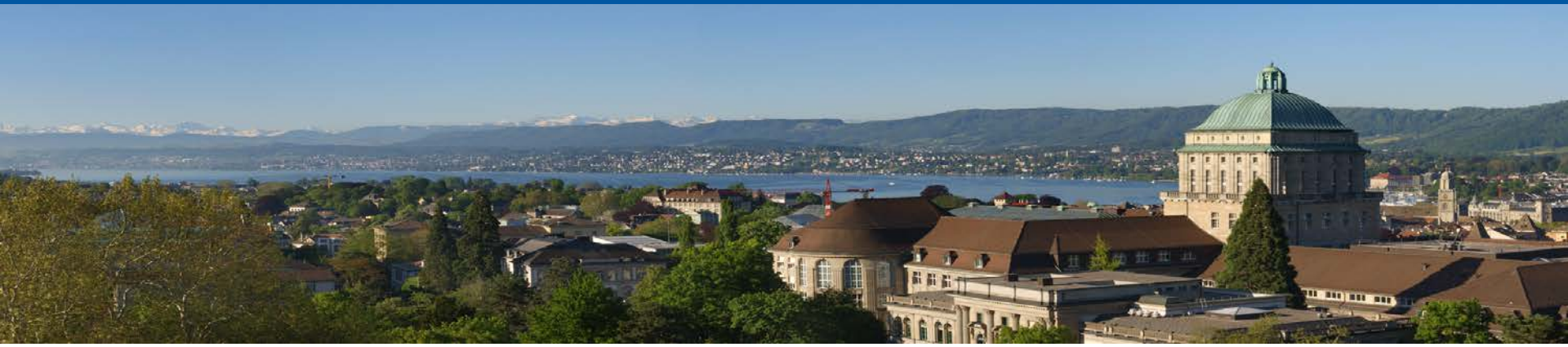


Rationale kardiale Vorsorgeuntersuchungen

bei ambitionierten Sportlern in der Hausarztpraxis

Fortbildungsnachmittag Hausarztmedizin
Zürich, 23. August 2018

PD Dr. med. Christian Marc Schmied
Klinik für Kardiologie, Universitäres Herzzentrum Zürich
Leiter Ambulatorium
Leiter Sportkardiologie

swiss olympic APPROVED

ETH zürich

UniversitätsSpital Zürich

INTERNATIONAL ICE HOCKEY FEDERATION

FIFA For the Game. For the World.

Disclosures

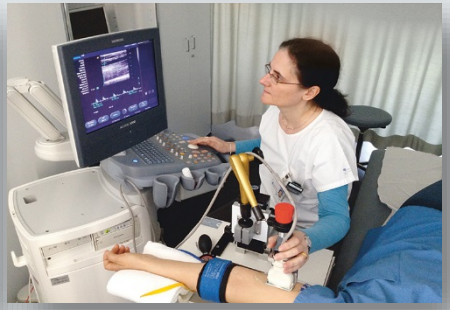
Consultancies and advisory board memberships
MSD, Pfizer, BMS, Amgen, Doetsch Grether, Bayer

Lecture fees and honoraria
MSD, Pfizer, BMS, Amgen, Sanofi, Servier, Edwards, Medtronic, Novartis, Daiichi Sankyo

Expert witness for a commercial entity
Boeringer Ingelheim, Astra Zeneca

Sportkardiologie/Sportmedizin, Präventive Kardiologie USZ

Klinische Kardiologie	Sport-/Bewegungs-kardiologie	Sportmedizin	Präventive Kardiologie



Allgemeine Kardiologie
Triage

EKG, Ergometrie, Echokardiographie, Schrittmacherabfrage

Spezialsprechstunde

Prävention/Screening SCD
Trainingsberatung bei kardiovask. Erkrankungen

Ambulante kardiale Rehabilitation

Leistungstests
Trainingsberatung
Feldeinsätze

Spezialsprechstunden:

Hypertonie
Dyslipidämie

Mantelstudium Sportmedizin (UZH)

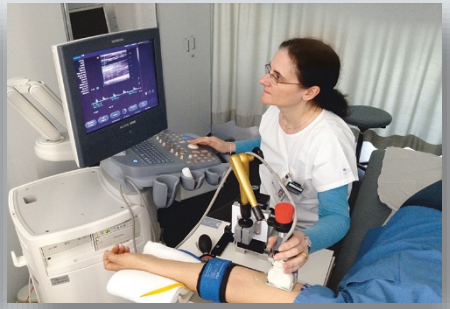
«Clinical Exercise Physiology» (ETHZ)

- **25-30 Masterarbeiten und Dissertationen**
- **rund 75 Publikationen**

SANTASANA St. Moritz

Sportkardiologie/Sportmedizin, Präventive Kardiologie USZ

Klinische Kardiologie	Sport-/Bewegungs-kardiologie	Sportmedizin	Präventive Kardiologie



Allgemeine Kardiologie
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Schweizerische Gesellschaft für Sportmedizin
Société Suisse de Médecine du Sport
Società Svizzera di Medicina dello Sport

Universität Zürich[UZH]

"FIFA Medical Center of Excellence"
University Heart Center Zurich

FIFA Philosophie der medizinischen Prävention

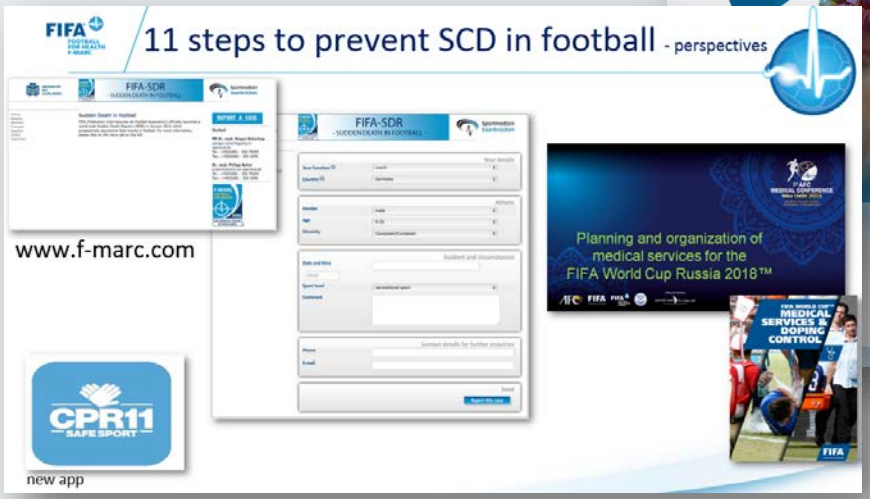
Football for Health

11+ ...to prevent injuries

11steps ...to prevent SCD

11roules ...to prevent doping

11for Health ...to prevent diseases



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Sports Cardiology Section

Cardiac screening, education and science evolution in Sports Cardiology

EUROPEAN SOCIETY OF CARDIOLOGY®

http://www.escardio.org/EAPC

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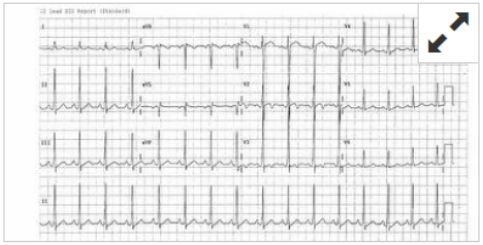
< Topics 4. Sports Cardiology

Courses

- Section 0 - Core Curriculum
- Section 1 - Anatomy, physiology, and health benefits
- Section 2 - Cardiac evaluation in sports cardiology

THE CASE:

A 20-year-old black football player collapsed during a football match on the pitch. He did not have any previous sinister cardiac symptoms. He was not on any regular medications and there was no family history of premature sudden cardiac death or cardiomyopathy. Bystander CPR was commenced immediately. Paramedics arrived within 7 minutes and found the patient in ventricular fibrillation. Sinus rhythm was restored after a single shock by automated external defibrillator. On arrival at the hospital his GCS was 14, maximum Troponin I was 139 ug/l (normal <0.05 ug/l) and his 12-lead ECG is presented below.



1. What is the most likely cause of the cardiac arrest based on the ECG features?

- A. Arrhythmogenic right ventricular cardiomyopathy
- B. Brugada syndrome
- C. Hypertrophic cardiomyopathy
- D. Long QT syndrome
- E. None of the above

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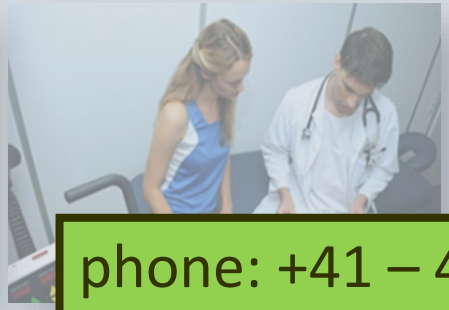
Sportkardiologie/Sportmedizin, Präventive Kardiologie USZ

Klinische Kardiologie	Sport-/Bewegungs-kardiologie	Sportmedizin	Präventive Kardiologie

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christian.schmied@usz.ch
sportkardiologie@usz.ch

Allgemeine Kardiologie
Triage

EKG, Ergometrie, Echokardiographie, Schrittmacherabfrage

Sp

Pr
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ka

Ambulante kardiale Rehabilitation

Spezialsprechstunden:

Hypertonie
Dyslipidämie
Raucherentwöhnung

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Agenda

Einleitung

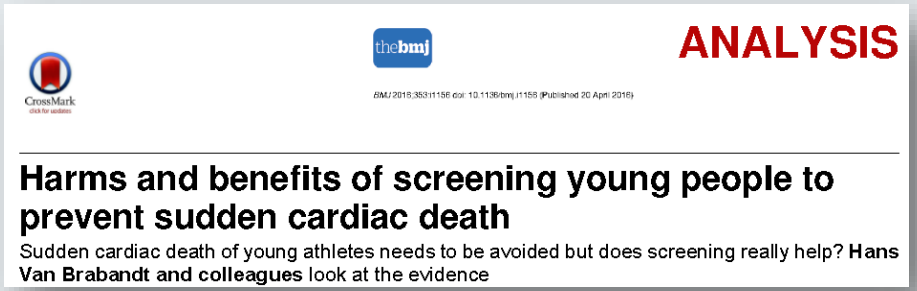
Ist Sport gesund?

