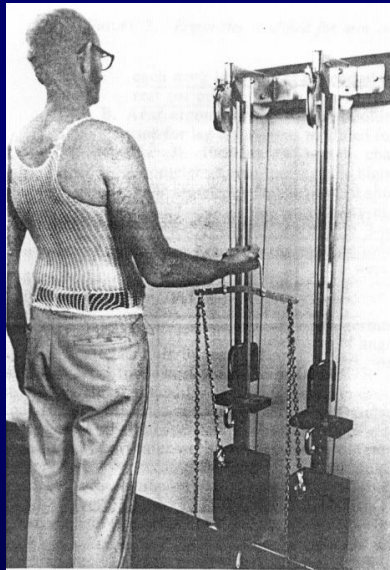


FUNÇÕES DO SISTEMA CARDIOVASCULAR DURANTE O EXERCÍCIO



TIPO DE EXERCÍCIO

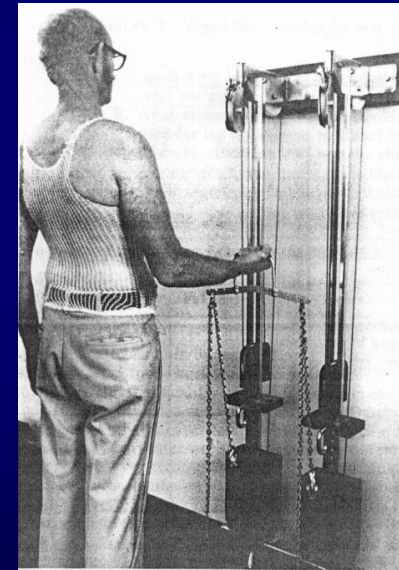
**Dinâmico ou
Isotônico**



**Contração muscular
e movimento articular**



**Estático ou
Isométrico**



**Contração muscular
sem movimento articular**

EXERCÍCIO ESTÁTICO - ISOMÉTRICO

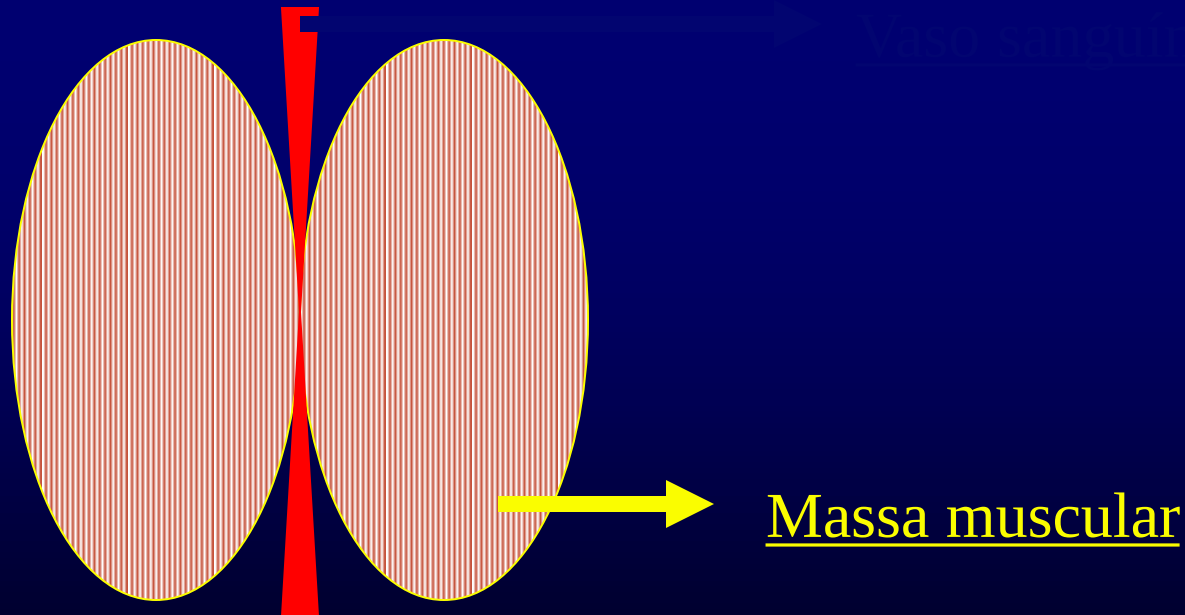
“Quando um músculo é ativado e desenvolve força sem causar movimento numa articulação” (Fleck e Kraemer)



RESPOSTAS CARDIOVASCULARES AGUDAS

● FLUXO SANGUÍNEO

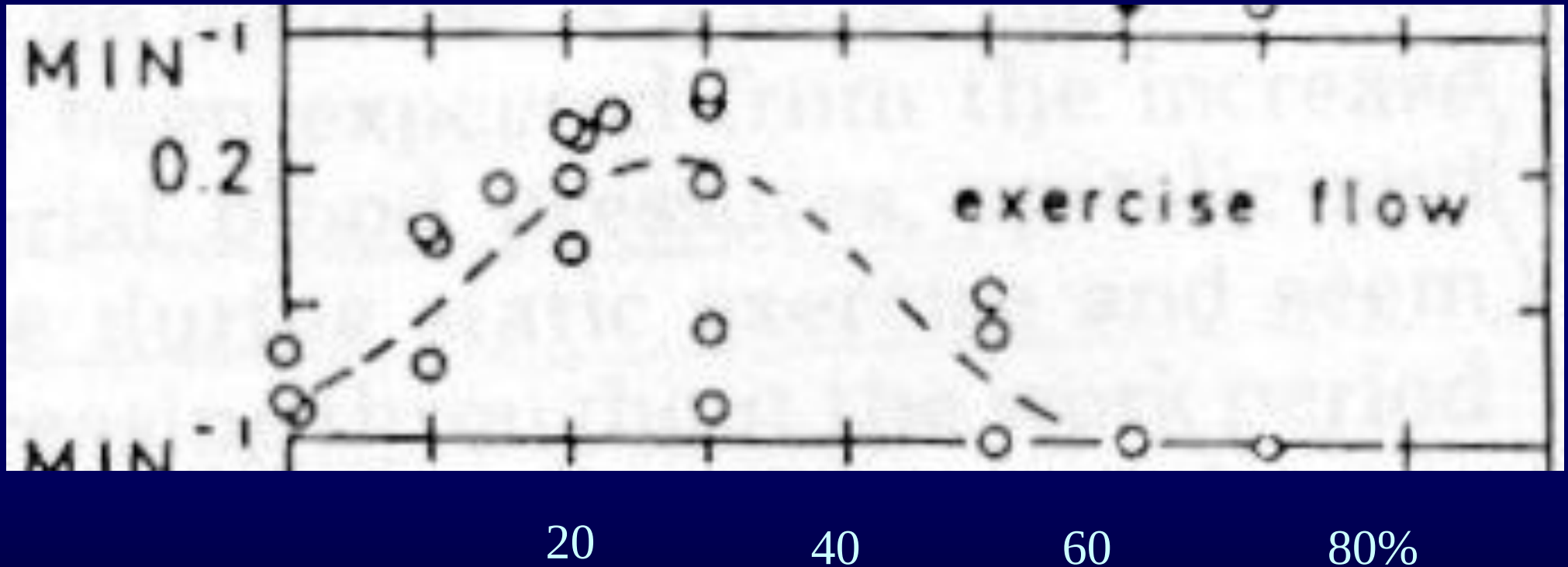
→ Quando a contração muscular aumenta acima de 15% da contração voluntária máxima há um impedimento progressivo do fluxo sanguíneo para o músculo ativo.



Acima de 70%
oclusão completa

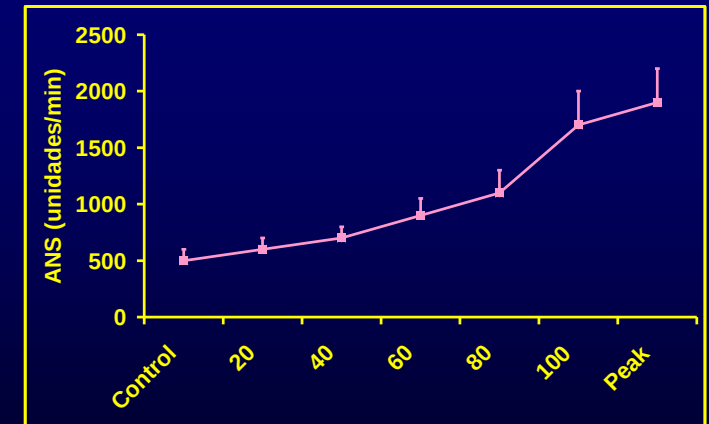
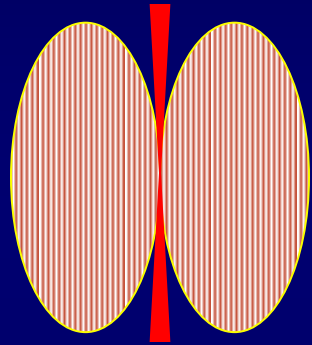
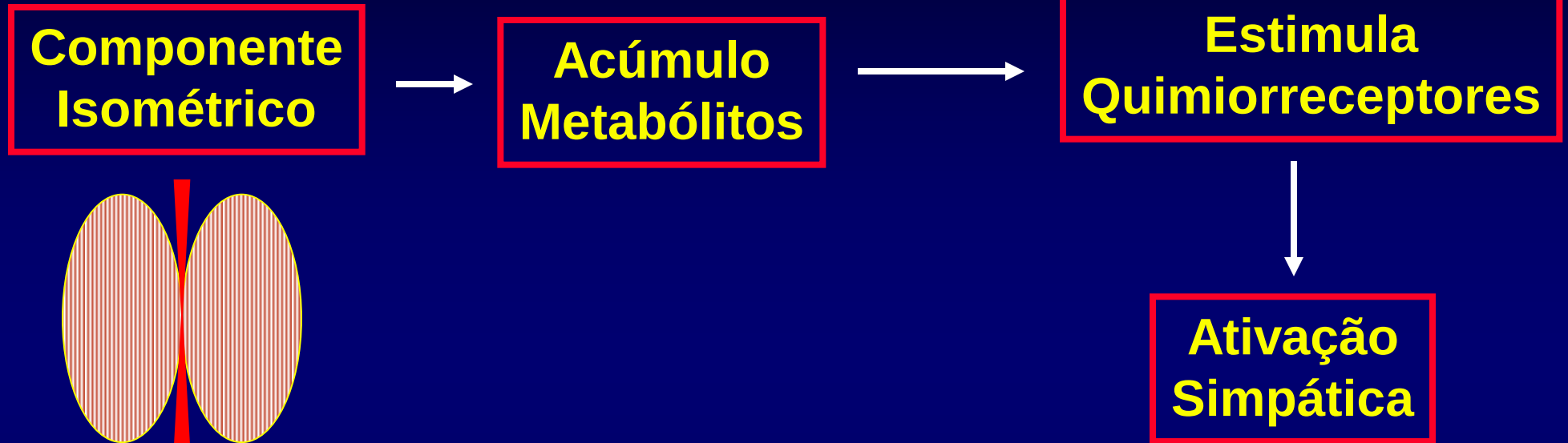
RESPOSTAS CARDIOVASCULARES AGUDAS

● FLUXO SANGUÍNEO

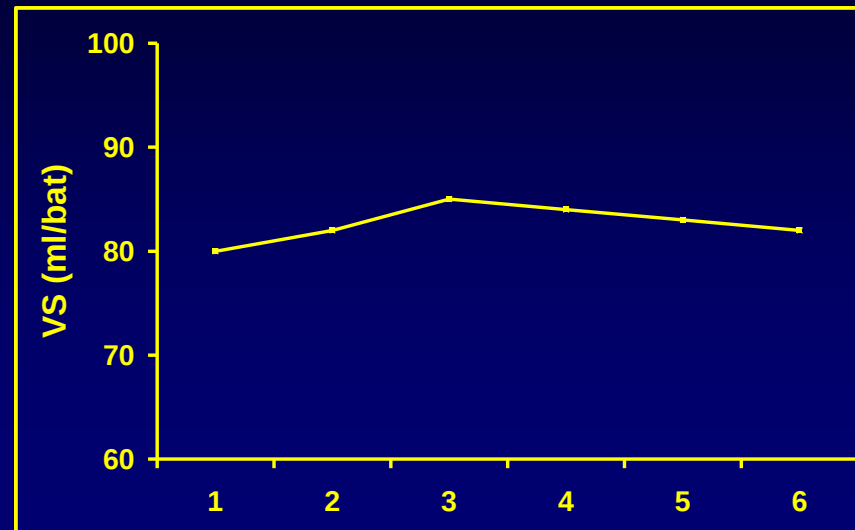
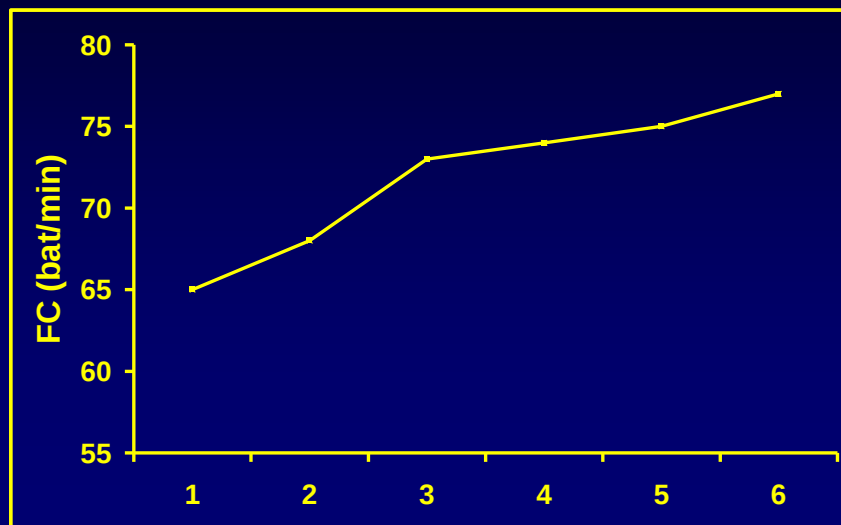


Adaptado de Asmussen Circulation Res. 48:i3-i10, 1981.

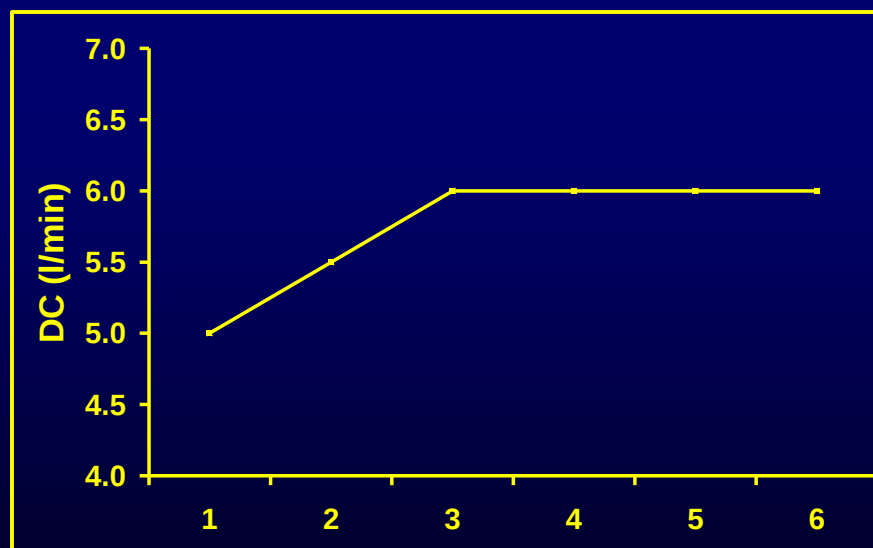
Mecanismo

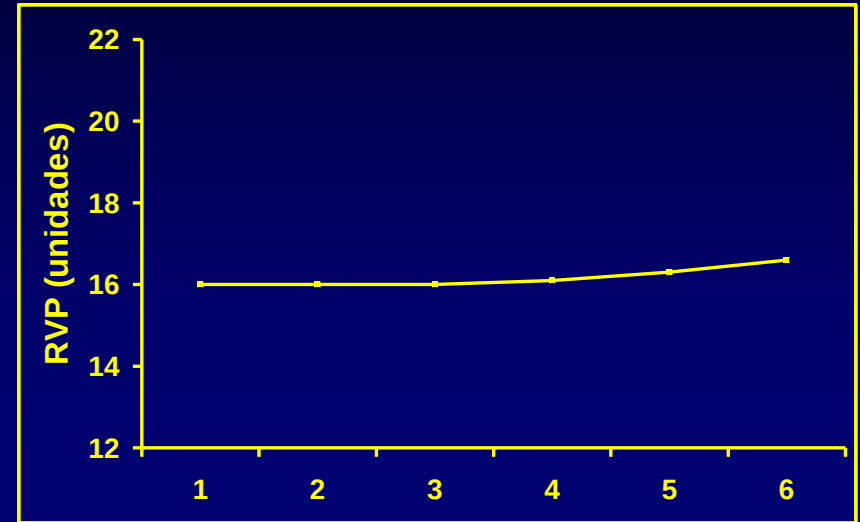
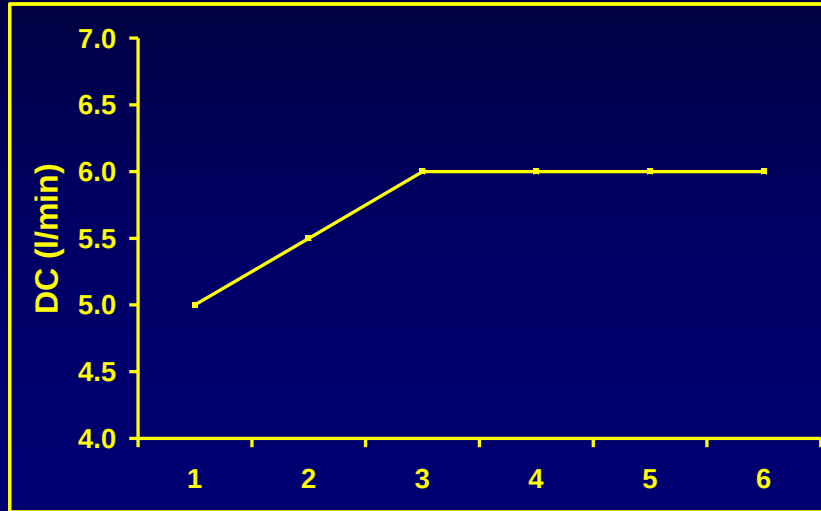


Seals DR J. Appl. Physiol. 75: 1426-31, 1993.

