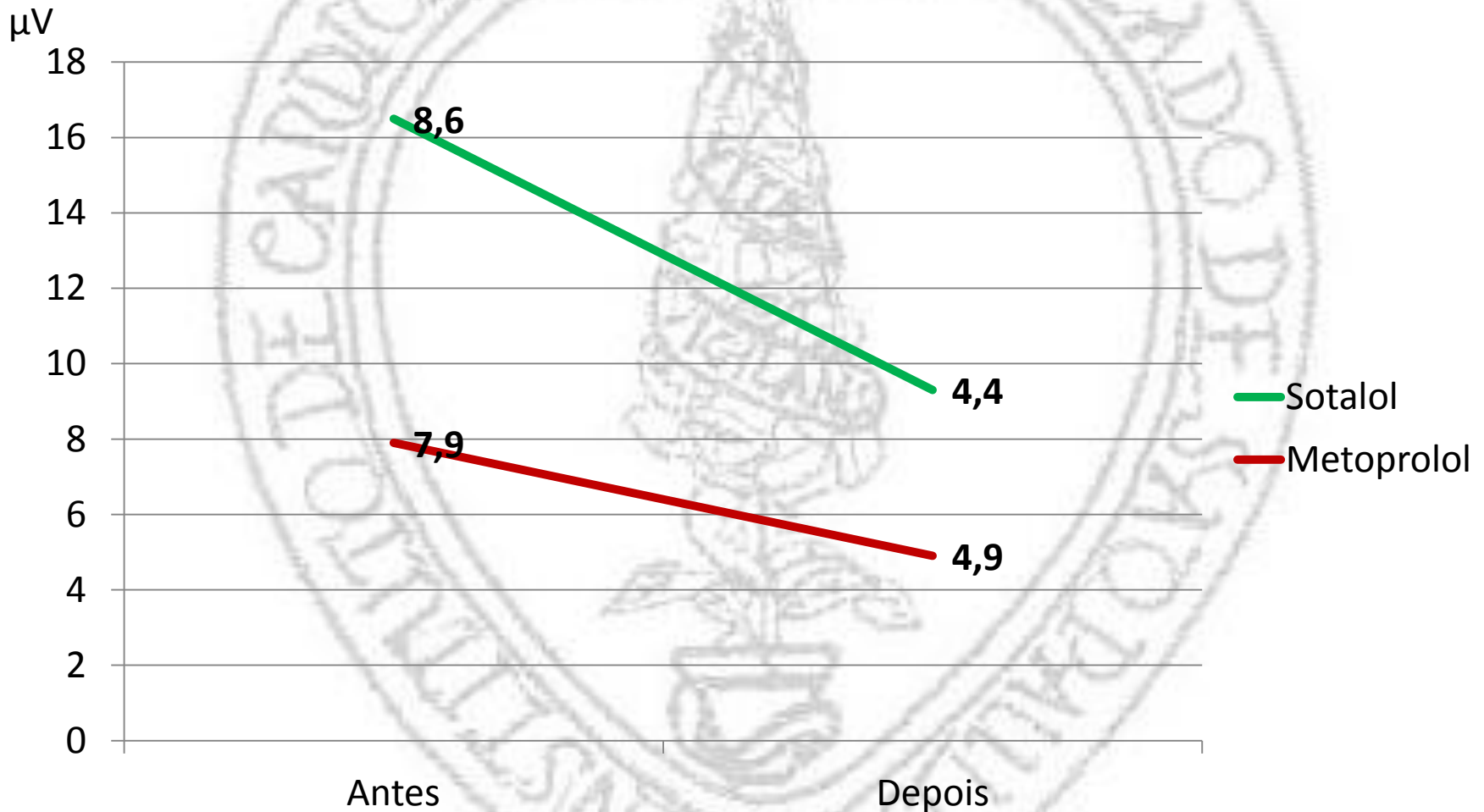


Custo efetividade da indicação do CDI é melhor quanto mais alto o magnitude do TWA