Der plötzliche Herztod im Sport

Aktuelle Screeningmethoden («EKG Spezial»)

Fragen und Diskussion

Kardiales Screening bei Sportlern – Die grosse Debatte



thebmj

ANALYSIS

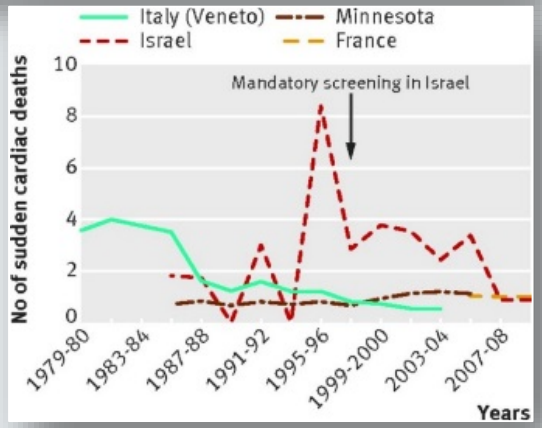
BMJ 2016;353:i1156 doi: 10.1136/bmj.i1156 (Published 20 April 2016)

Harms and benefits of screening young people to prevent sudden cardiac death

Sudden cardiac death of young athletes needs to be avoided but does screening really help? **Hans Van Brabandt and colleagues** look at the evidence

Therefore, based on current evidence, it cannot be justified and, in our view, it is even unethical, to intrude into the life of an asymptomatic sportive youngster by submitting him or her to such screening.

As long as those at high risk of sudden death cannot reliably be identified and appropriately managed, young athletes should not be submitted to pre-participation screening.



Van Brabandt H, et al. BMJ 2016;353:i1156

American Heart Association. Learn and Live

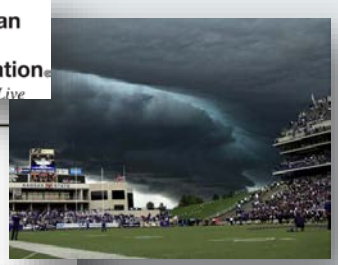


TABLE. The 12-Element AHA Recommen
Preparticipation Cardiovascular Screenin
Competitive Athletes

Medical history*

Personal history

1. Exertional chest pain/discomfort
2. Unexplained syncope/near-syncope†
3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure

Family history

6. Premature death (sudden and unexpected, or otherwise) before age 50 years due to heart disease, in ≥1 relative
7. Disability from heart disease in a close relative <50 years of age
8. Specific knowledge of certain cardiac conditions in family members:

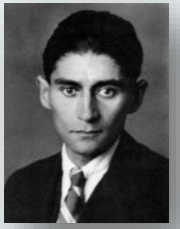
10. Femoral pulses to exclude aortic coarctation

Sensitivity,: 45.5% [95% CI, 16.8% to 76.2%]
Specificty, 94.4% [CI, 92.0% to 96.2%]

Sensitivität und Spezifität >90%
(unpublished)

Baggish AL, et al. Ann Intern Med. 2010;152(5):269-75

Verbringe die Zeit nicht mit der Suche nach einem Hindernis –
Vielleicht gibt es keines.



Franz Kafka
1888-1924

Die aktuelle Debatte rund um das kardiale Screening ist wichtig -

…aber sie sollte das Konzept verbessern und nicht verhindern


PRINCIPLES AND PRACTICE
OF SCREENING FOR
DISEASE

J. M. G. WILSON
Principal Medical Officer, Ministry of Health, London, England

G. JUNGNER
Chief, Clinical Chemistry Department, Sahlgren's Hospital, Gothenburg, Sweden

WORLD HEALTH ORGANIZATION
GENEVA

Wilson and Jungner: "The central idea of early disease detection and treatment is essentially simple. However, the path to its successful achievement (on the one hand, bringing to treatment those with previously undetected disease, and, on the other, avoiding harm to those persons not in need of treatment) is far from simple though sometimes may appear deceptively easy."

- Der plötzliche Herztod ist eines der wichtigsten medizinischen und sozio-ökonomischen Themen unserer Zeit.

- Dies gilt vor allem, aber nicht nur, für den sport-induzierten plötzlichen Herztod (*sog. "Sport Paradox").*

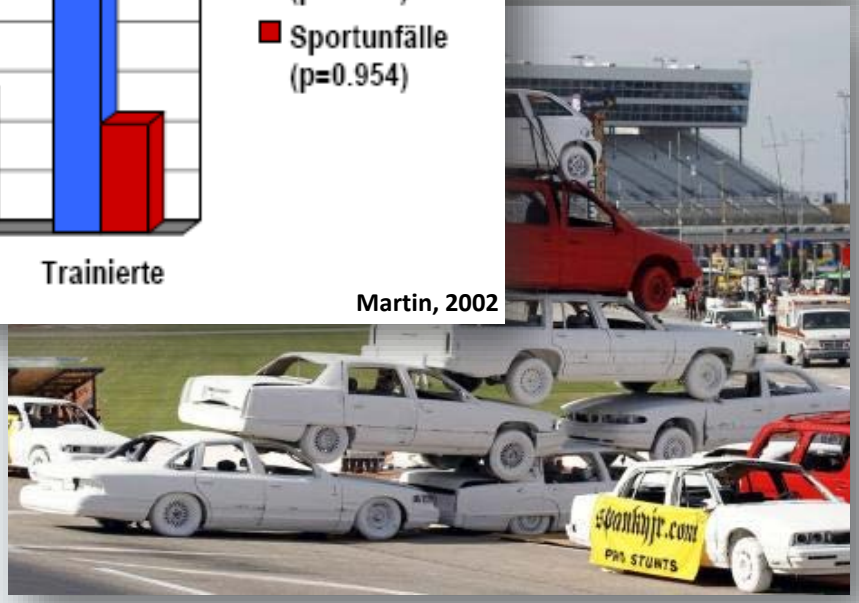
- Ziel sollte eine Reduktion der Mortalität aber auch der Morbidität sein.

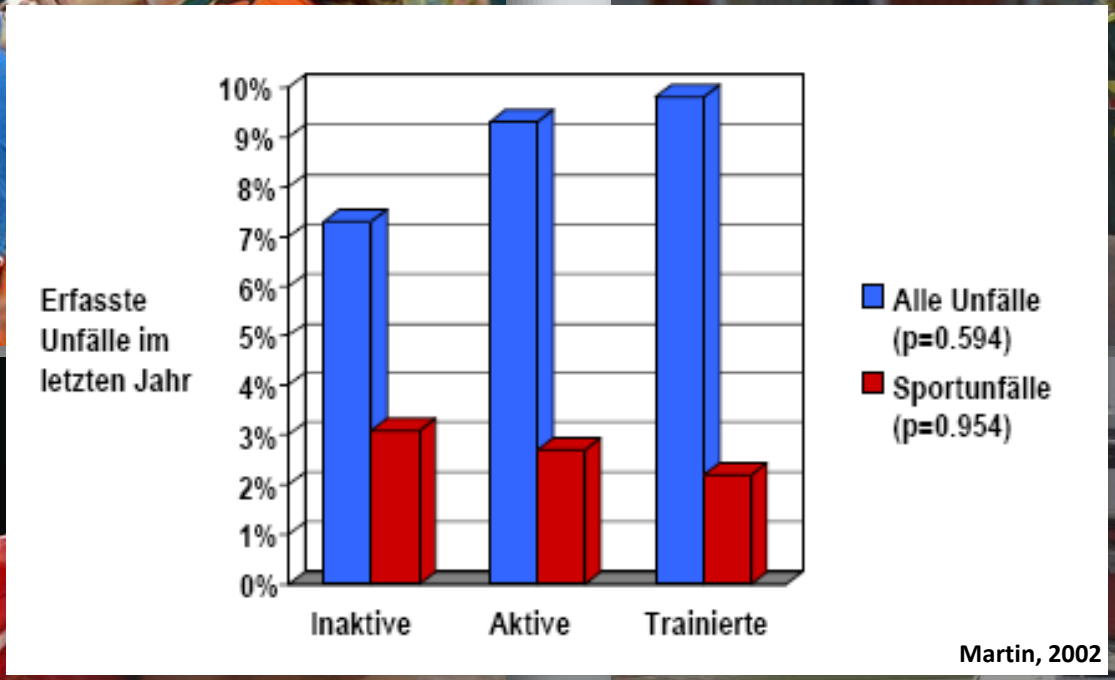
- Die Auswahl des zu untersuchenden Athletenkollektivs ist letztendlich entscheidend *(nicht nur junge kompetitive Sportler)*

- Das EKG muss dabei integraler und zentraler Bestandteil das kardialen Screenings sein *(mittlerweile sehr hoher negative prädiktiver Wert – "refined/international Seattle Criteria")*

Ist Sport gesund?