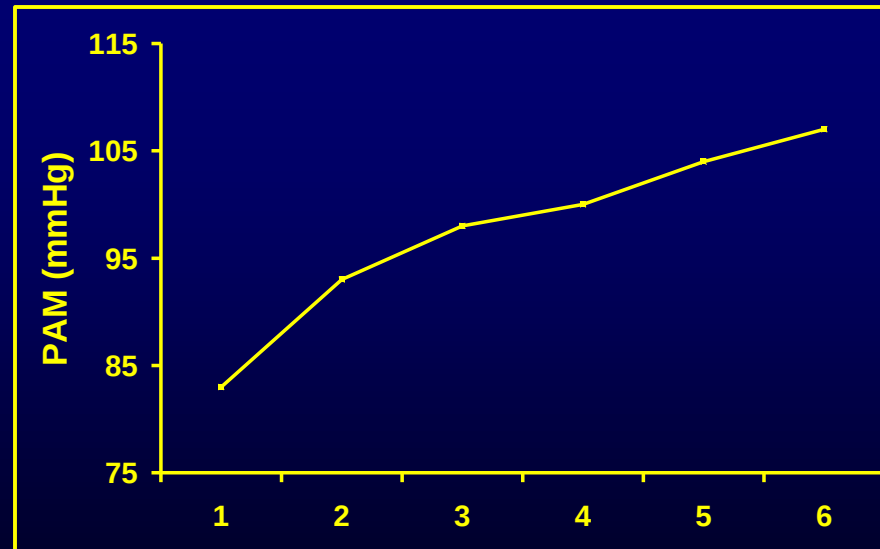


Isométrico
Extensão do Joelho
5 minutos
20% CVM

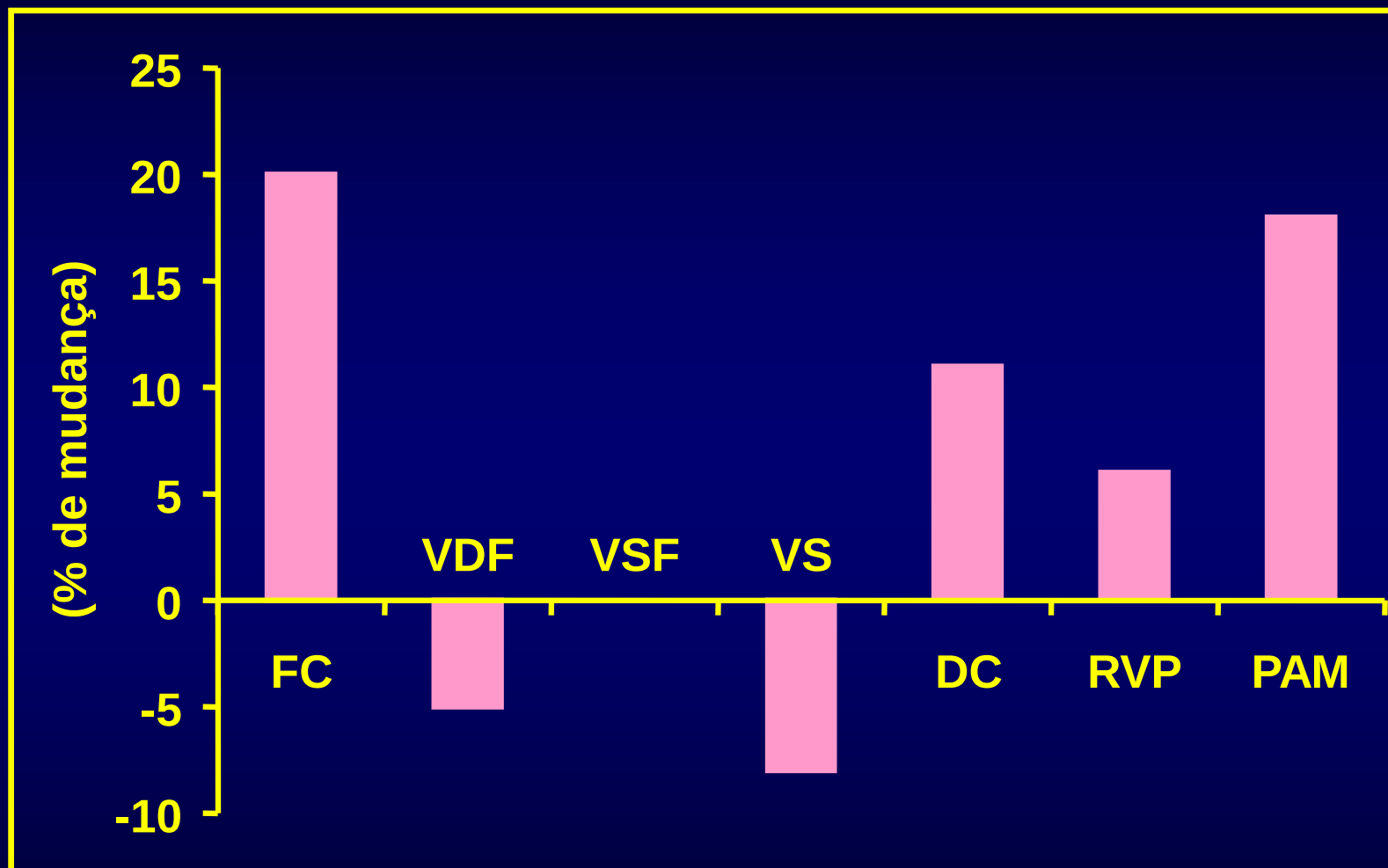




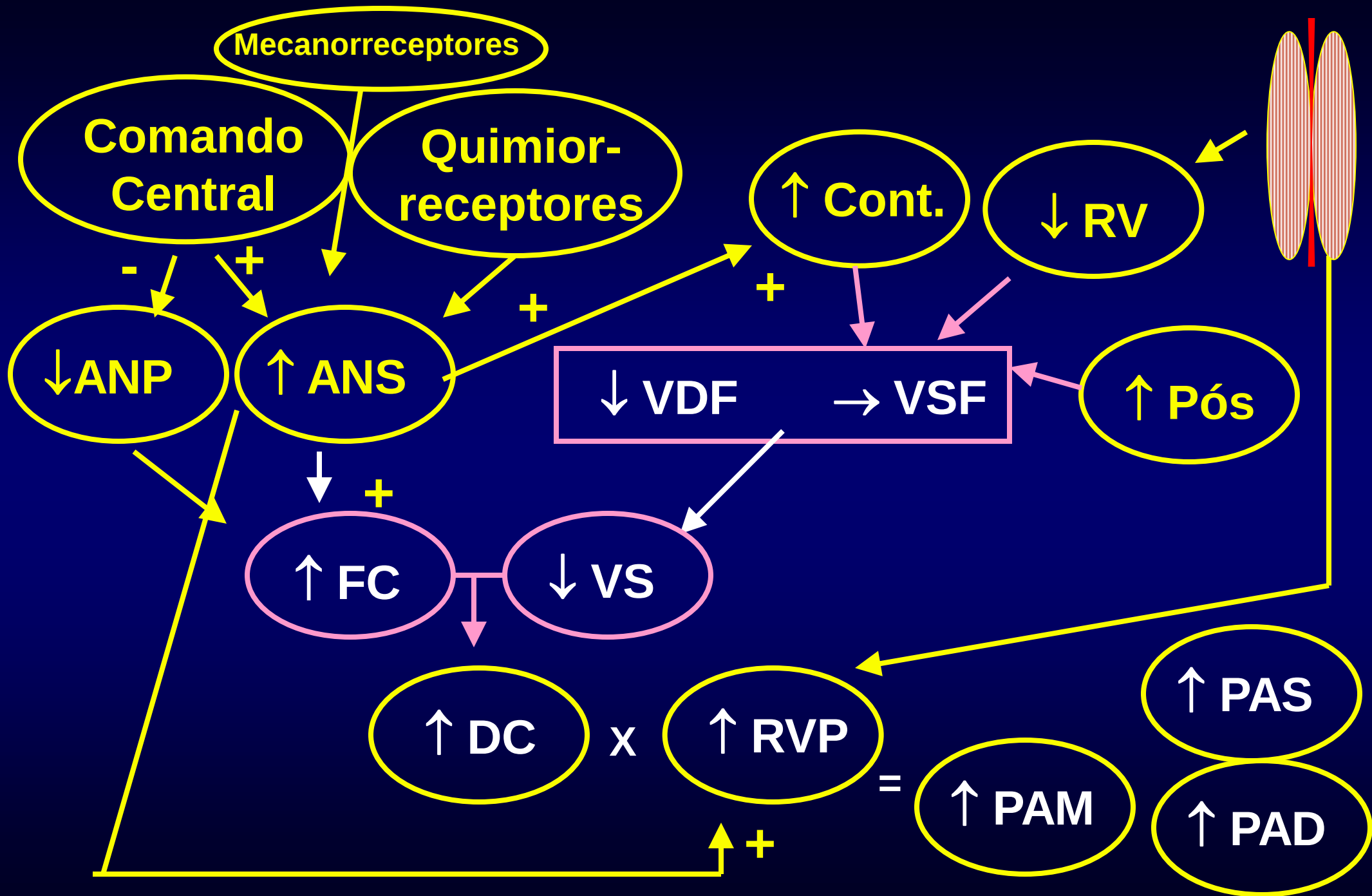
Isométrico
Extensão do Joelho
5 minutos
20% CVM