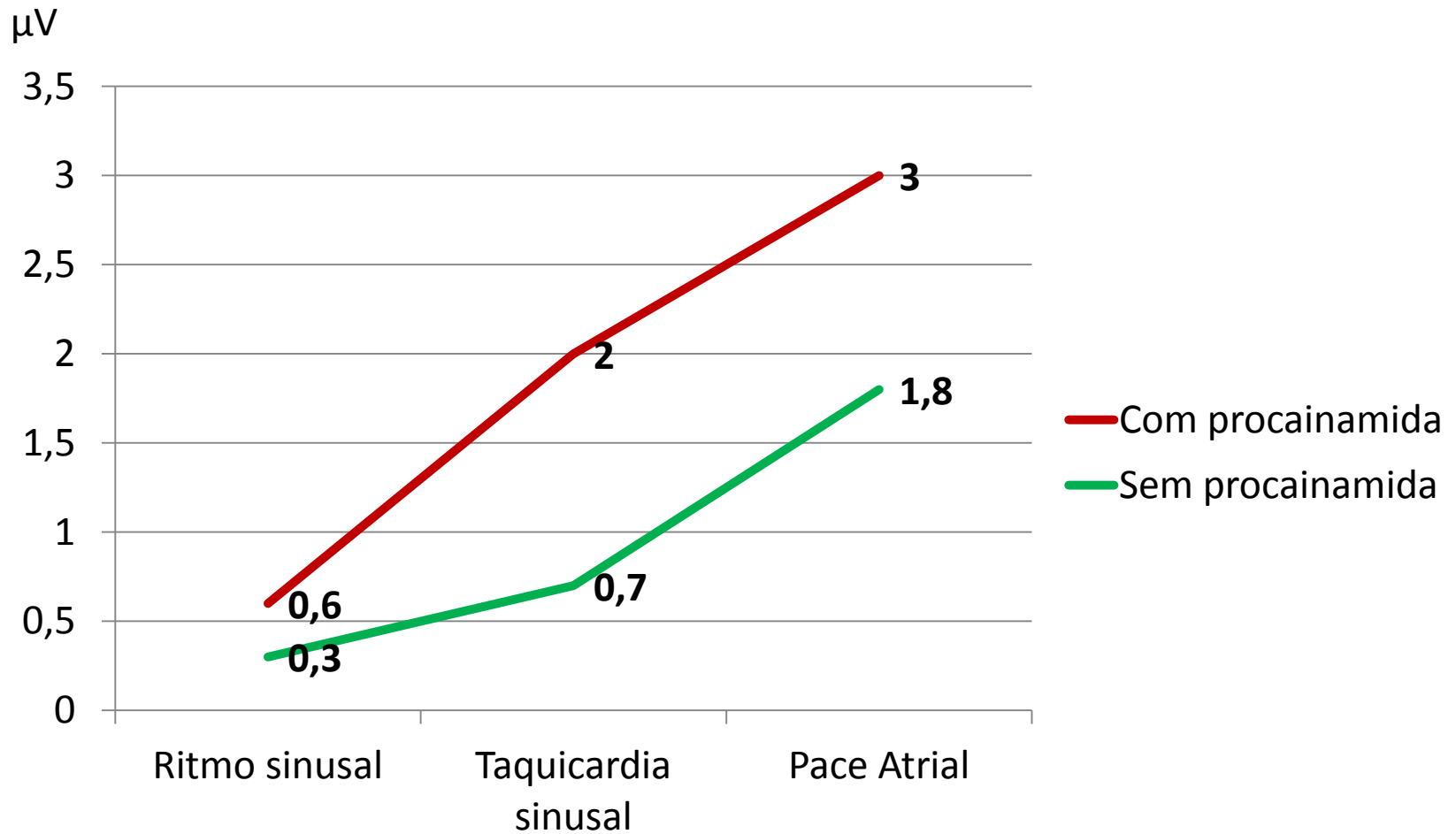
Chan P, Stein K, Chow T, et al: [Cost-effectiveness of a microvolt T-wave alternans screening strategy for implantable cardioverter-defibrillator placement in the MADIT-II-eligible population](#). *J Am Coll Cardiol* 2006; 48:112-121.