FRANIC
18


stuntkjr.com
PRO STUNTS

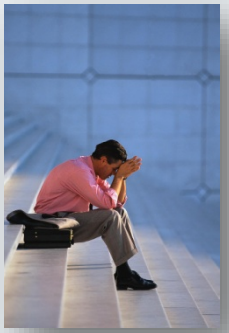

Erfasste Unfälle im letzten Jahr
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
Inaktive
Aktive
Trainierte
Alle Unfälle (p=0.594)
Sportunfälle (p=0.954)

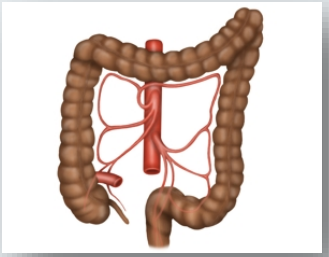
Martin, 2002

Gesundheitlicher Nutzen von Sport

Starke Evidenz

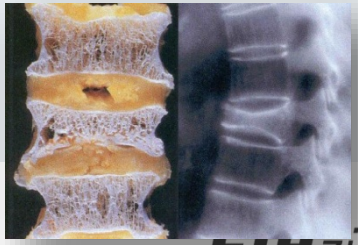
- Überleben
- Risiko für Herzinfarkt/Hirnschlag
- Risiko für arterielle Hypertonie, Dyslipidämie, Diabetes mellitus Typ 2
- Dickdarm-, Brust-Karzinom
- Risiko für Stürze
- Depression, kognitive Dysfunktion





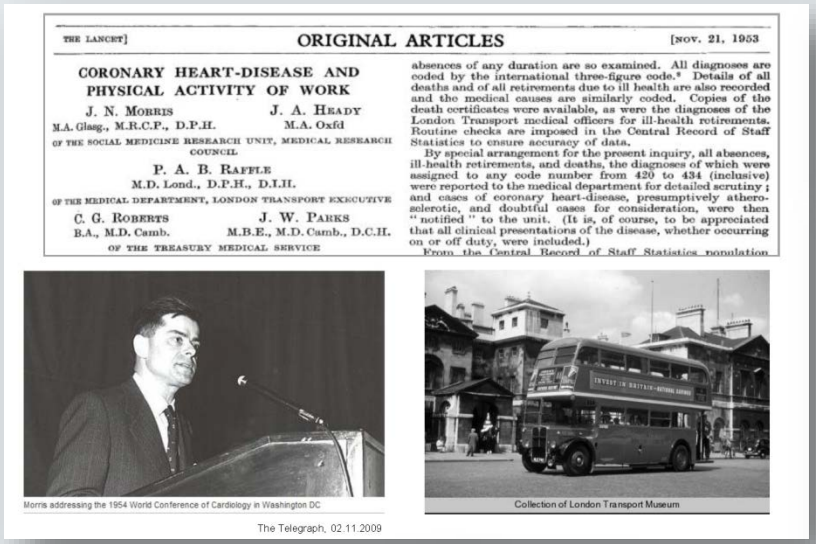
Mässige Evidenz

- Übergewicht
- Pflegebedürftigkeit im Alter
- Bronchus-, Endometrium-Karzinom
- Erneute Gewichtszunahme («Jo-Jo-Effekt»)
- Osteoporose
- Schlafstörungen



Der Benefit von Sport zur Prävention der Koronaren Herzkrankheit…

…wurde bereits vor langer Zeit erkannt.



THE LANCET] ORIGINAL ARTICLES [NOV. 21, 1953

CORONARY HEART-DISEASE AND PHYSICAL ACTIVITY OF WORK

J. N. MORRIS M.A. Glasg., M.R.C.P., D.P.H. — J. A. HEADY M.A. Oxfd

OF THE SOCIAL MEDICINE RESEARCH UNIT, MEDICAL RESEARCH COUNCIL

P. A. B. RAFFLE M.D. Lond., D.P.H., D.I.H.

OF THE MEDICAL DEPARTMENT, LONDON TRANSPORT EXECUTIVE

C. G. ROBERTS B.A., M.D. Camb. — J. W. PARKS M.B.E., M.D. Camb., D.C.H.

OF THE TREASURY MEDICAL SERVICE

absences of any duration are so examined. All diagnoses are coded by the international three-figure code.[3] Details of all deaths and of all retirements due to ill health are also recorded and the medical causes are similarly coded. Copies of the death certificates were available, as were the diagnoses of the London Transport medical officers for ill-health retirements. Routine checks are imposed in the Central Record of Staff Statistics to ensure accuracy of data.

By special arrangement for the present inquiry, all absences, ill-health retirements, and deaths, the diagnoses of which were assigned to any code number from 420 to 434 (inclusive) were reported to the medical department for detailed scrutiny; and cases of coronary heart-disease, presumptively atherosclerotic, and doubtful cases for consideration, were then "notified" to the unit. (It is, of course, to be appreciated that all clinical presentations of the disease, whether occurring on or off duty, were included.)

From the Central Record of Staff Statistics population

Morris addressing the 1954 World Conference of Cardiology in Washington DC

Collection of London Transport Museum

The Telegraph, 02.11.2009

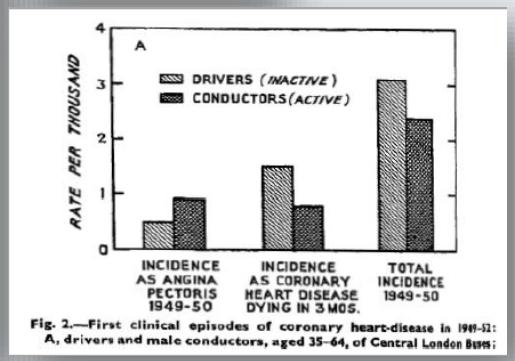


Fig. 2.—First clinical episodes of coronary heart-disease in 1949–52: A, drivers and male conductors, aged 35–64, of Central London Buses;

"Harvard Alumni" study

Physical activity 1962/66 [kcal per week]	Relative risk of death
<500	1.00
500-999	0.78
1000-1499	0.73
1500-1999	0.63
2000-2499	0.62
2500-2999	0.52
3000-3499	0.46
>=3500	0.62

Paffenbarger R, et al. N Engl J Med 1986;314:605-613

"Nurses' Health" study

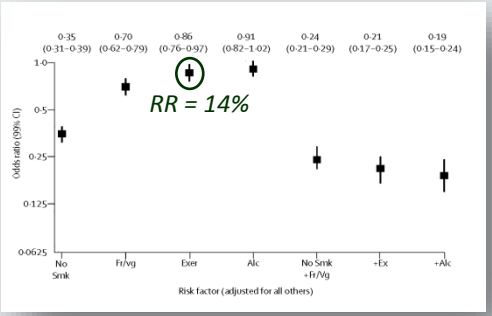
The Nurses' Health Study

TABLE 1. DISTRIBUTIONS OF INDIVIDUAL MODIFIABLE RISK FACTORS AND RELATIVE RISK OF CORONARY EVENTS IN THE NURSES' HEALTH STUDY, 1980 TO 1994.

FACTOR	RELATIVE RISK (95% CI)*	PERCENTAGE IN EACH CATEGORY†
Exercise (hr/wk)§		
<1.0	1.41 (1.15–1.75)	20
1.0–2.2	1.23 (0.99–1.53)	15
2.3–3.5	1.18 (0.94–1.47)	18
3.6–5.5	1.05 (0.82–1.34)	18
>5.5	1.0 (reference)	17