Resposta Cardiovascular - Handgrip – 3 min – 30%CVM

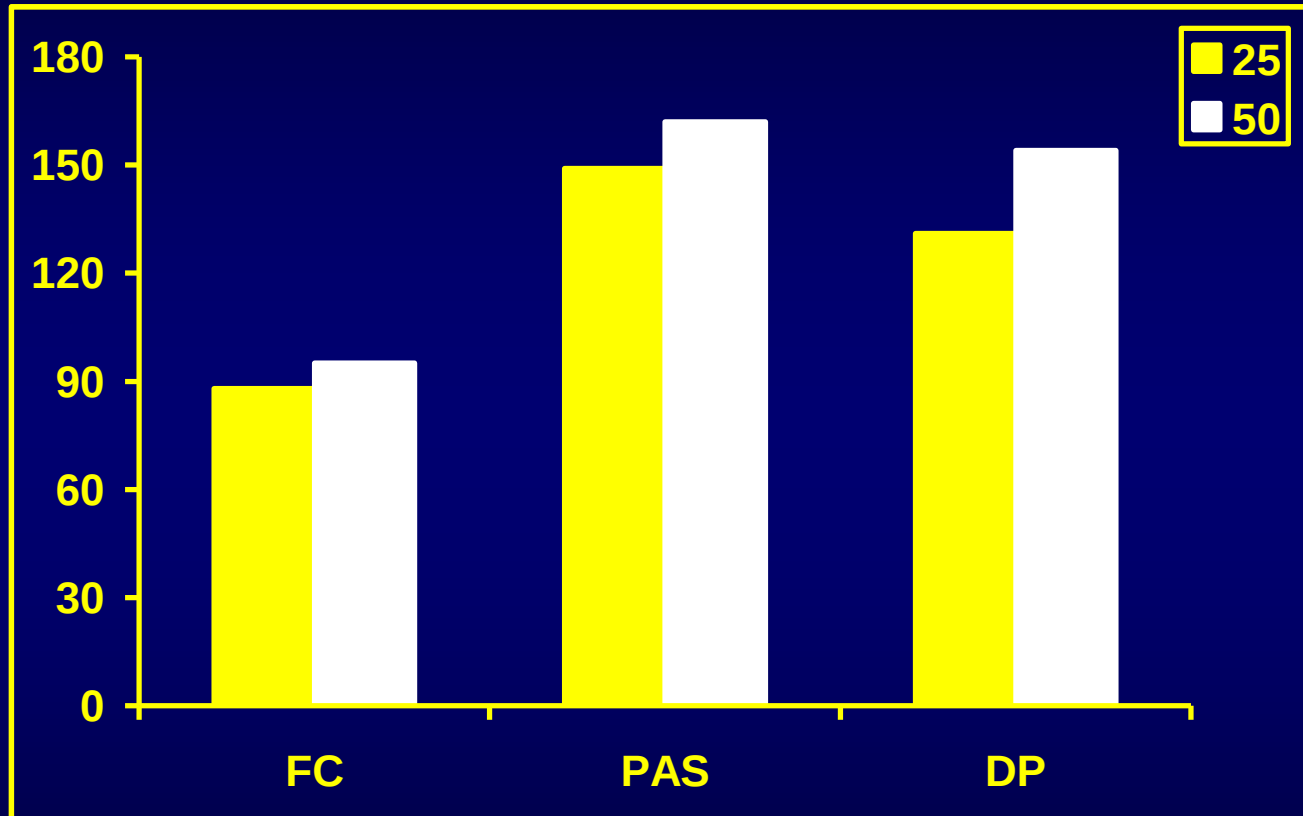


Adaptado de Bastos. MSSE. 32: 1114-18,2000



EFEITO DA INTENSIDADE

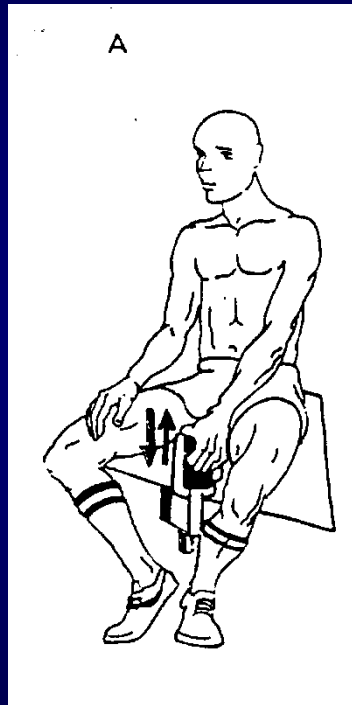
INTENSIDADE



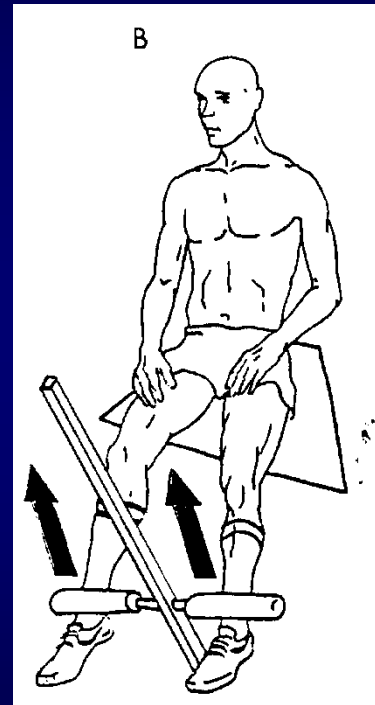
1 minuto
Isométrico
Braço

Adaptado de DeBusk et al. Circulation 58: 368-75, 2000

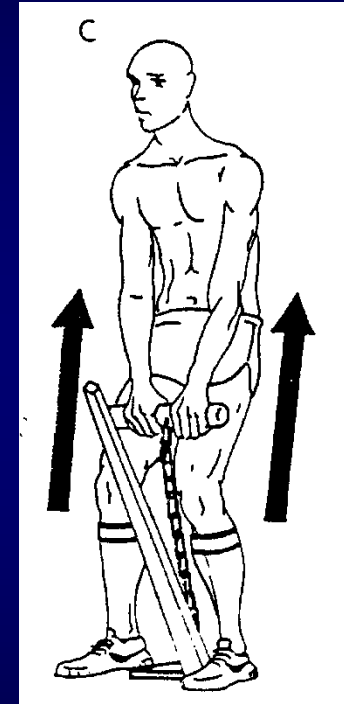
MASSA MUSCULAR



Mão

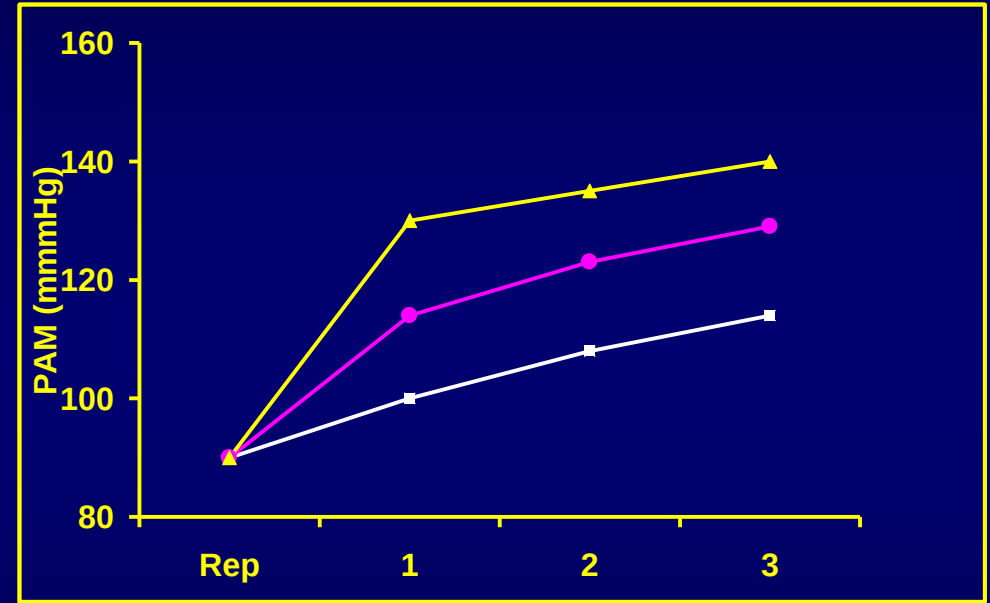
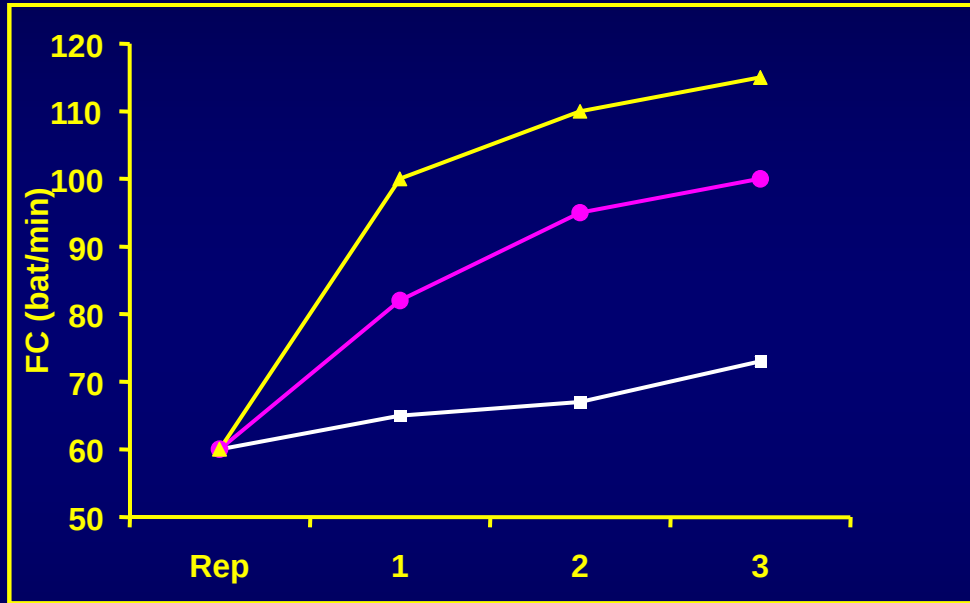


Perna



Perna + Braço

MASSA MUSCULAR



Isométrico
3 minutos
30% CVM



Mão

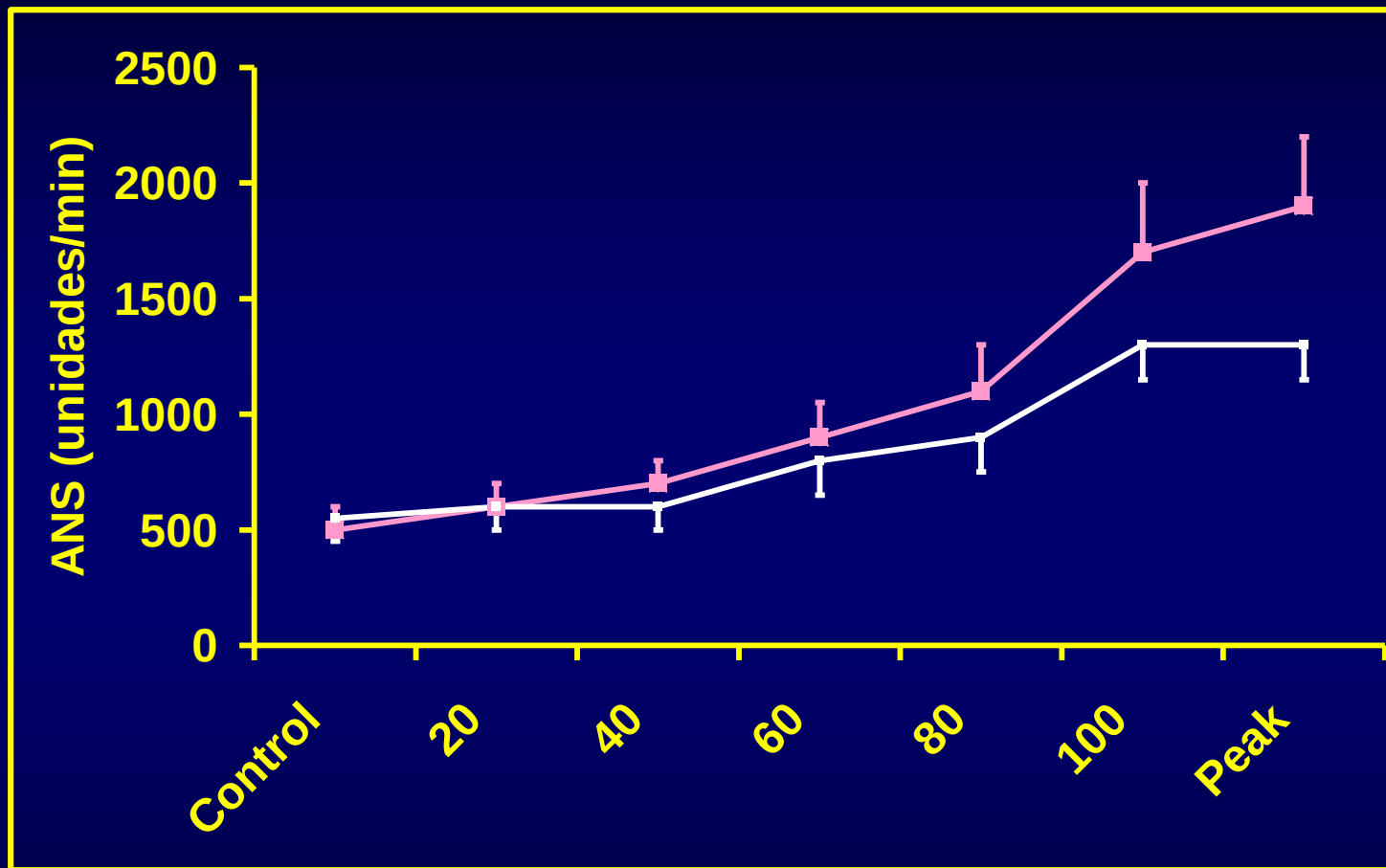


Perna



Mão+Perna

Adaptado de Seals et al. J. Appl. Physiol. 54: 434-7, 1983.



■ Braço - 35%CVM

■ Dedo - 35%CVM

Exercício Estático - Isométrico

FC	↑
VS	→ ↓
DC	↑
RVP	→ ↑
PAM	↑↑
PAS	↑↑
PAD	↑↑

Exercício com maior massa muscular, duração e intensidade levam a maior aumento da Resistência Vascular Periférica (RVP), Pressão Arterial (PA) média, sistólica e diastólica.



RESPOSTAS CARDIOVASCULARES AGUDAS AO EXERCÍCIO RESISTIDO DINÂMICO



Exercício Resistido:

Localizado

Contra resistência

Levantamento de Peso

Musculação

Weight Training

Resistance Training

Strength Training



EXERCÍCIOS RESISTIDOS



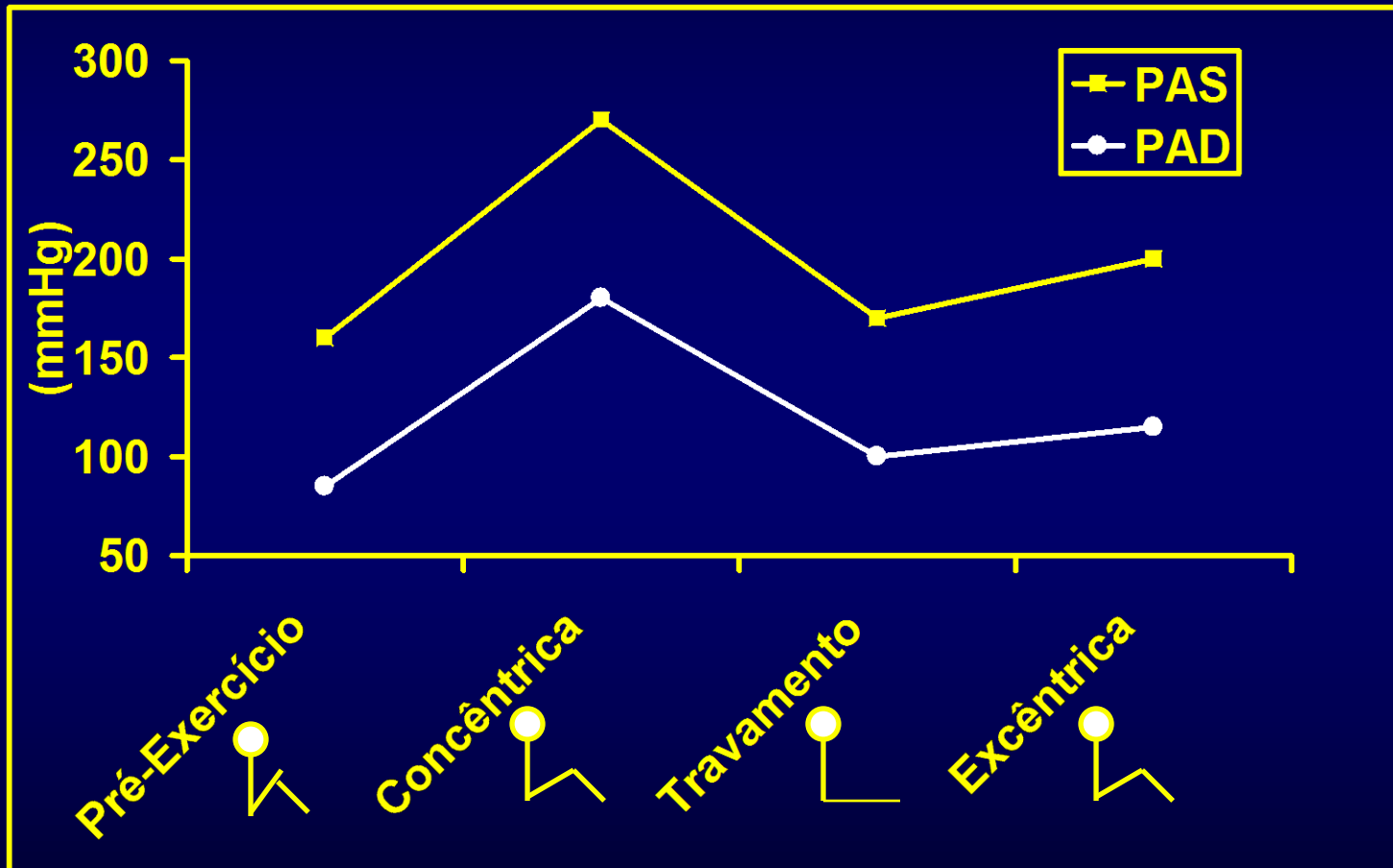
Alta Intensidade
Isométrico
Força

X

Baixa Intensidade
Isotônico
Resistência

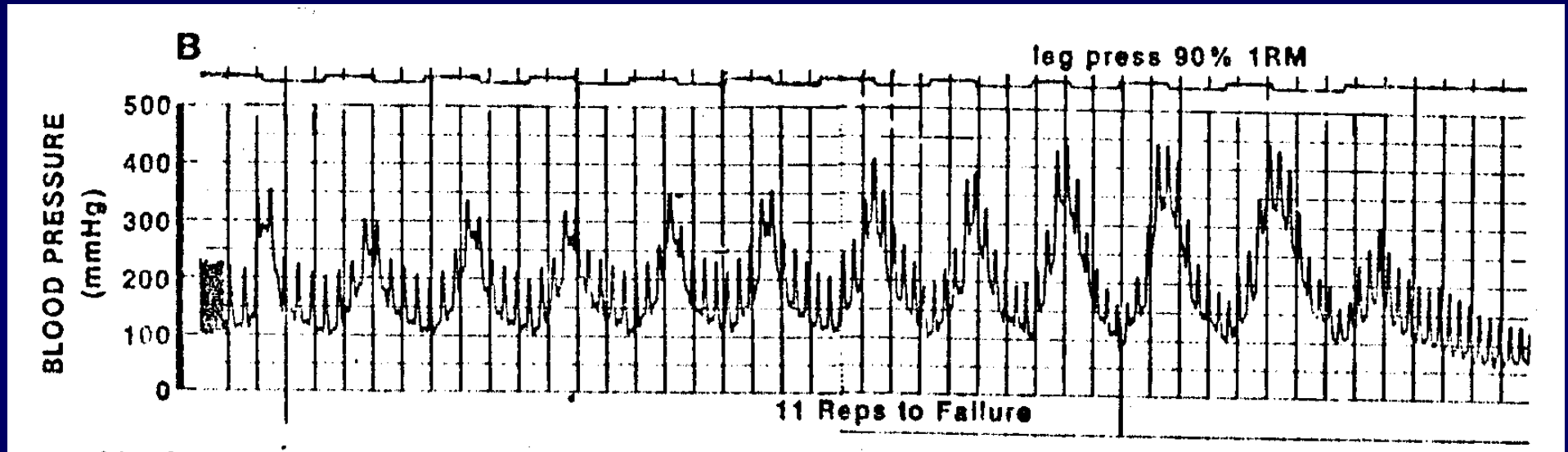
PA AO LONGO DA REPETIÇÃO

Leg Press Duplo



Adaptado de McCartney. Med. Sci. Sports Exerc. 31:31-7,1999

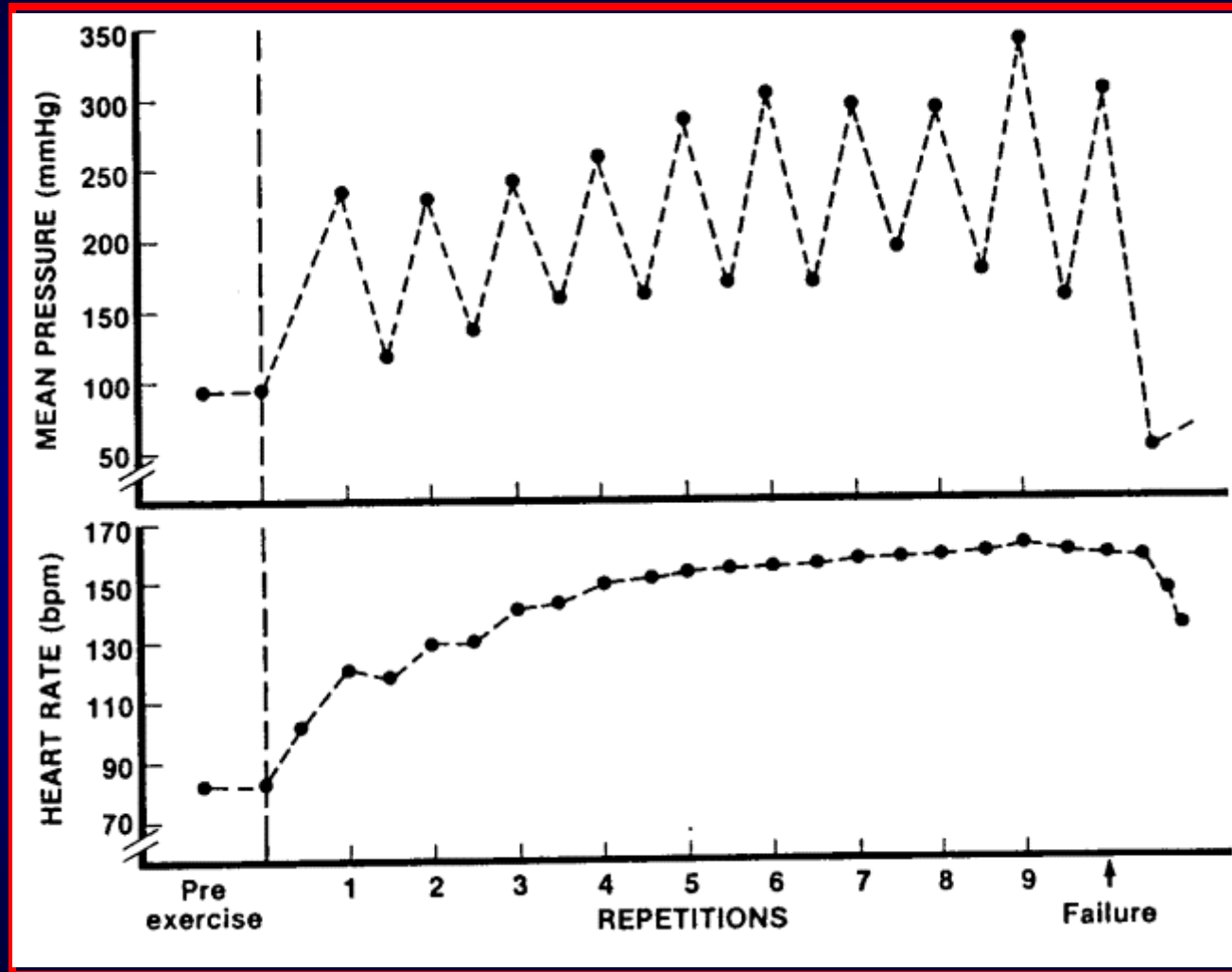
PA INTRAARTERIAL AO LONGO DA SÉRIE



**Leg Press Duplo
90% CVM
Até exaustão**

Adaptado de MacDougall. J. Appl. Physiol. 58:785-90, 1985.