Efeito da Outros antiarrítmicos na amplitude da Repolarização



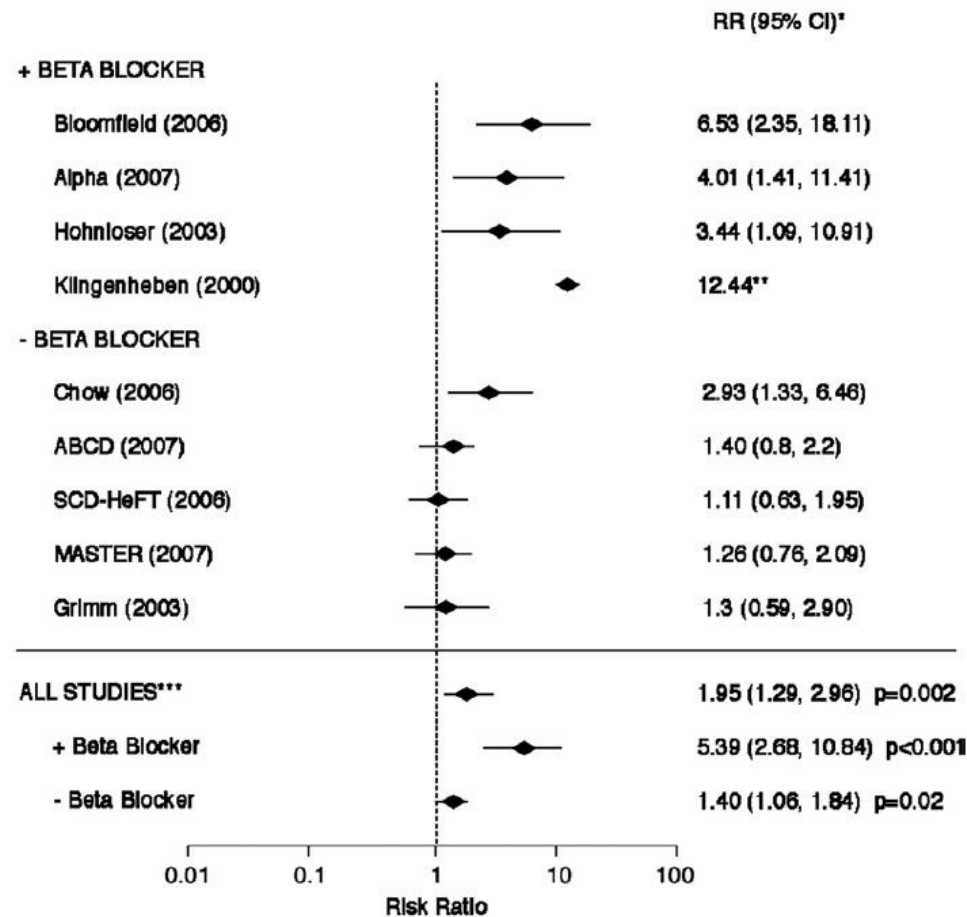
Klingenheben T, Grönefeld G, Li YG, Hohnloser SH: [Effect of metoprolol and d,l-sotalol on microvolt-level T-wave alternans.](#) *J Am Coll Cardiol* 2001; 38:2013-2019

Efeito da Procainamida na amplitude da Repolarização



Kavesh NG, Shorofsky SR, Sarang SE, Gold MR: [The effect of procainamide on T wave alternans](#). *J Cardiovasc Electrophysiol* 1999; 10:649-654.

Chan PS, Gold MR, Nallamothu BK. Do beta-blockers impact microvolt T-wave alternans testing in patients at risk for ventricular arrhythmias? A meta-analysis. *J Cardiovasc Electrophysiol* 2010;21:1009–14.



Noninvasive Strategies in Identifying Patients at Risk for Life-Threatening Arrhythmic Events

Ikeda et al

	Sensibilidade	Especificidade	VPP	VPN
FE baixa	64%	90%	38%	96%
TWA	91%	67%	23%	99%
FE+TWA	61%	96%	65%	96%



Seção Médica de Eletrofisiologia Clínica e Arritmias Cardíacas
Instituto Dante Pazzanese de Cardiologia

Obrigado!!!

rogerioandalaft@arritmiaonline.com.br