Stampfer MJ, et al. N Engl J Med 2000;343:16-22

"INTERHEART" study



Yusuf S, et al. Lancet 2004;364(9438):937-52

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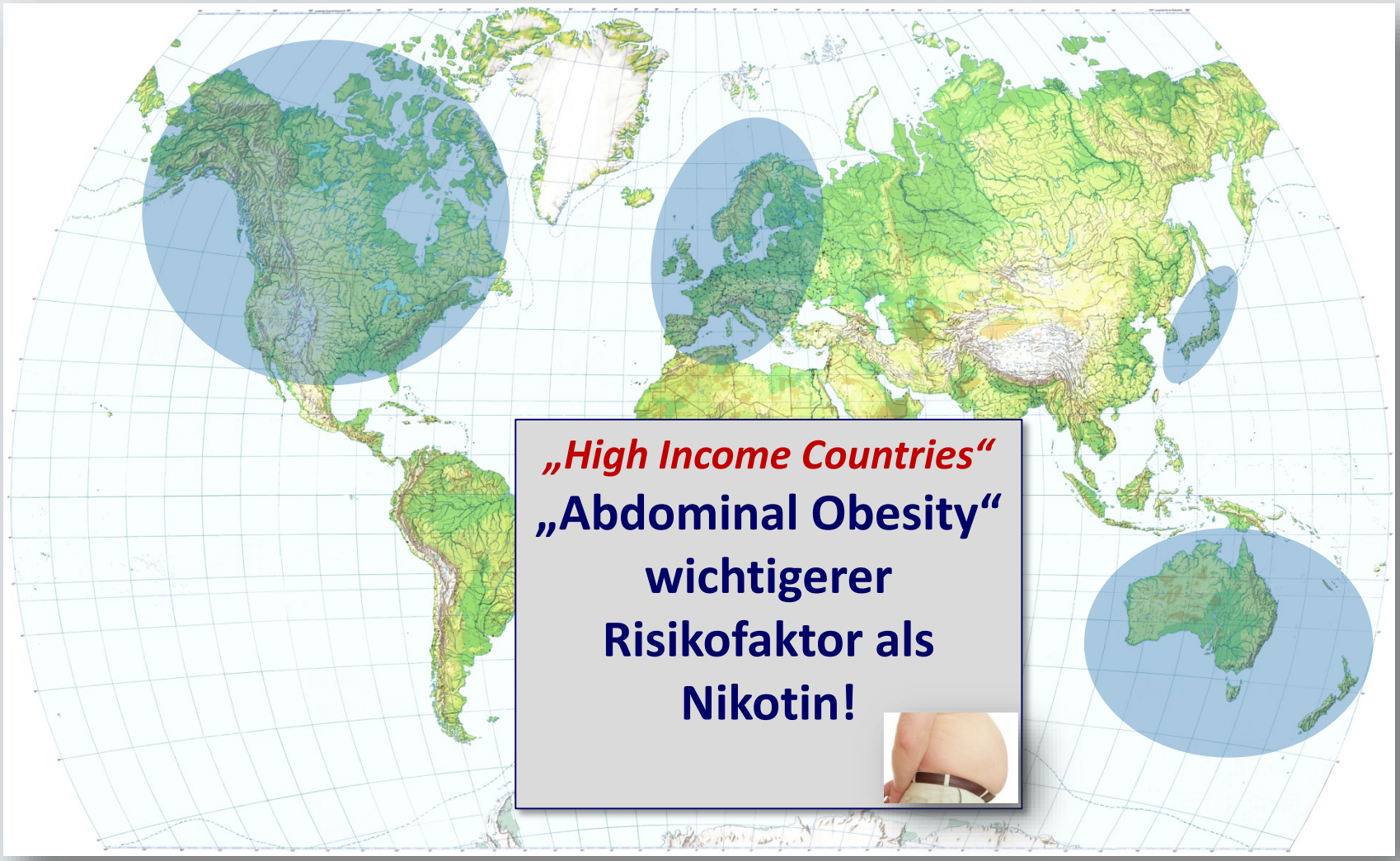
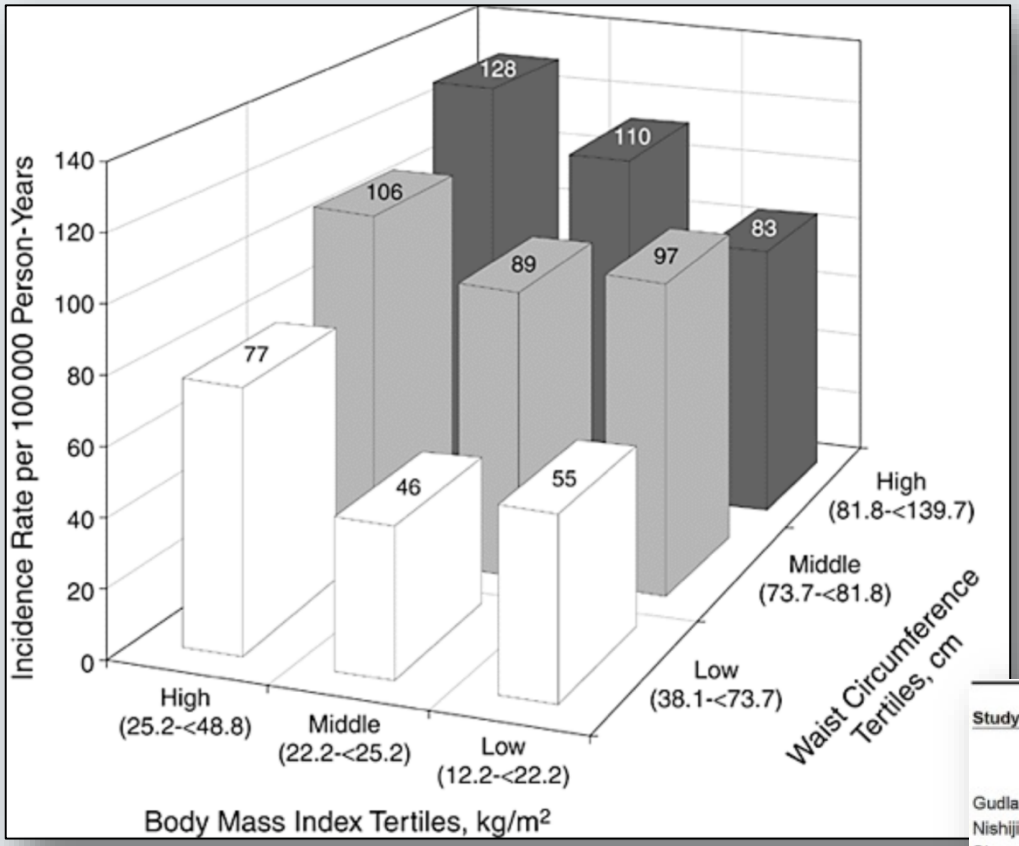
Globale Unterschiede (INTERHEART Studie)

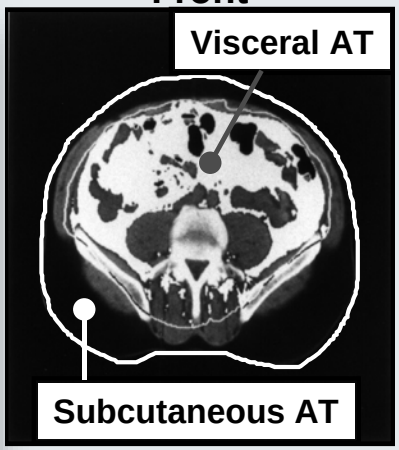
Globale Unterschiede (INTERHEART Studie)

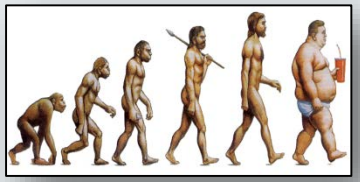


Der Bauchumfang ist ein unabhängiger (und bedeutender) Risikofaktor

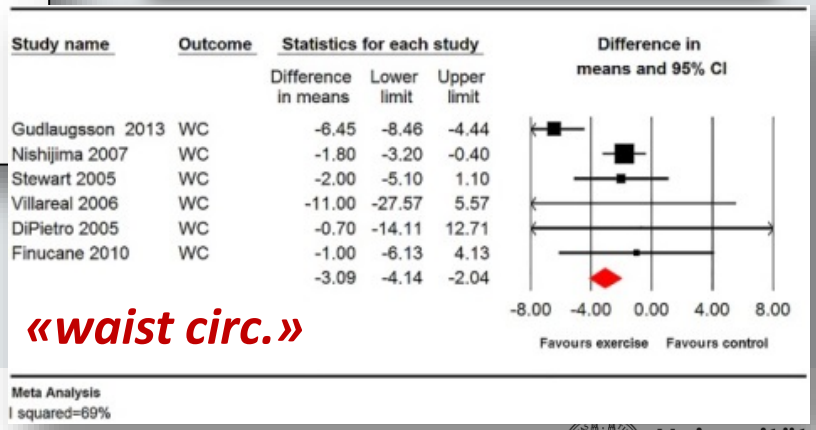


Rexrode KM, et al.; Abdominal adiposity and coronary heart disease in women. JAMA. 1998 Dec 2;280(21):1843-8.





Männer <94-102cm
Frauen <80-88cm



«waist circ.»