PA INTRAARTERIAL AO LONGO DA SÉRIE



**Aumento médio:
320/250 mmHg**

**Maior Aumento:
480/350 mmHg**

**Leg Press Duplo
90% 1RM
Até exaustão**

(MacDougall. J. Appl. Physiol. 58:785-90, 1985.)

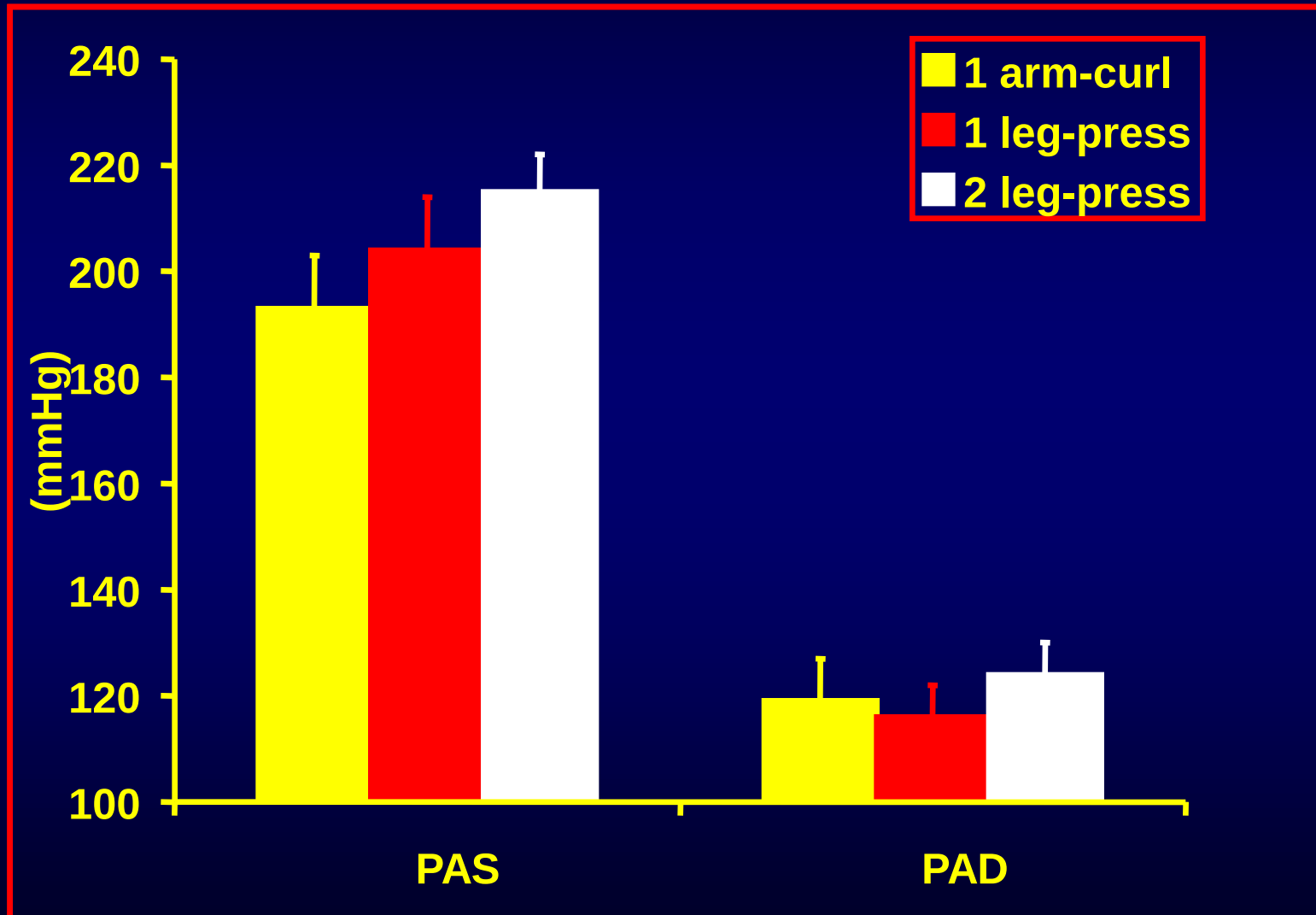
Author	Subjects	Exercise	BP measure	Maximum (mmHg)
Fleck and Dean ¹³	Athletes Beginners Controls	50%, 70%, 80% e 90% de 1 RM	Intra-arterial	SBP = 190 DBP = 150
Harris e Holly ²¹	Hypertensives	40% de 1 RM	Auscultation	SBP = 155±12 DBP = 87±11
Haslam et al. ²²	Cardiac Patients	20%, 40%, 60% e 80% de 1 RM	Intra-arterial	SBP = 215±17 DBP = 124±6
Lamotte et al. ²⁵	Cardiac Patients	40% e 70% de 1 RM	Pletismografia	SBP = 213±25
MacDougall et al. ³⁰	Athletes	95% de 1 RM	Intra-arterial	SBP = 320 DBP = 250
MacCartney et al. ³⁴	Healthy	60% e 80% de 1 RM	Intra-arterial	SBP = 260±9 DBP = 175±12
Nery ³⁷	Healthy Hypertensives	40%, 80% e 100% de 1 RM	Intra-arterial	SBP = 231±16 DBP = 128±11
Oliver et al. ³⁸	Cardiac Patients	50% de 1 RM	Intra-arterial	SBP = 180±14 DBP = 116±7
Palatini et al. ⁴⁰	Hypertensives Normotensives	90% de 1 RM	Intra-arterial	SBP = 345 DBP = 245
Sale et al. ⁴⁸	Healthy	50%, 70%, 80%, 85%,85% e 87,5% de 1 RM	Intra-arterial	SBP = 360 DBP = 234
Wescott e Howes ⁵⁴	Young Elderly	10 RM, 10 RM – 2 kg 10 RM – 4,5 kg	Auscultation	SBP = 165±5 DBP = 75±3
Wiecek et al. ⁵⁵	Cardiac Patients	40% e 60% de 1 RM	Intra-arterial	SBP = 249±16 DBP = 152±12

Factors of Influence

- ❖ **Population**
- ❖ **Medication**
- ❖ **Intensity**
- ❖ **Concentric fatigue**
- ❖ **Intervals**
- ❖ **Sets, repetitions, exercises**
- ❖ **BP measurement**

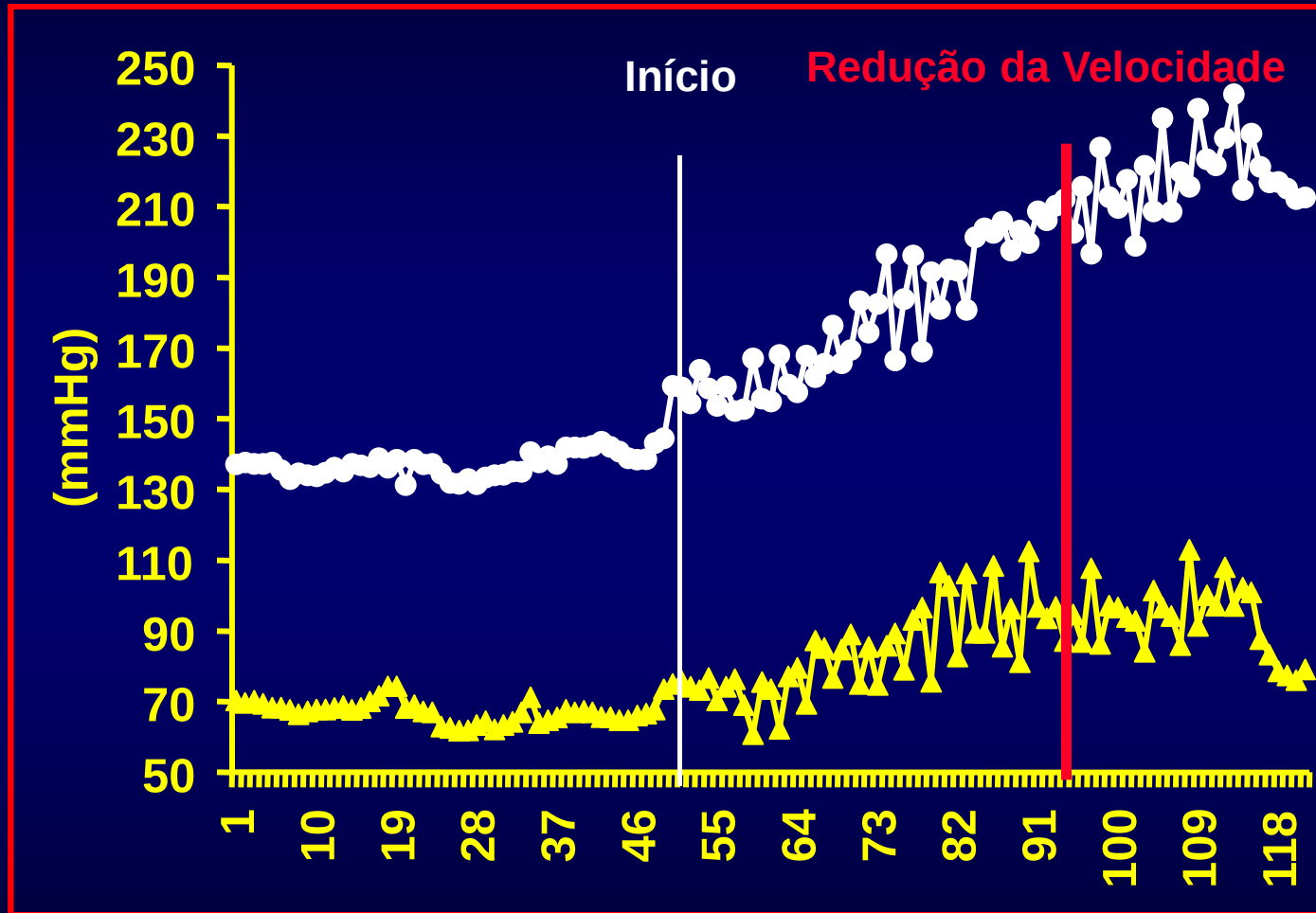


Massa Muscular



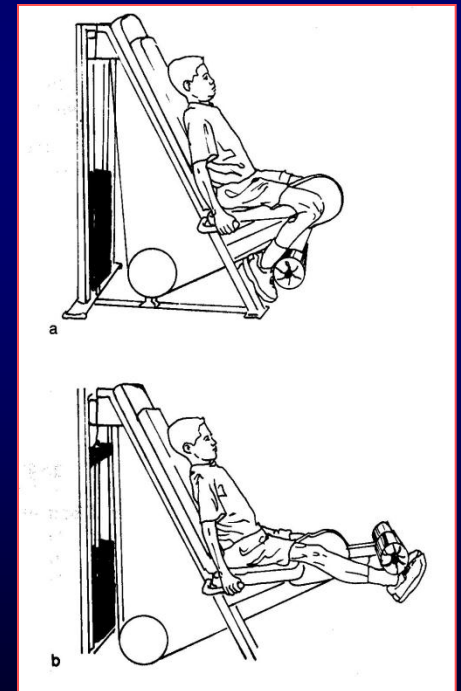
DAC
Leg-press
duplo

Riscos – Resistidos - Hipertenso



Início
138/67 mmHg

Fadiga Concêntrica
242/113 mmHg

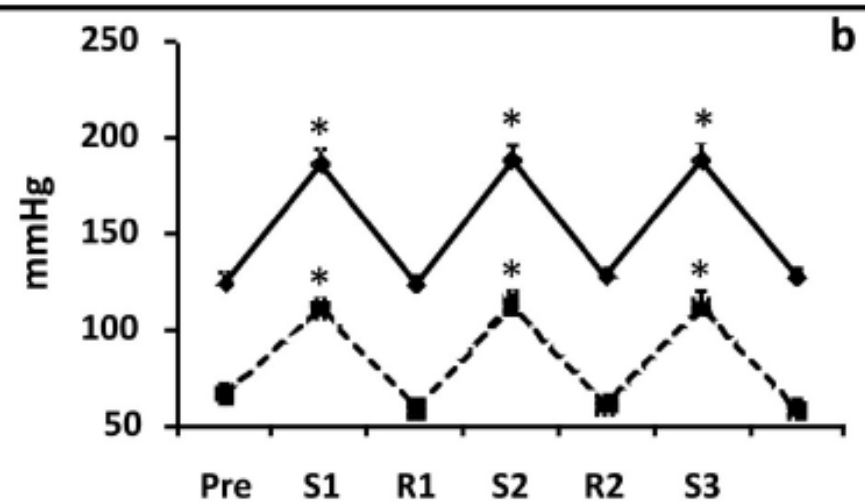
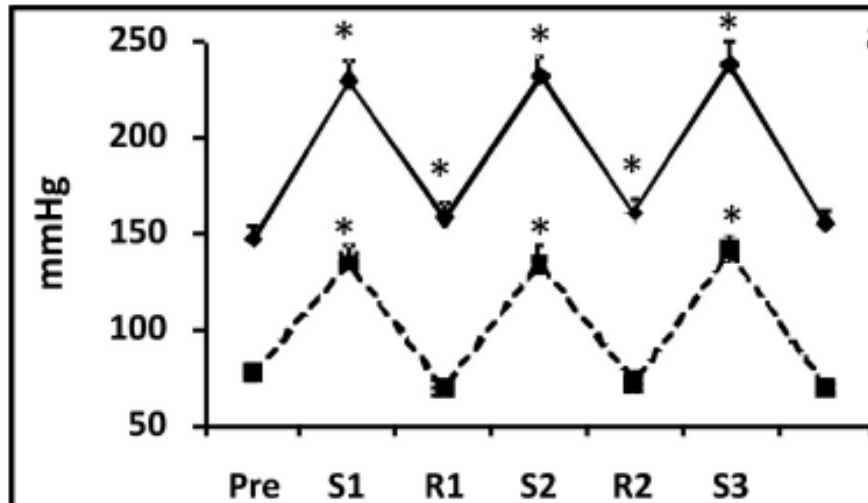


Extensão de pernas - 40% CVM – até exaustão

POPULATION

Hypertensives

Normotensives



Repouso = 140/80 mmHg

S1, RML = 229/125

S2, PML = 224/121

S3, RML = 239/128

Repouso = 124/66 mmHg

S1, RML = 186/110

S2, PML = 188/113

S3, RML = 187/111

hypertensives (10)

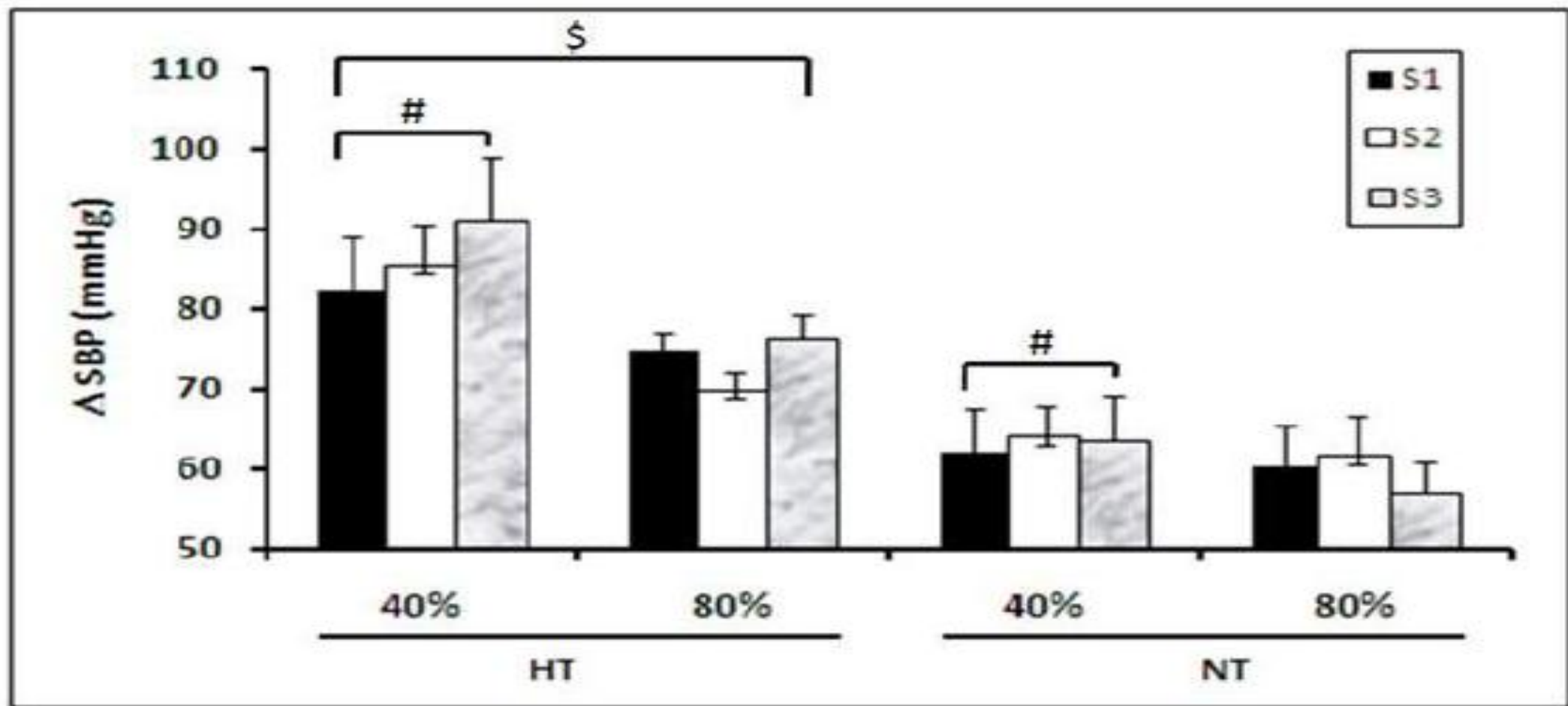
Normotensives (10)

40 % of 1RM

To Exhaustion

Leg Extension

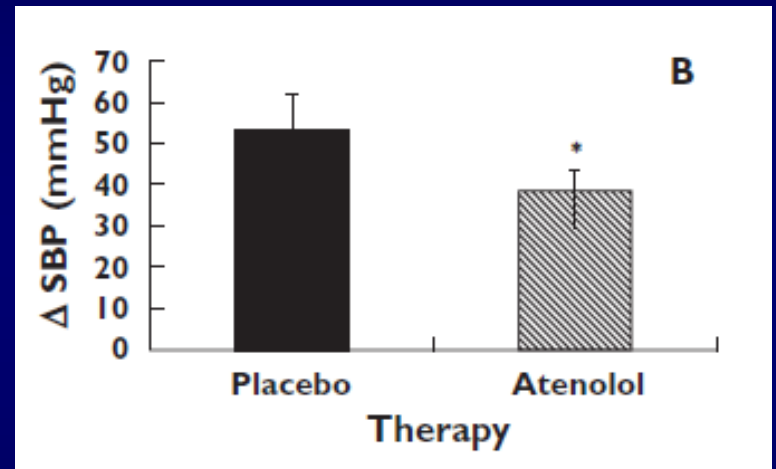
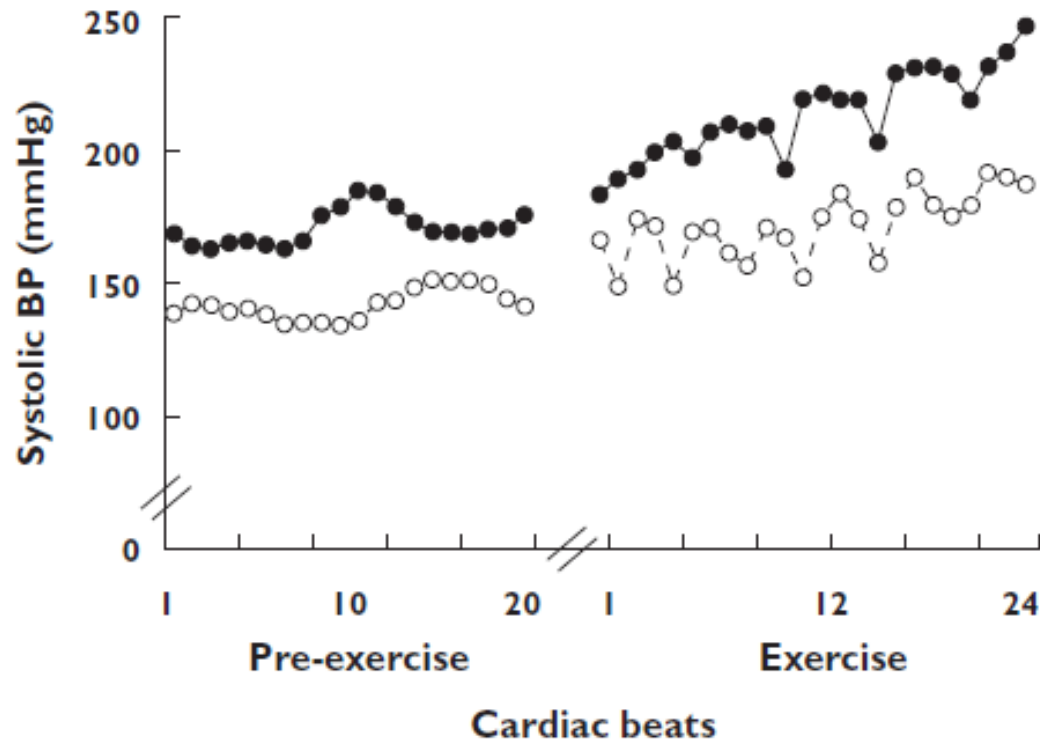
POPULATION



mean increase in SBP during exercise sets was significantly greater in hypertensive vs. normotensive subjects (40% of 1RM, $+86.4 \pm 3.7$ vs. $+63.3 \pm 2.7$ mmHg and 80% of 1RM = $+73.7 \pm 4.3$ vs. $+59.7 \pm 2.7$ mmHg, respectively,

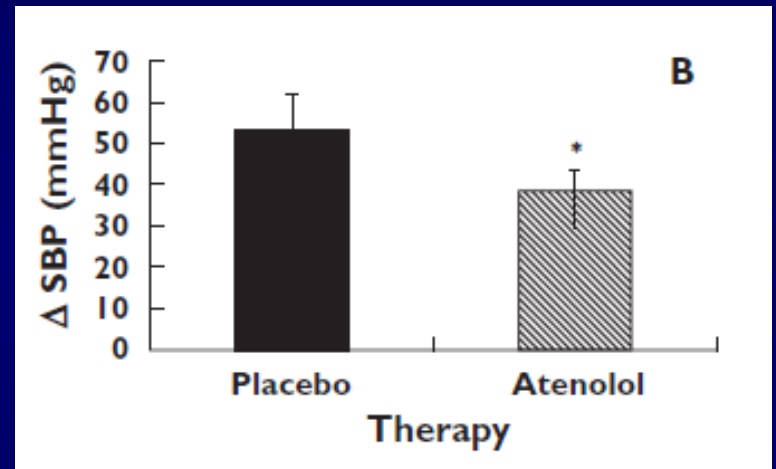
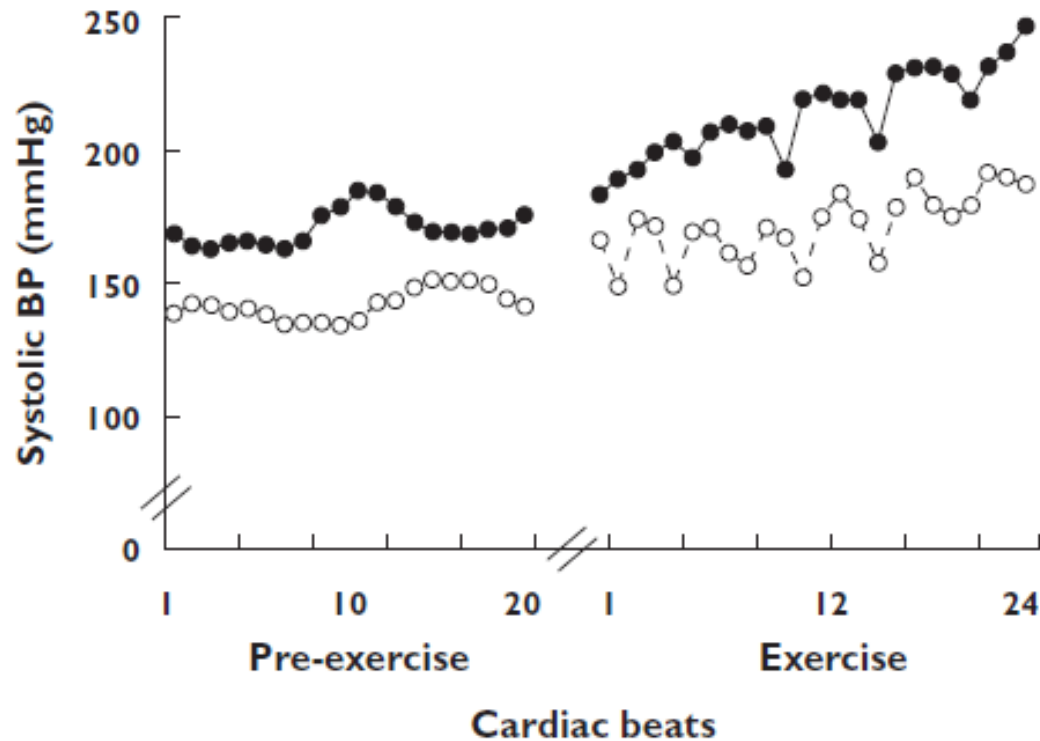
hypertensives (10)
Normotensives (10)
40 e 80% of 1RM
To Exhaustion
Leg Extension

Medication



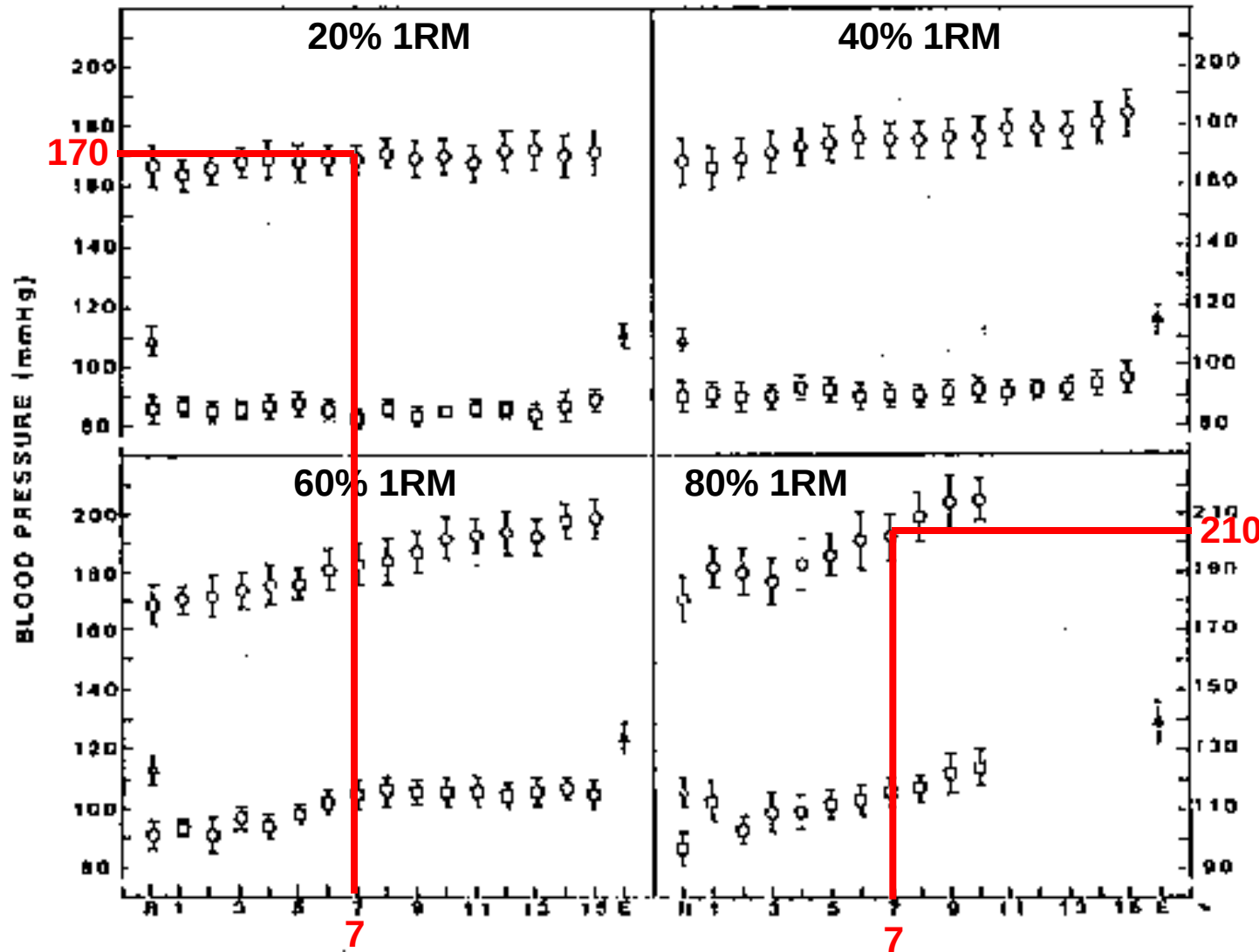
Hipertensive Subject
Placebo (black circles) and atenolol (open circles).
Leg extension
80% of 1RM until concentric fatigue

Medication



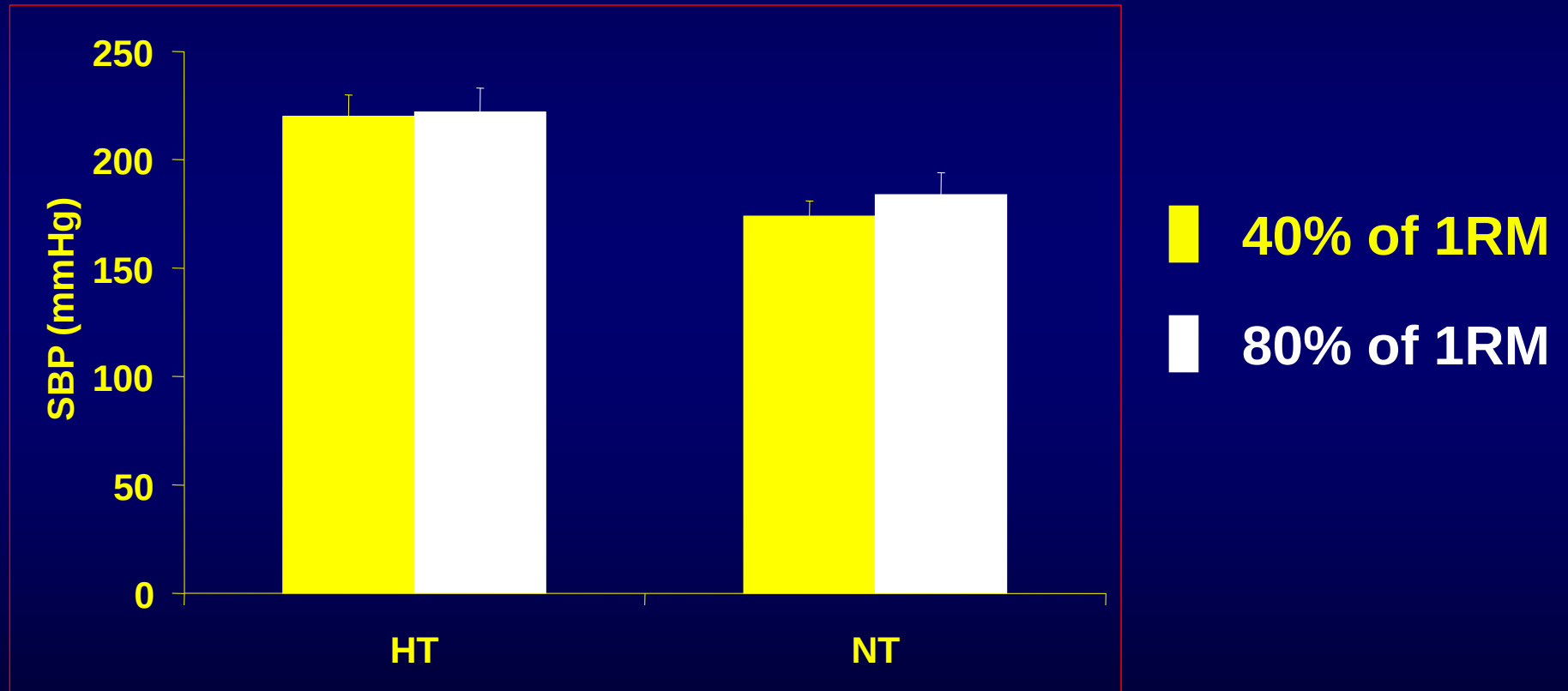
Hipertensive Subject
Placebo (black circles) and atenolol (open circles).
Leg extension
80% of 1RM until concentric fatigue