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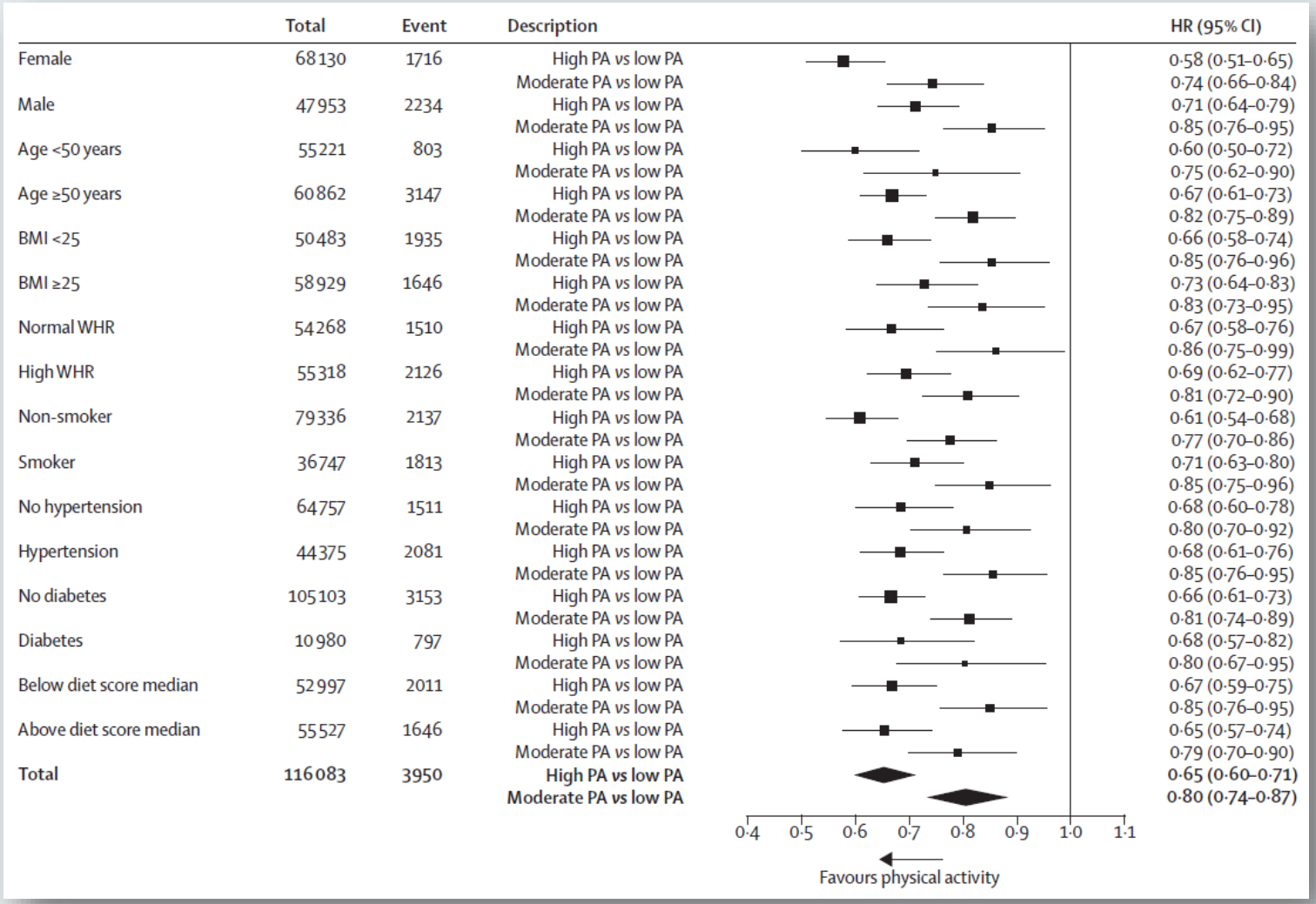
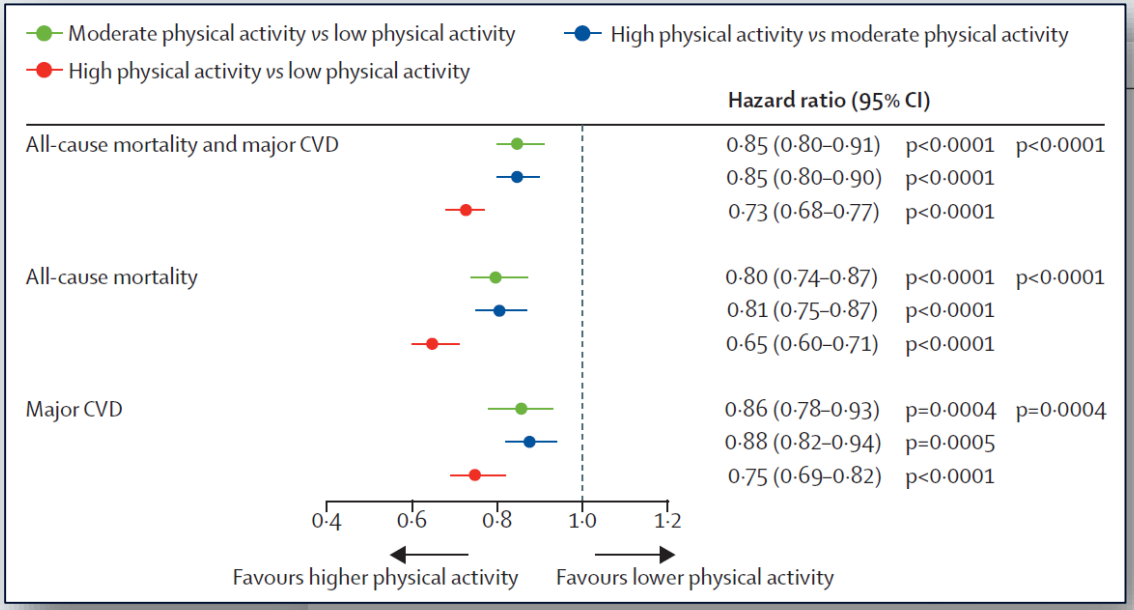
Sport in der Primärprophylaxe *(„PURE“)* – „je mehr desto besser“



	Total	Event	Description	HR (95% CI)
Female	68130	1716	High PA vs low PA	0·58 (0·51–0·65)
			Moderate PA vs low PA	0·74 (0·66–0·84)
Male	47953	2234	High PA vs low PA	0·71 (0·64–0·79)
			Moderate PA vs low PA	0·85 (0·76–0·95)
Age <50 years	55221	803	High PA vs low PA	0·60 (0·50–0·72)
			Moderate PA vs low PA	0·75 (0·62–0·90)
Age ≥50 years	60862	3147	High PA vs low PA	0·67 (0·61–0·73)
			Moderate PA vs low PA	0·82 (0·75–0·89)
BMI <25	50483	1935	High PA vs low PA	0·66 (0·58–0·74)
			Moderate PA vs low PA	0·85 (0·76–0·96)
BMI ≥25	58929	1646	High PA vs low PA	0·73 (0·64–0·83)
			Moderate PA vs low PA	0·83 (0·73–0·95)
Normal WHR	54268	1510	High PA vs low PA	0·67 (0·58–0·76)
			Moderate PA vs low PA	0·86 (0·75–0·99)
High WHR	55318	2126	High PA vs low PA	0·69 (0·62–0·77)
			Moderate PA vs low PA	0·81 (0·72–0·90)
Non-smoker	79336	2137	High PA vs low PA	0·61 (0·54–0·68)
			Moderate PA vs low PA	0·77 (0·70–0·86)
Smoker	36747	1813	High PA vs low PA	0·71 (0·63–0·80)
			Moderate PA vs low PA	0·85 (0·75–0·96)
No hypertension	64757	1511	High PA vs low PA	0·68 (0·60–0·78)
			Moderate PA vs low PA	0·80 (0·70–0·92)
Hypertension	44375	2081	High PA vs low PA	0·68 (0·61–0·76)
			Moderate PA vs low PA	0·85 (0·76–0·95)
No diabetes	105103	3153	High PA vs low PA	0·66 (0·61–0·73)
			Moderate PA vs low PA	0·81 (0·74–0·89)
Diabetes	10980	797	High PA vs low PA	0·68 (0·57–0·82)
			Moderate PA vs low PA	0·80 (0·67–0·95)
Below diet score median	52997	2011	High PA vs low PA	0·67 (0·59–0·75)
			Moderate PA vs low PA	0·85 (0·76–0·95)
Above diet score median	55527	1646	High PA vs low PA	0·65 (0·57–0·74)
			Moderate PA vs low PA	0·79 (0·70–0·90)
Total	**116083**	**3950**	**High PA vs low PA**	**0·65 (0·60–0·71)**
			Moderate PA vs low PA	**0·80 (0·74–0·87)**

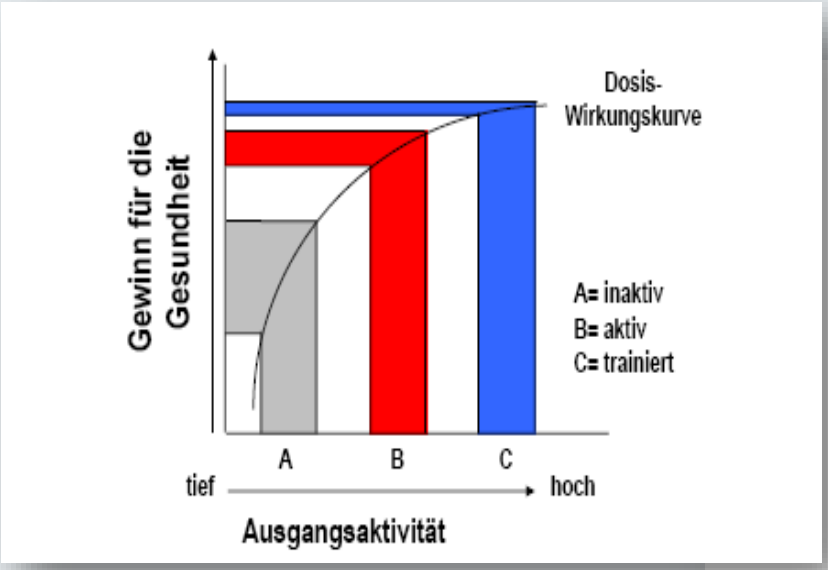
Lancet 2017; 390: 2643–54

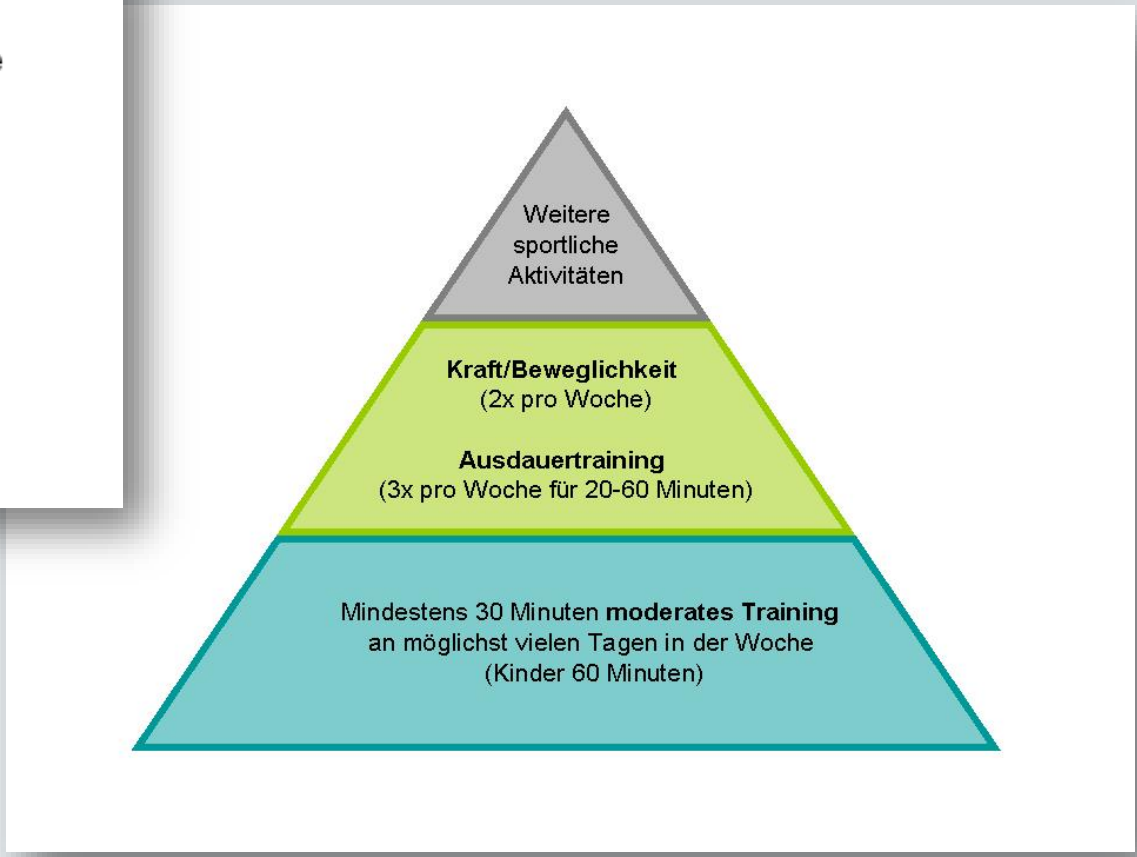
Sport in der Primärprophylaxe *(„PURE“)* – „je mehr desto besser“