Intensity (Same Repetition Number)

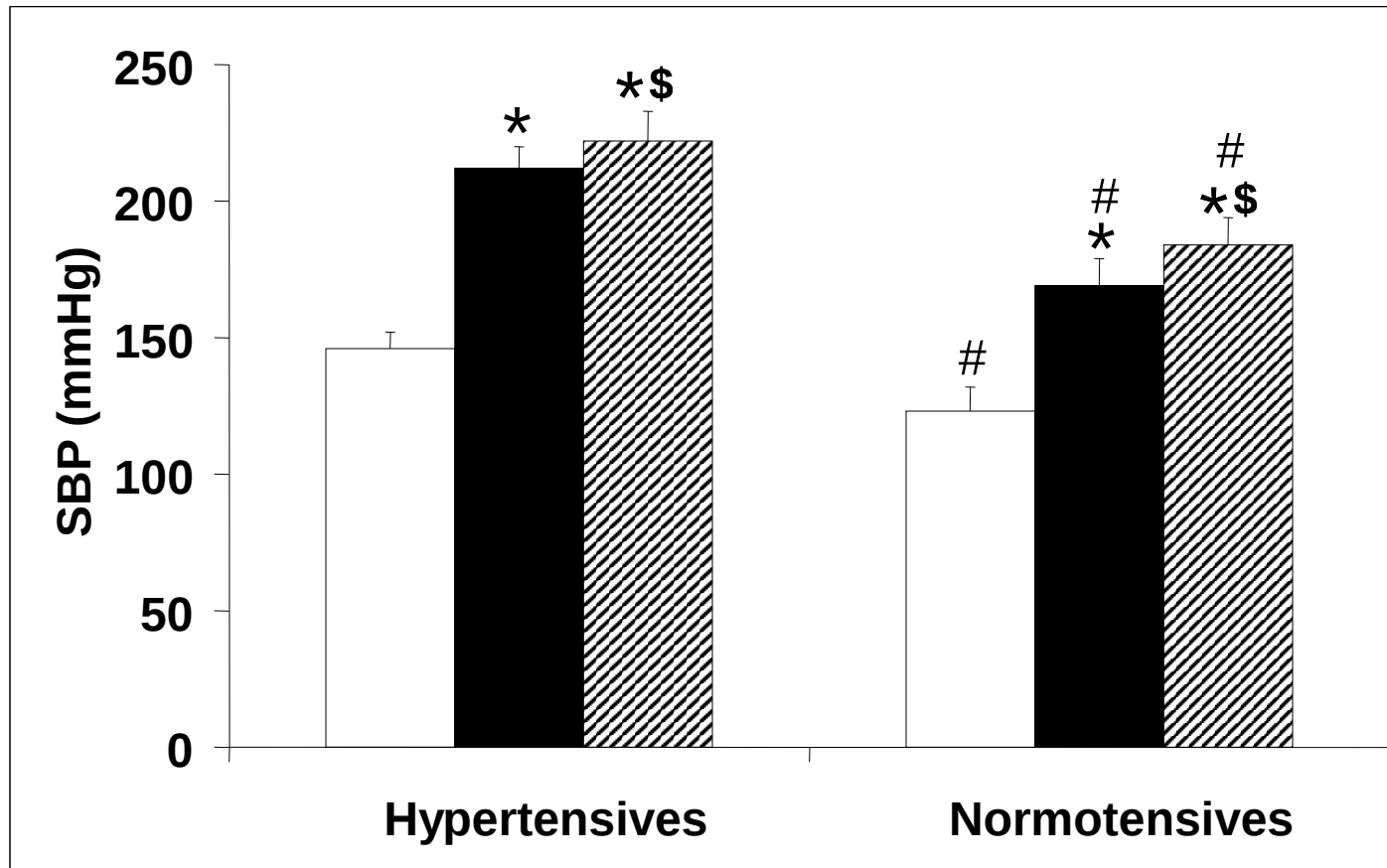


DAC
Leg-press

Intensity to Fatigue



EXERCISE INTENSITY AND CONCENTRIC FAILURE



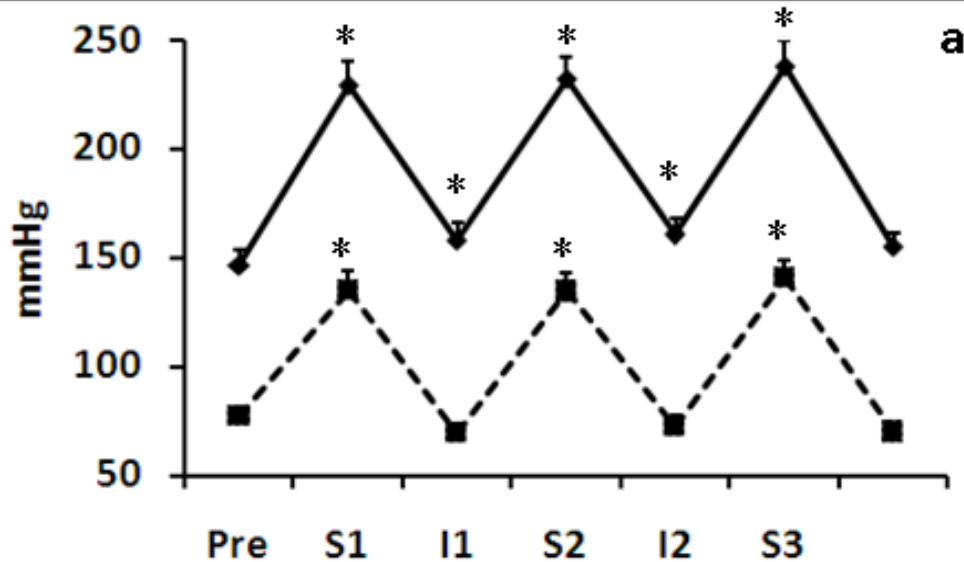
- Beginning
- Moderate Fatigue
- Concentric Fatigue

Δ Conc - Moderate
 $+25 \pm 9$ mmHg

Moderate Fatigue = reduction of movement velocity

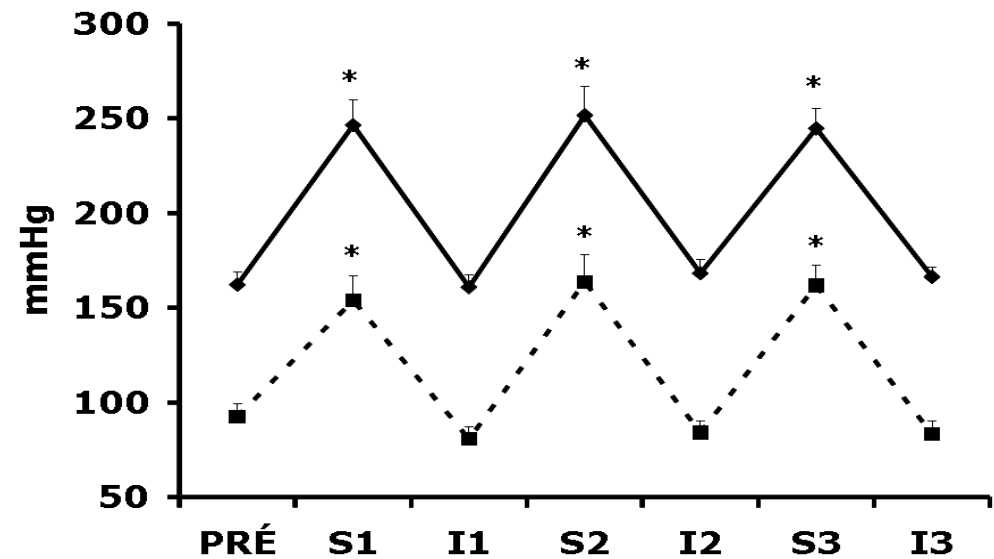
INTERVALS AND SETS

Hypertensives



45 seconds of pause

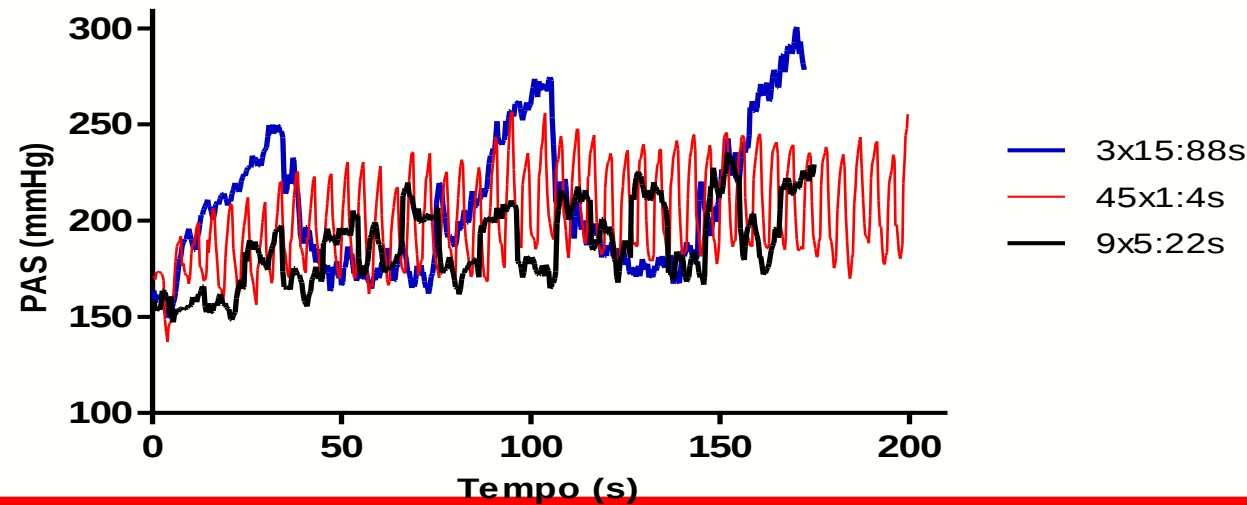
Hypertensives



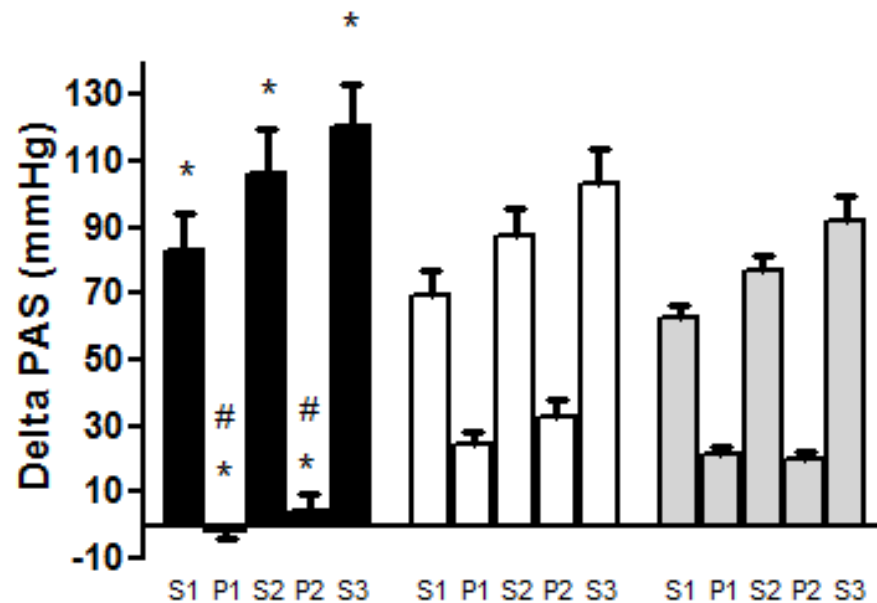
90 seconds of pause

**40 % of 1RM
3 sets
To Exhaustion
Leg Extension**

SETS, REPETITIONS AND INTERVALS



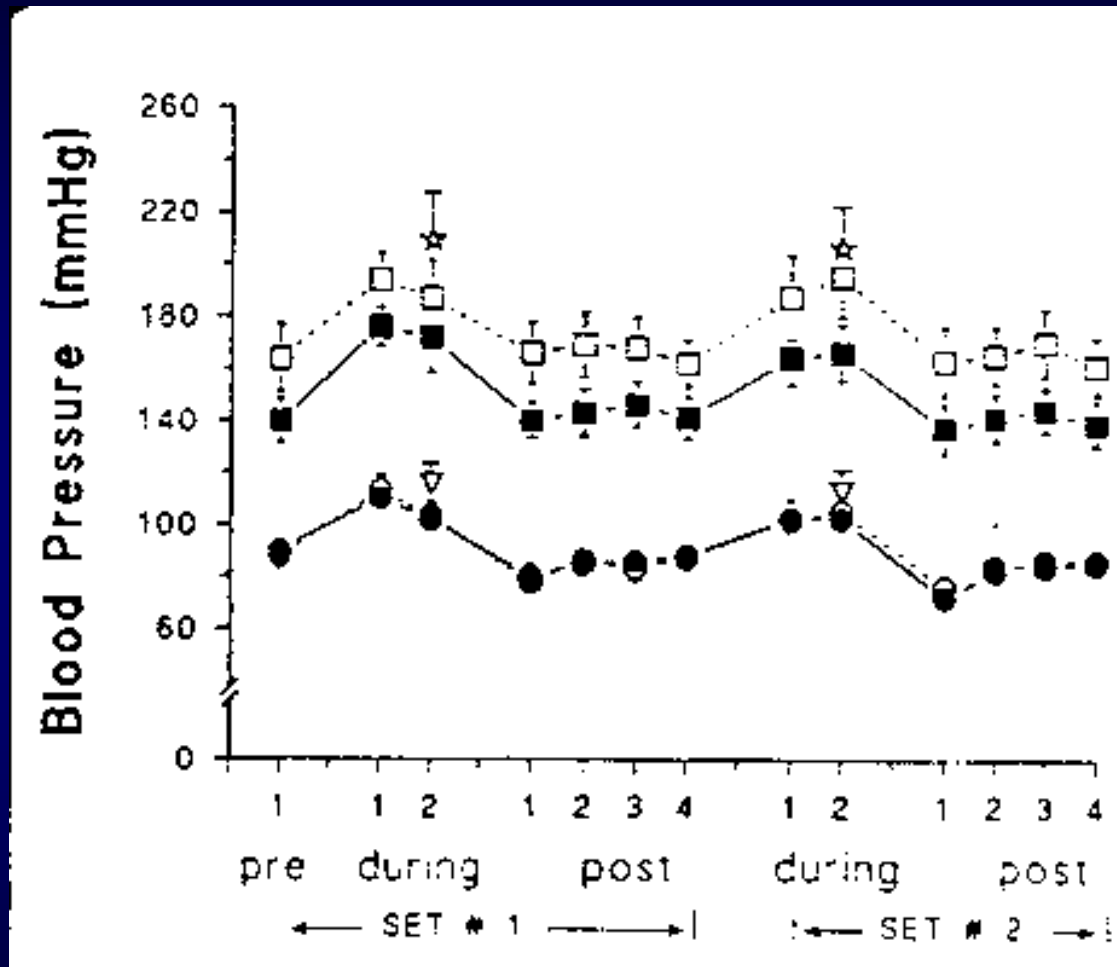
> Sets
< repetitions
> intervals



■ 3x15:88s
□ 45x1:4s
■ 9x5:22s

Autor	Amostra	Exercício	Medida da PA	Resposta Máxima
Lamote et al., 2005	DAC	40 e 70% 1RM	Finapress	PAS=213±25
Haslam et al., 1988	DAC	20,40,60, 80%1RM	Intraarterial	PAS=215±7 PAD=124±6
Wiecek et al., 1990	DAC	40,60%1RM	Intraarterial	PAS=249±16 PAD=152±12
Olivier et al.,2001	Transp	50% 1RM	Intraarterial	PAS=180±14 PAD=116±7
Wescott e Howes, 1983	Jovens Idosos	10rep – 10RM, 10RM-2kg, 10RM-4,5 kg	Auscultatorio	PAS = 165±5 PAD = 75±3
Freedson et al., 1984	Saud	25 e 50% 1RM	Intraarterial	PAS=245±14 PAD=160±10
MacDougall et al., 1985	Atletas	95% 1RM	Intraarterial	PAS=320 PAD=250
Harris e Holly, 1987	HT	40% 1RM	Auscultatório pós	PAS=155±12 PAD=87±11
McCartney et al., 1993	Saud	60 e 80% 1RM	Intraarterial	PAS=260±9 PAD=175±12
Fleck and Dean, 1987	Atletas Novatos Controle	90,80,70,50%1RM	Intraarterial	PAS=±190 PAD=±150
Sale et al., 1994	Saud	50,70,80,85,87.5%RM	Intraarterial	PAS=360 PAD=234

BLOOD PRESSURE MEASUREMENT



□ Intra-arterial
■ Auscultatory

Auscultatory

Inactive limb - during
13 a 15% lower

Immediately after
31 a 34% lower

BLOOD PRESSURE MEASUREMENT



	Intra-arterial		FPP		P	ICC	P
	Mean $\pm$ SD	Range	Mean $\pm$ SD	Range			
pre-exercise mean values (n = 635 measurements)							
systolic BP, mmHg	152 $\pm$ 10	132–182	157 $\pm$ 13	126–201	<0.01	0.81	<0.01
diastolic BP, mmHg	89 $\pm$ 7	72–117	84 $\pm$ 8	69–112	<0.01	0.77	<0.01
exercise mean values (n = 854 measurements)							
systolic BP, mmHg	198 $\pm$ 26	122–249	202 $\pm$ 29	128–284	<0.01	0.89	<0.01
diastolic BP, mmHg	127 $\pm$ 22	77–219	117 $\pm$ 24	64–211	<0.01	0.77	<0.01
exercise maximal values (n = 24 measurements)							
systolic BP, mmHg	234 $\pm$ 16	191–249	240 $\pm$ 26	173–284	<0.05	0.87	<0.01
diastolic BP, mmHg	167 $\pm$ 24	134–219	153 $\pm$ 28	99–211	<0.01	0.98	<0.01
difference between maximal and last minute pre-exercise values (n = 24 measurements)							
Δ systolic BP, mmHg	+71 $\pm$ 18	29–101	+73 $\pm$ 29	20–124	0.59	0.90	<0.01
Δ diastolic BP, mmHg	+79 $\pm$ 25	46–132	+71 $\pm$ 27	22–122	<0.01	0.99	<0.01

BLOOD PRESSURE DURING RESISTANCE EXERCISE SUMMARY

Substantial increase in both Systolic and Diastolic BP

Greater BP increase

Intensity

concentric fatigue

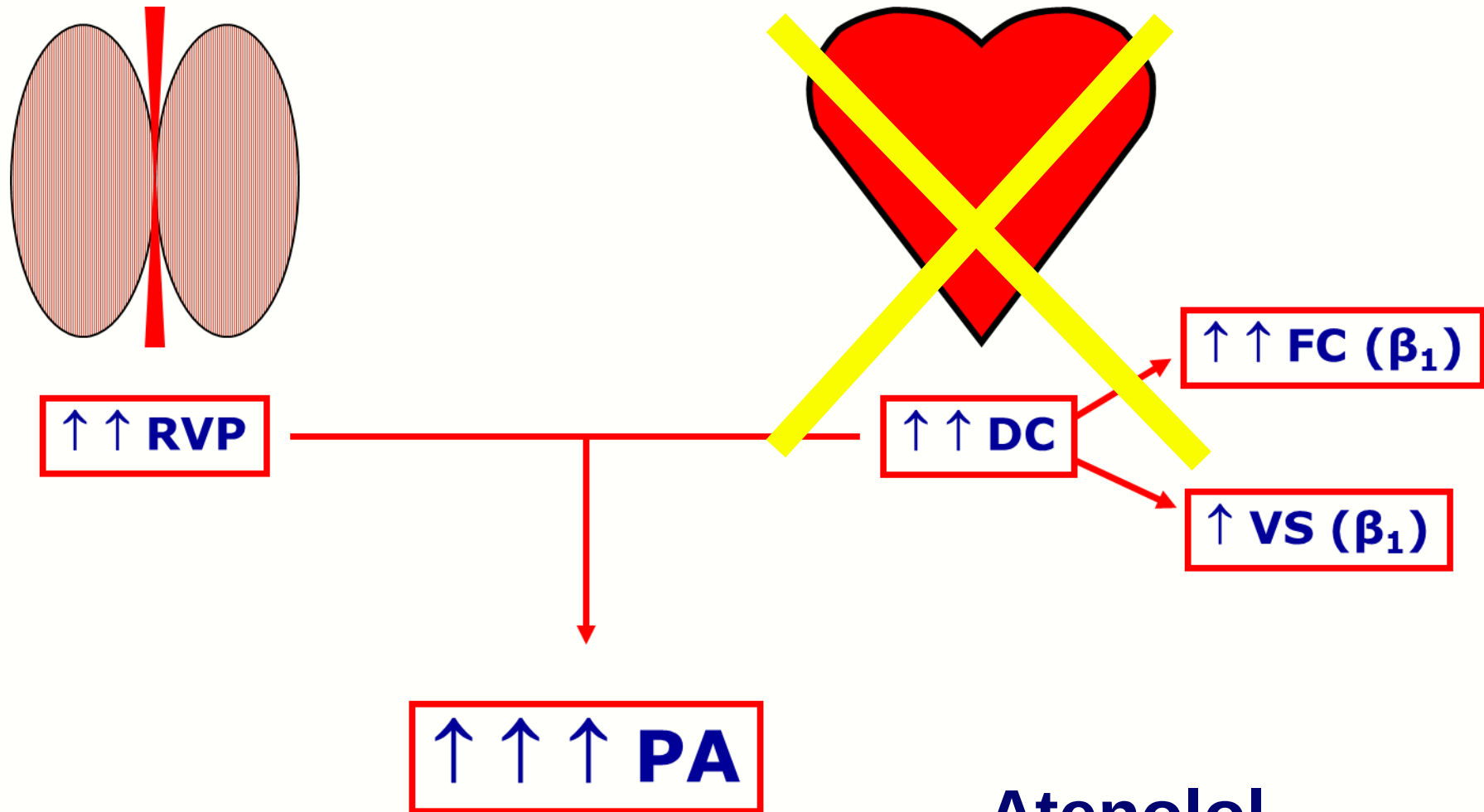
Pause duration

**Minimize BP – Increase sets, reduce repetitions, increase pauses,
and stop at MODERATE fatigue**

Blood Pressure Measurement

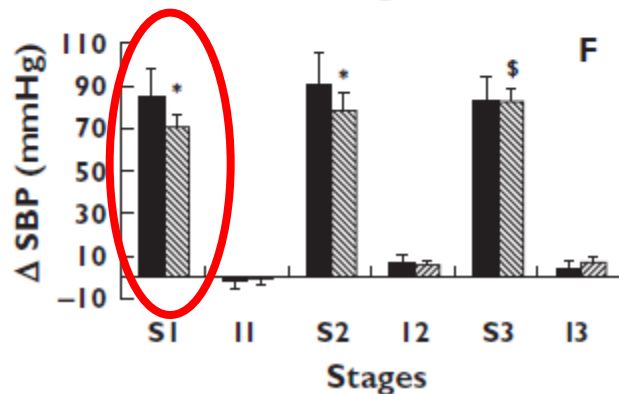
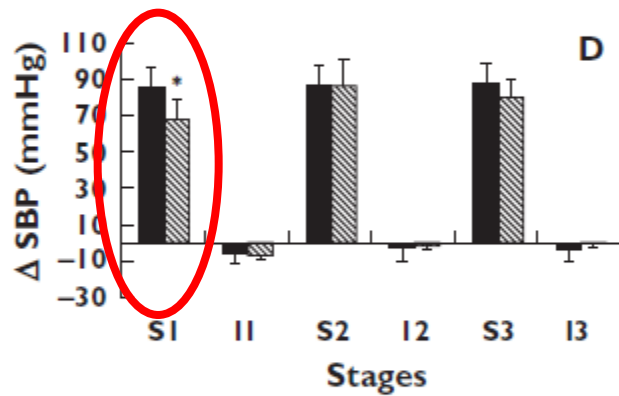
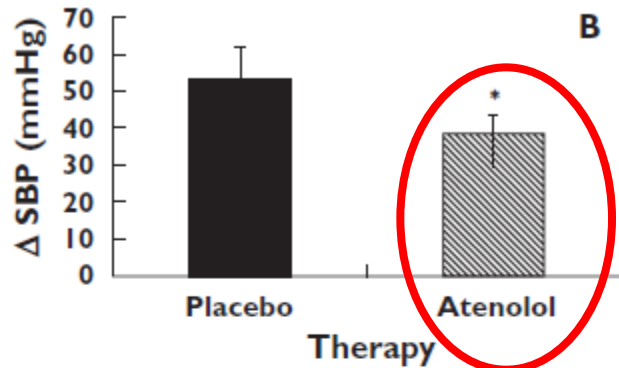
Changes are possible to be assessed with Finometer

Mechanisms



Atenolol

Mechanism



100%1RM

80%1RM

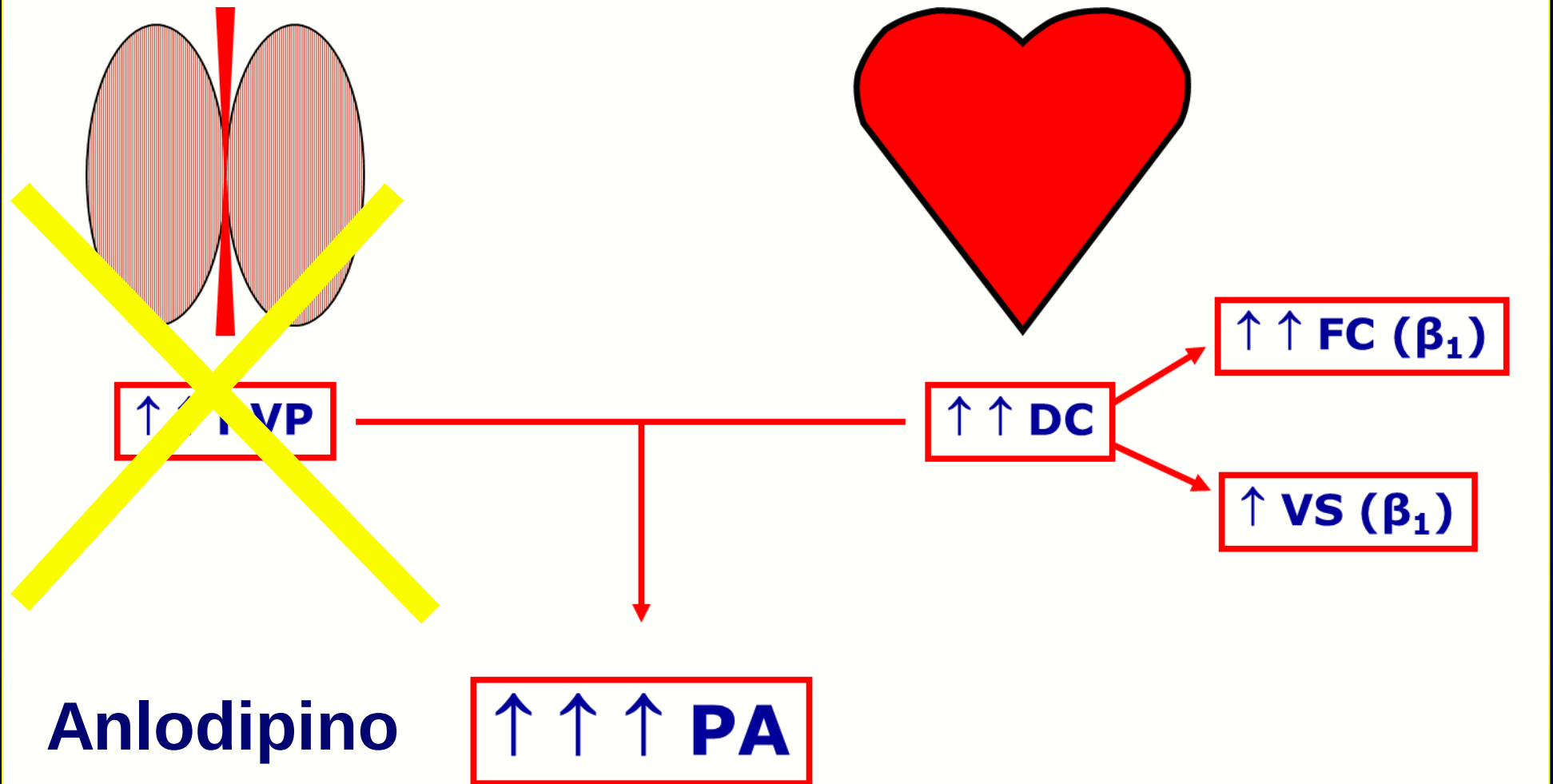
40%1RM

Atenolol

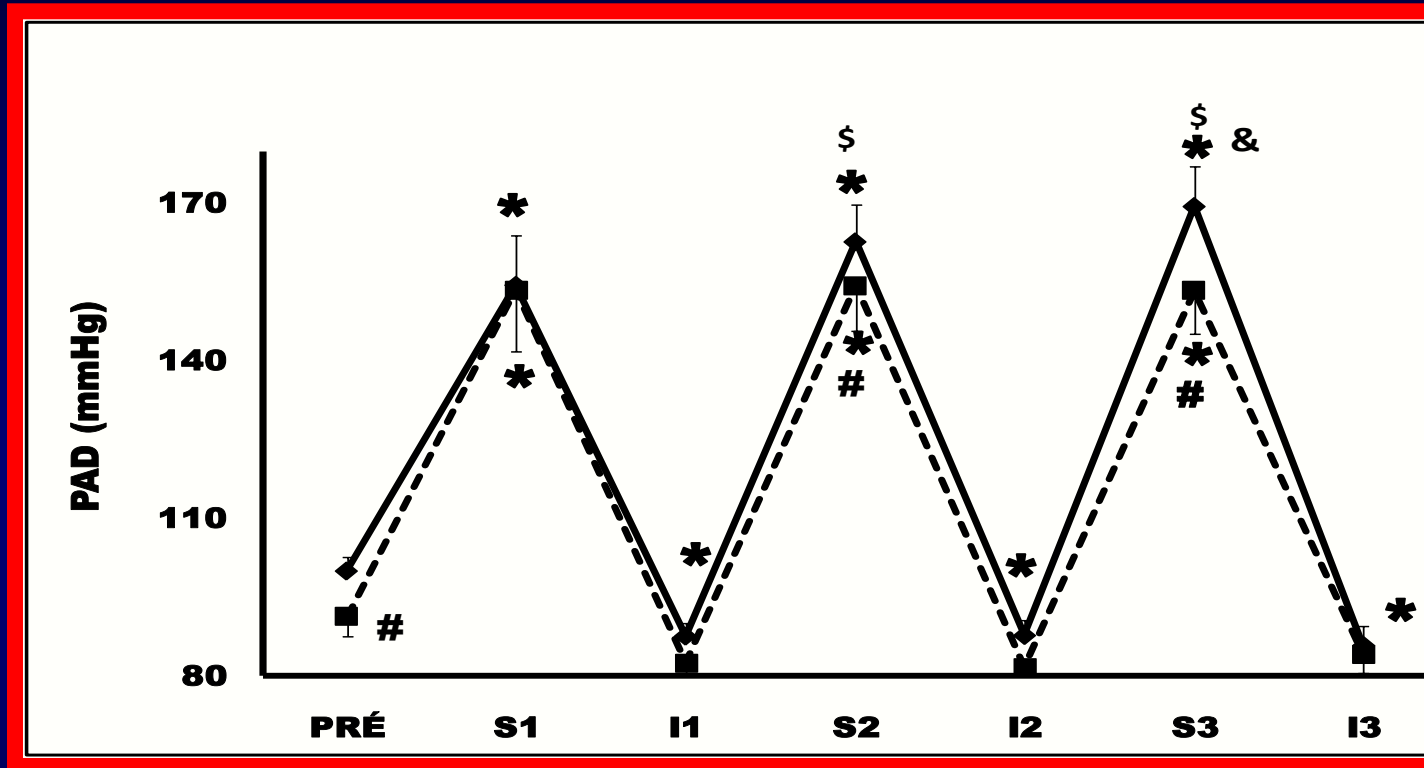
↓ ΔBP in the 1st set
CO important

Gomides et al.
BJCP, 2010

Mechanisms



Mechanism



Anlodipíno

* ≠ Pré; # ≠ Placebo; \$ ≠ S1; & ≠ S2, () efeito principal na ANOVA ($P < 0,05$).