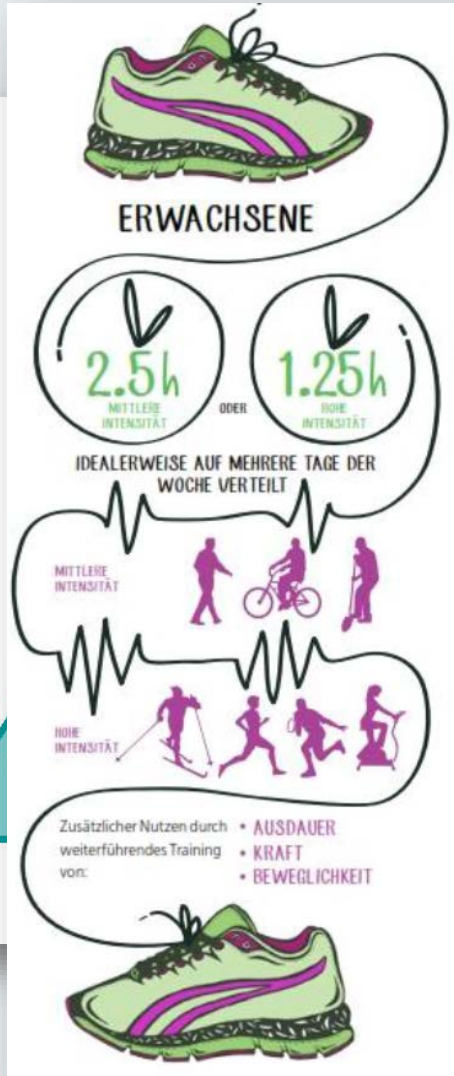
Lancet 2017; 390: 2643–54

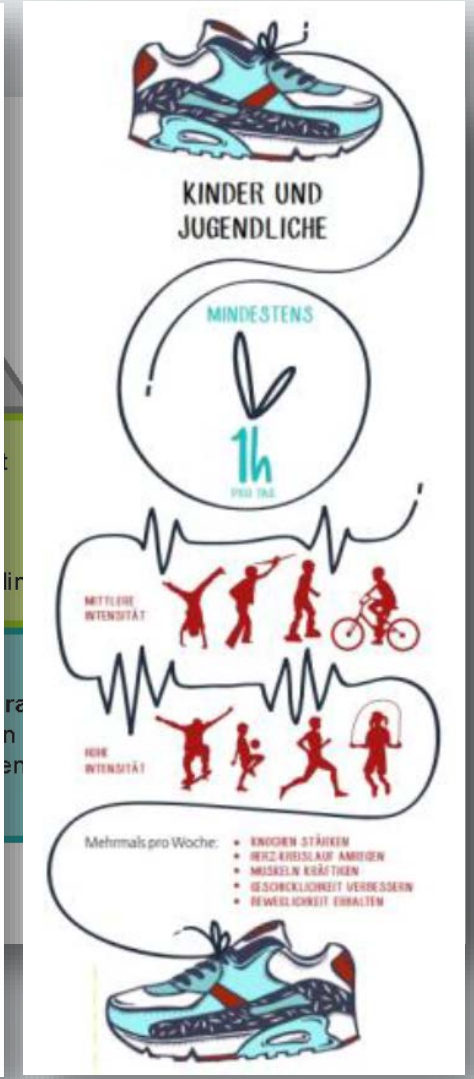
Empfehlungen für präventives Sporttreiben *(„Gesundheits-Sport“)*



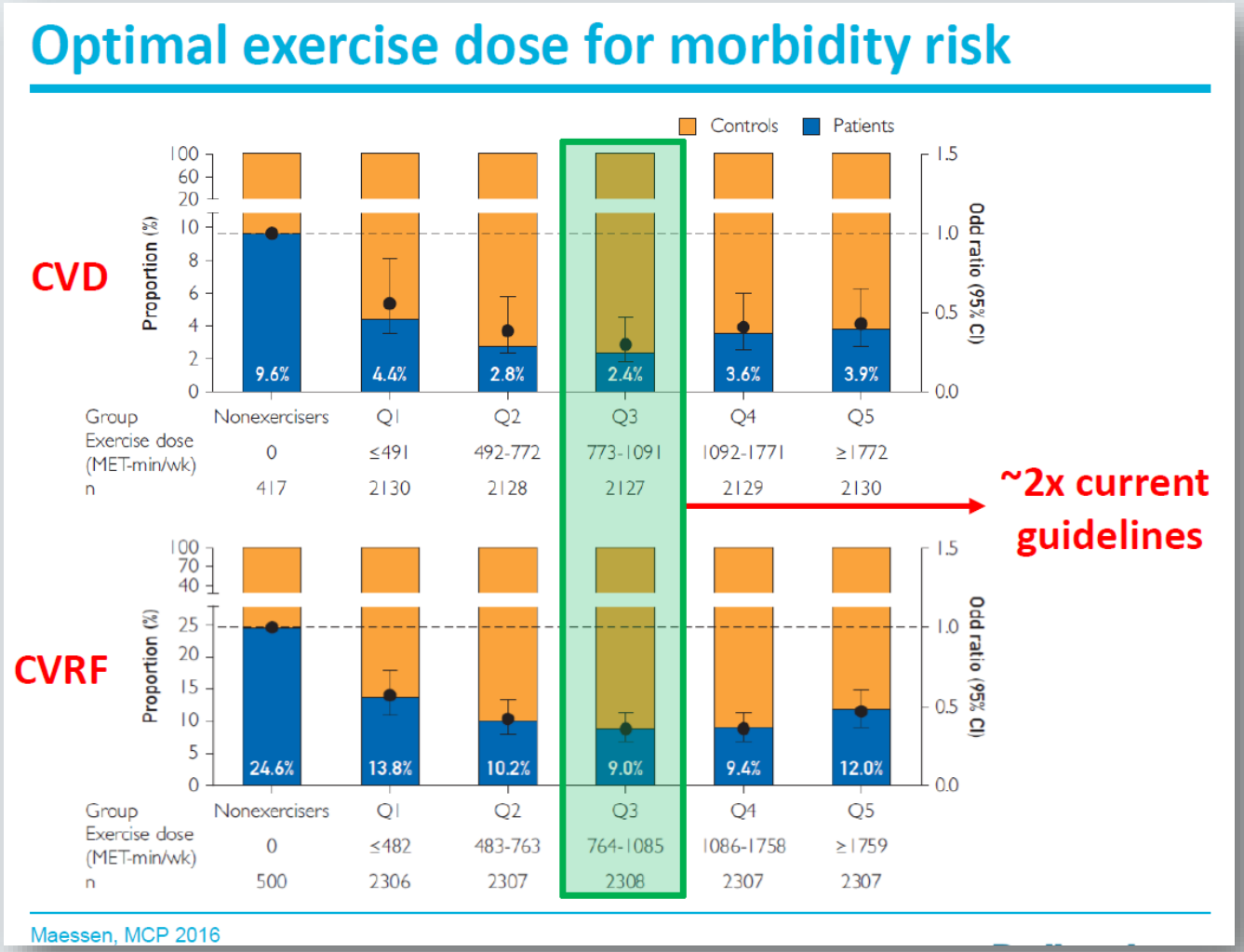


Empfehlungen für präventives Sporttreiben *(„Gesundheits-Sport“)*





Die «J-Kurve» – Gilt auch für das optimale Mass an Sport



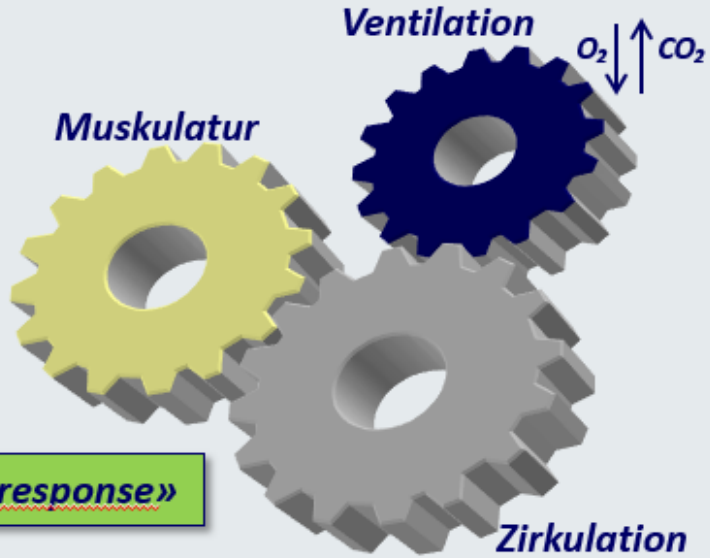
Die «integrative körperliche Leistung»

Adolf Eugen Fick
(1829-1901)

Fick'sches Prinzip

$VO_2 = (SV \times HF) \times (CaO_2 - CvO_2)$

«zentral» *«peripher»*



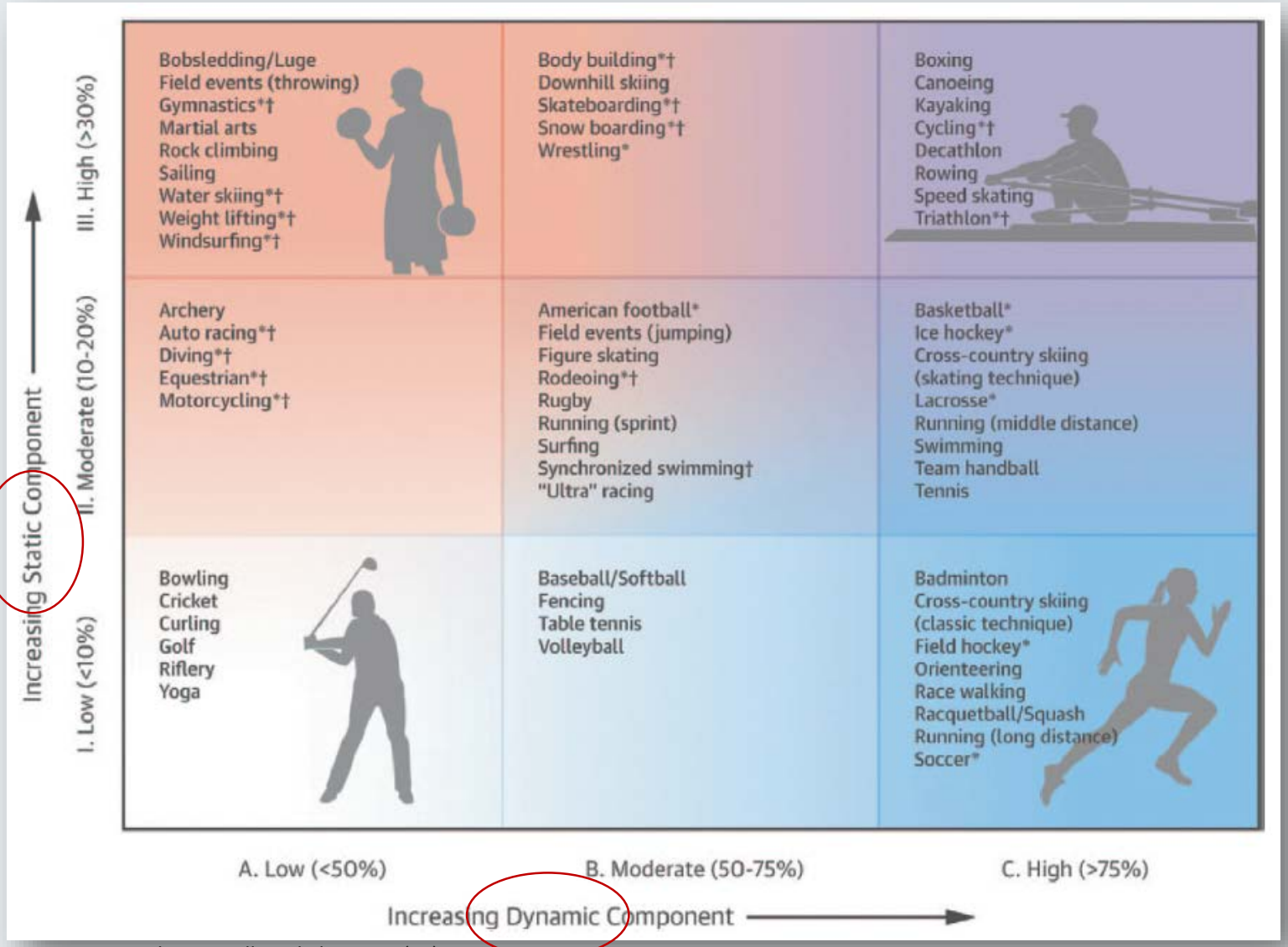
«integrative exercise response»

zentral $VO_2 = (SV \times HF) \times (CaO_2 - CvO_2)$

Herzzeitvolumen (HZV)	4-6fach
Schlagvolumen (SV)	ca. 50%
Herzfrequenz	4-7fach
Ventilation	40fach
VO2	2-5fach

perifer $VO_2 = (SV \times HF) \times (CaO_2 - CvO_2)$

Kapillarisierung der Muskulatur
Vermehrte vasodilatatorische Kapazität
Zunahme der Zahl und Grösse der Mitochondrien
Zunahme der Aktivität der anaeroben Stoffwechselenzyme



Levine BD, et al. J Am Coll Cardiol 2015;66(21):2350-55

Das “physiologische” Sportherz

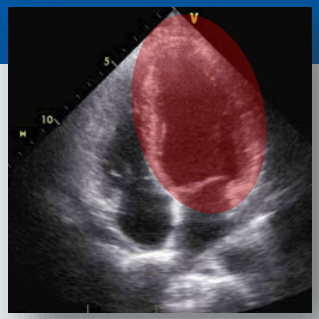
Weitere adaptive Veränderungen nach Überschreiten einer gewissen (individuellen, genetisch festgelegten) Schwelle:

„Herzhypertrophie“

60-70km Lauftraining pro Woche

- Erreicht im Mittel ab ca. 3-4x/Woche Mindesttrainingsbelastung
- Alle 4 „Herzhöhlen“ beteiligt (leichte Betonung des RV)
- Im Gegensatz zur pathologischen Hypertrophie: Innenvolumina immer parallel zur Wanddickenzunahme (Erhaltung systolische Wandspannung)

Laplace-Gesetz: Spannung = p x r / 2 x Wanddicke



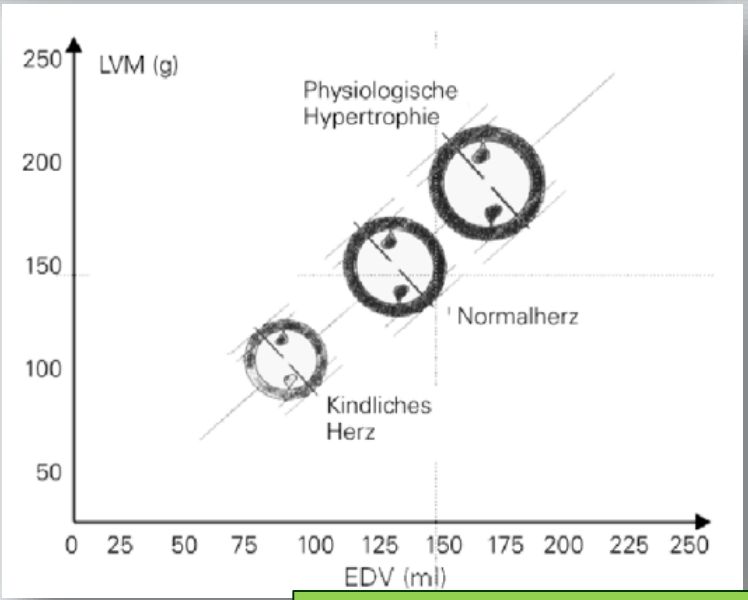
(dynamisches) Ausdauer-Training

(statisches) Kraft-Training

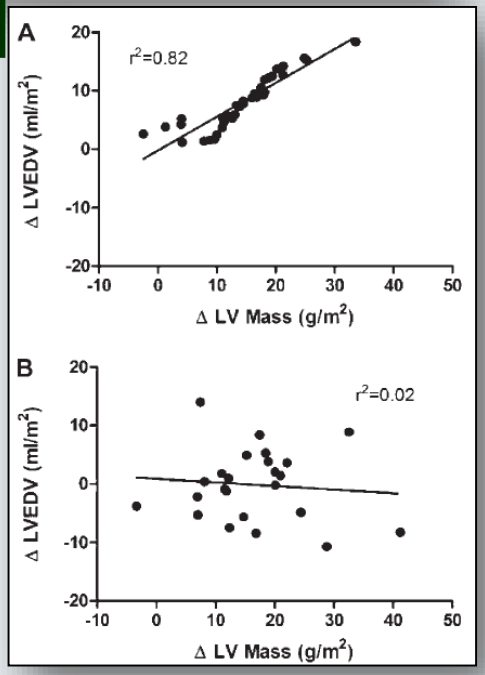
Exzentrische Hypertrophie	*Konzentrische Hypertrophie*

«Morganroth Hypothesis»

?