Aumento da PA no exercício Resistido



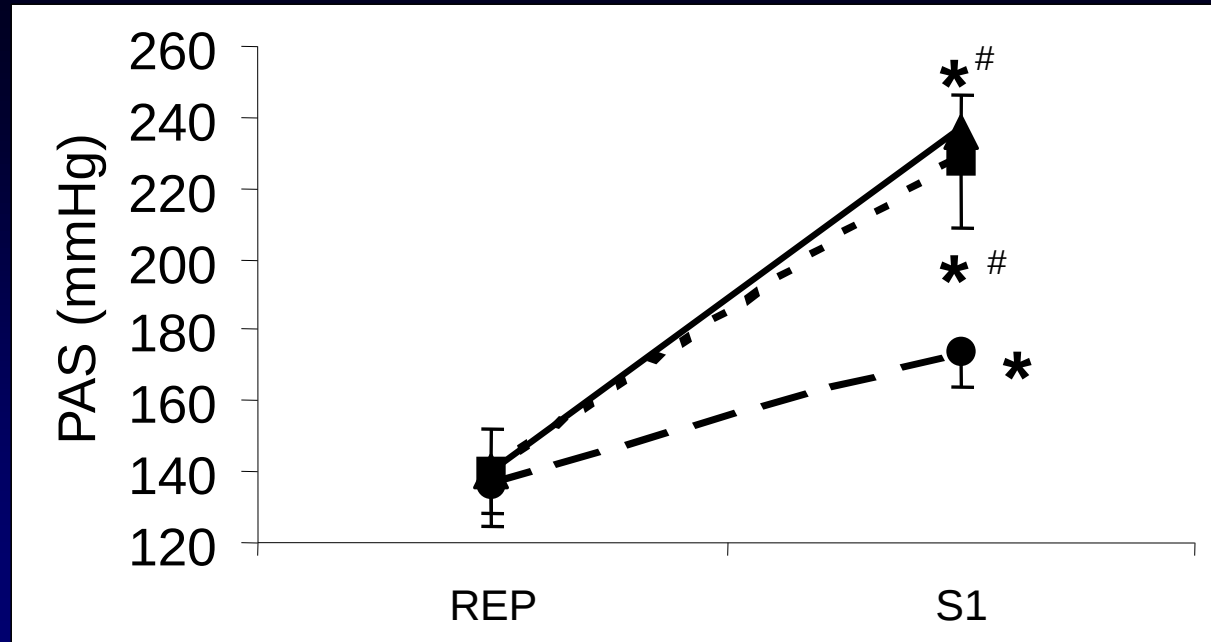
**Não é controlável
Mas pode ser minimizado**

- **Estar medicado**
- **Estar controlado (<160/105 mmHg)**
- **Menor massa**
- **Baixa intensidade**
- **Parar antes da fadiga (↓ vel movimento)**
- **Pausa longas entre as séries**

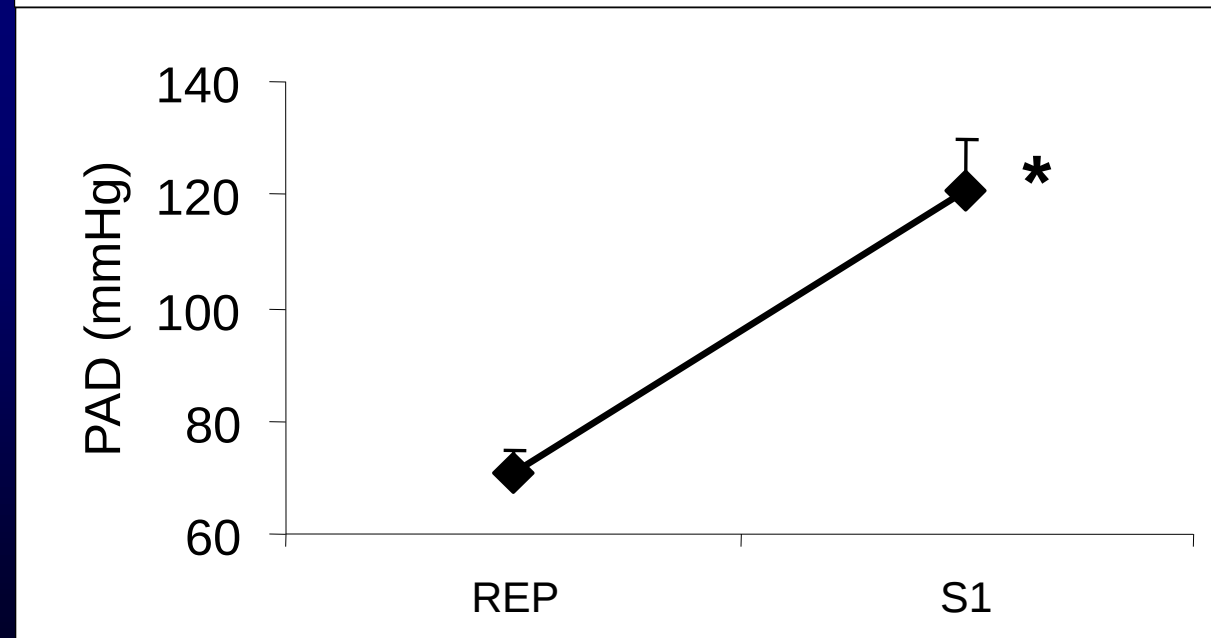
PA no teste de 1RM

Hipertensos

* Diferente do rep
Diferente de 100%



—●— 100% de 1RM —▲— 80% de 1RM -■- 40% de 1RM



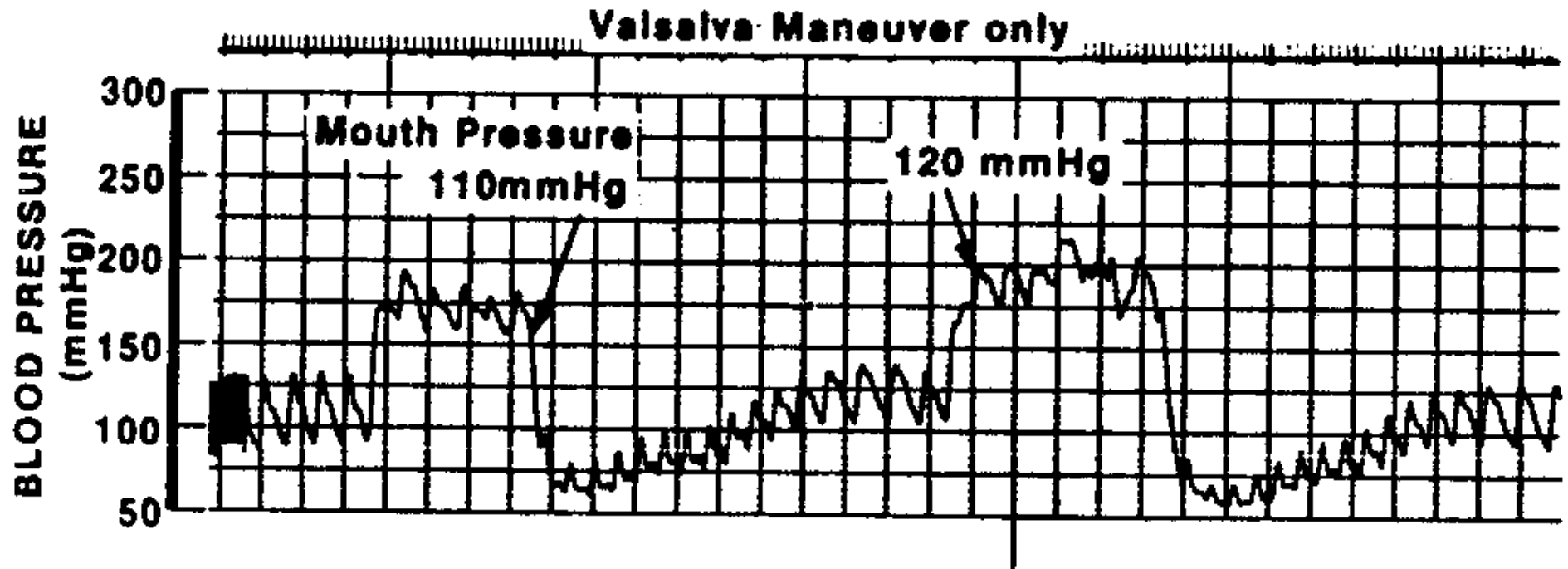
—◆— valor combinado intensidade (100%, 80% e 40% de 1RM)

Manobra de Valsalva:

- Proteção ?**

- Risco ?**

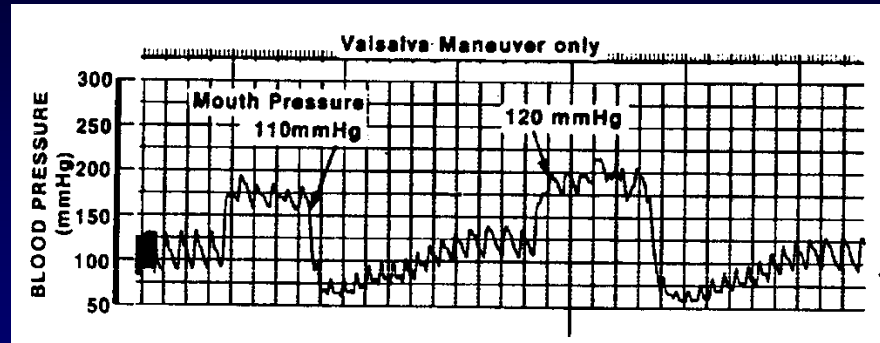
VALSALVA



Adaptado de MacDougall. J. Appl. Physiol. 58:785-90, 1985.

SEGURANÇA – VASALVA

↑ PAS
↑ PAD



EVITAR

↑ Pressão
Intratorácica

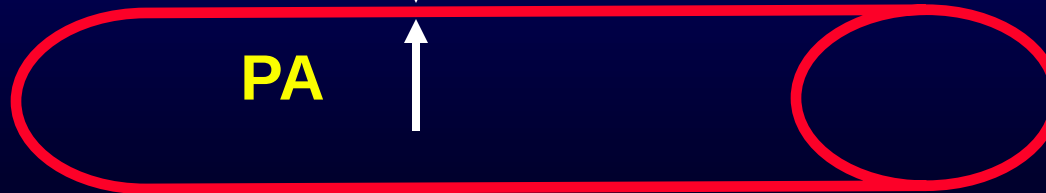
↑ Pressão
Cérebro Espinhal

→ Pressão Transmural
Protege Cérebro

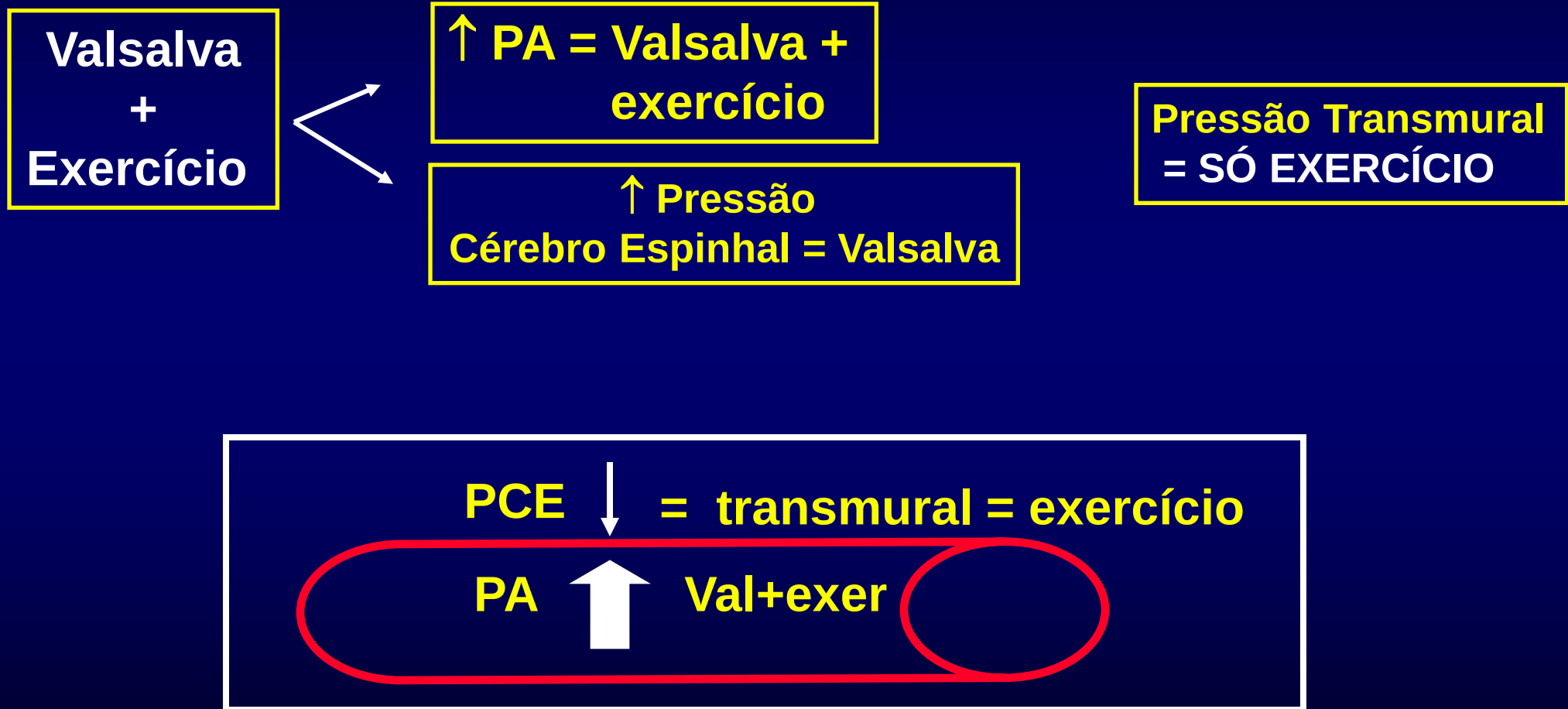
FAZER

PCE ↓ = transmural = 0

PA ↑

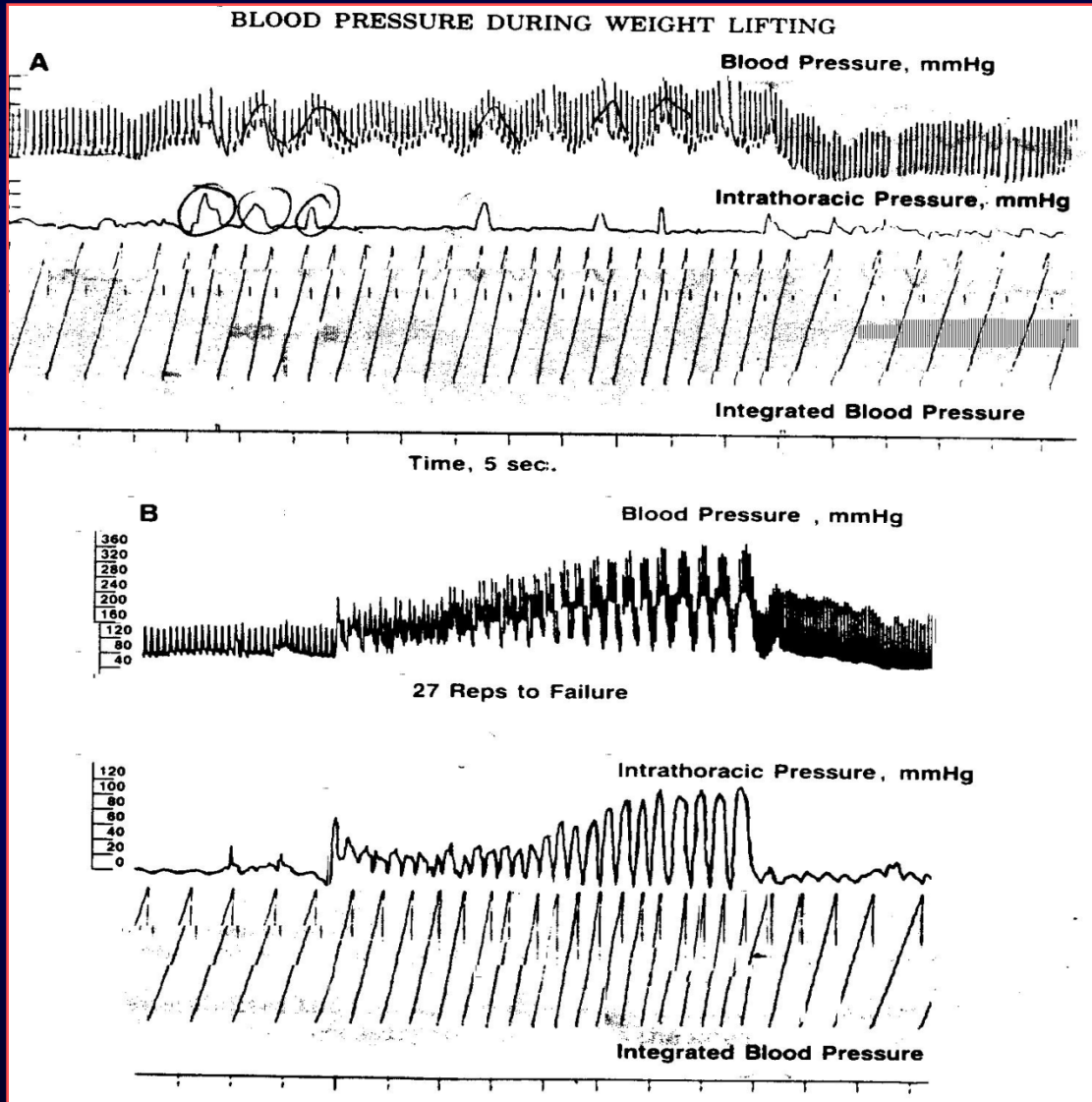


SEGURANÇA – VASALVA



Não se indica Valsalva no treino ?

- Obrigatória em + 80% CVM



até 75% de 1RM- ocasionalmente
85% de 1RM-inevitável

SEGURANÇA – VASALVA

- Obrigatória em + 80% CVM

- ↑ Pressão Intratorácica

- ↑ Pressão Arterial Sistólica
- ↑ Pressão Arterial Diastólica

- ↓ RV
- ↓ VS

- ↑ PAD
- ↑ Perfusão Coronária

- ↑ Pressão Intratorácica
- ↑ Pressão Cérebro Espinhal
- ↓ Pressão Transmural
- Protege Cérebro ?????



Não se indica Valsalva no treino