Laplace:
Wandspannung = p x r / 2x Wanddicke



Baggish AL. *J Appl Physiol* 104: 1121–28, 2008

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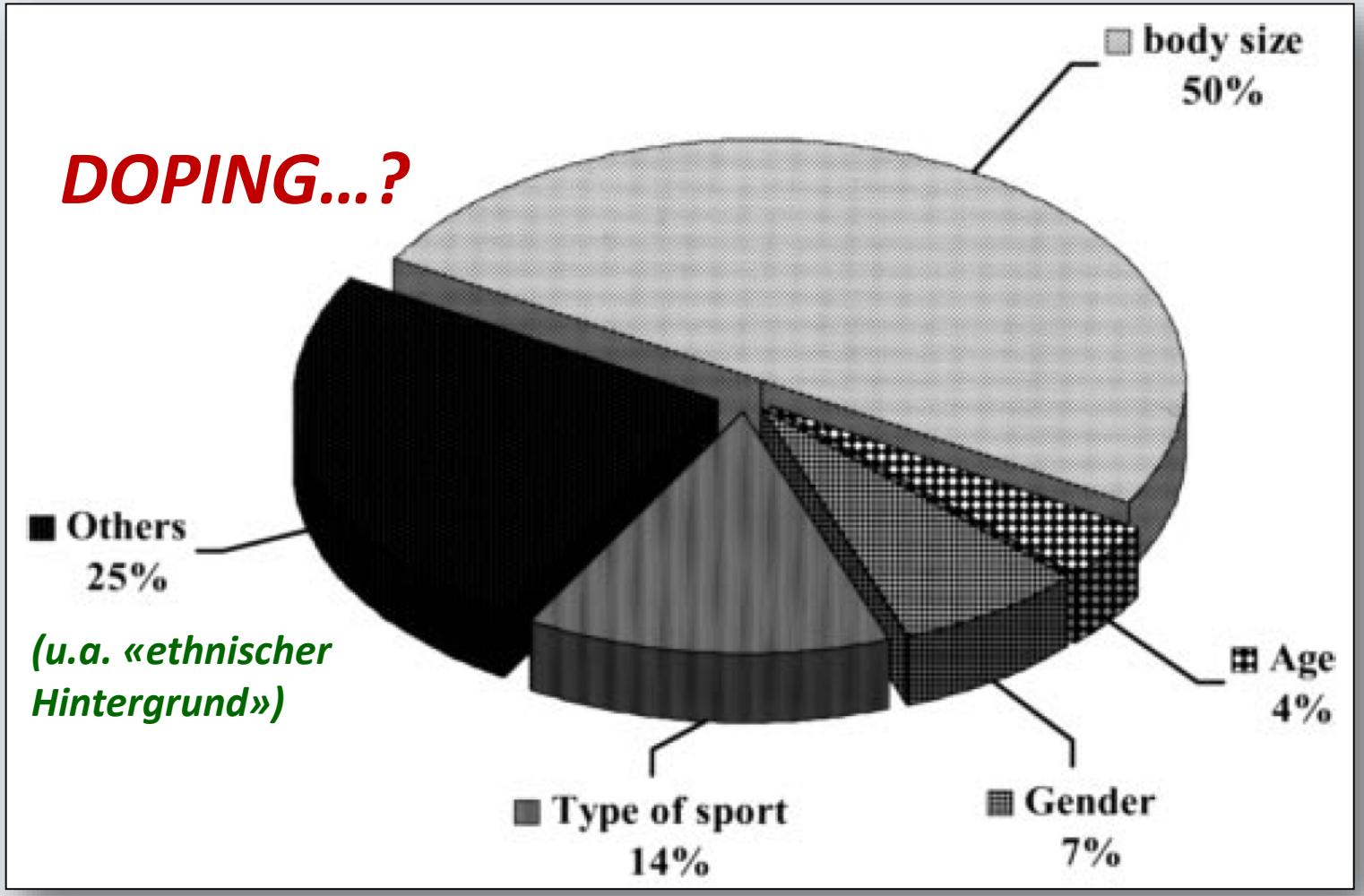
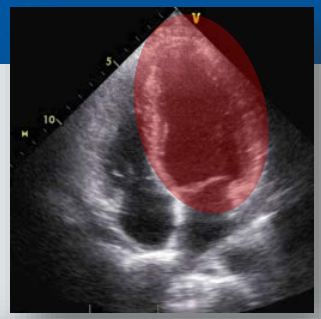
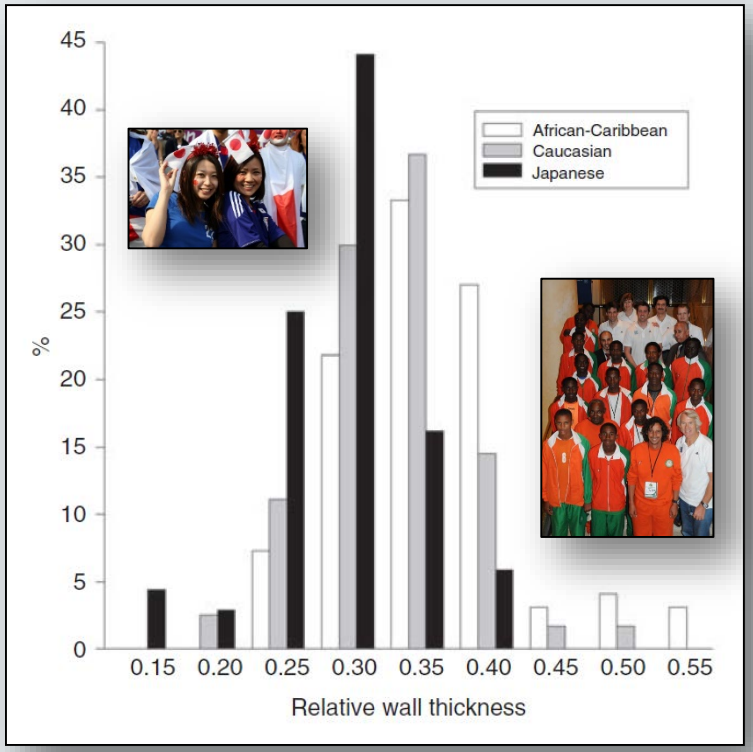
Einfluss von klinischen Variablen auf end-diastolische LV-Dimensionen



Barry J. Maron and Antonio Pelliccia. Sudden Death The Heart of Trained Athletes: Cardiac Remodeling and the Risks of Sports, Including. *Circulation.* 2006;114:1633-1644

Einfluss des ethnischen Hintergrundes auf das «Sportherz»





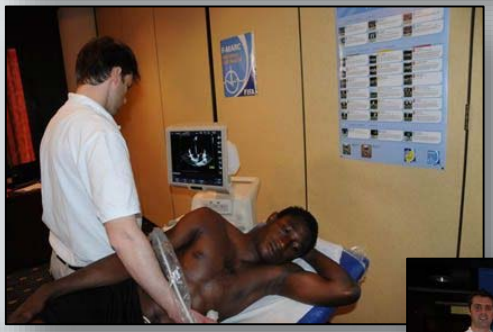
Kervio G, Pelliccia A. et al. Eur J Prev Cardiol 2013;20(5):880-8

Br J Sports Med 2009;43:716-721 doi:10.1136/bjsm.2009.064196

Original article

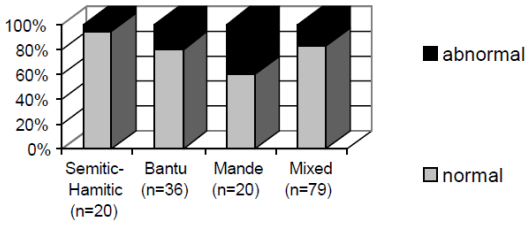
Cardiac findings in the precompetition medical assessment of football players participating in the 2009 African Under-17 Championships in Algeria

C Schmied[1], Y Zerguini[2], A Junge[3], P Tscholl[3], A Pelliccia[4], B M Mayosi[5], J Dvorak[3]



CAF

Figure 2: Distribution of ECG findings with regard to ethnicity



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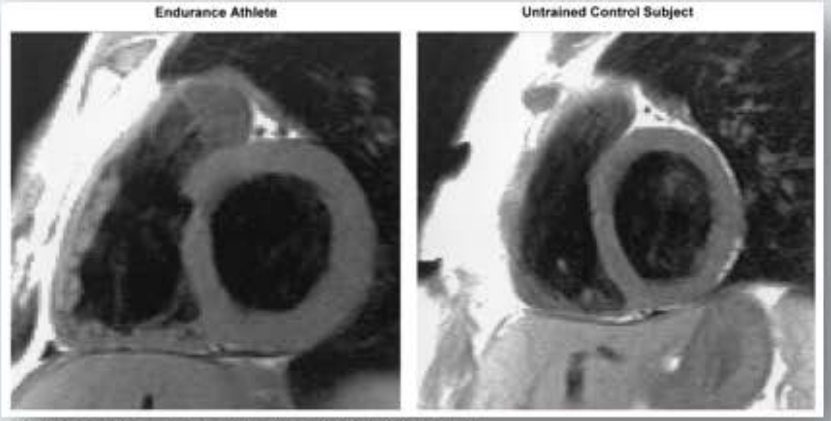
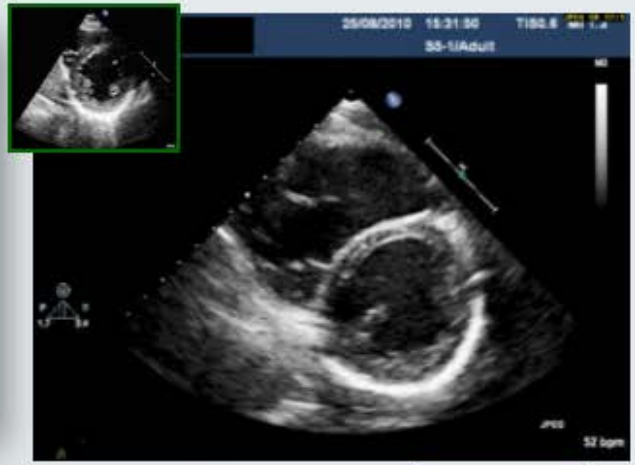
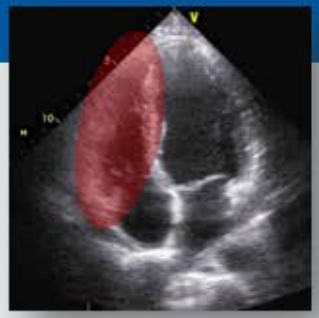
Der rechte Ventrikel – «Achillesferse» der Ausdauersportler



Scharhag J, et al. J Am Coll Cardiol 2002;40(10):1856-63





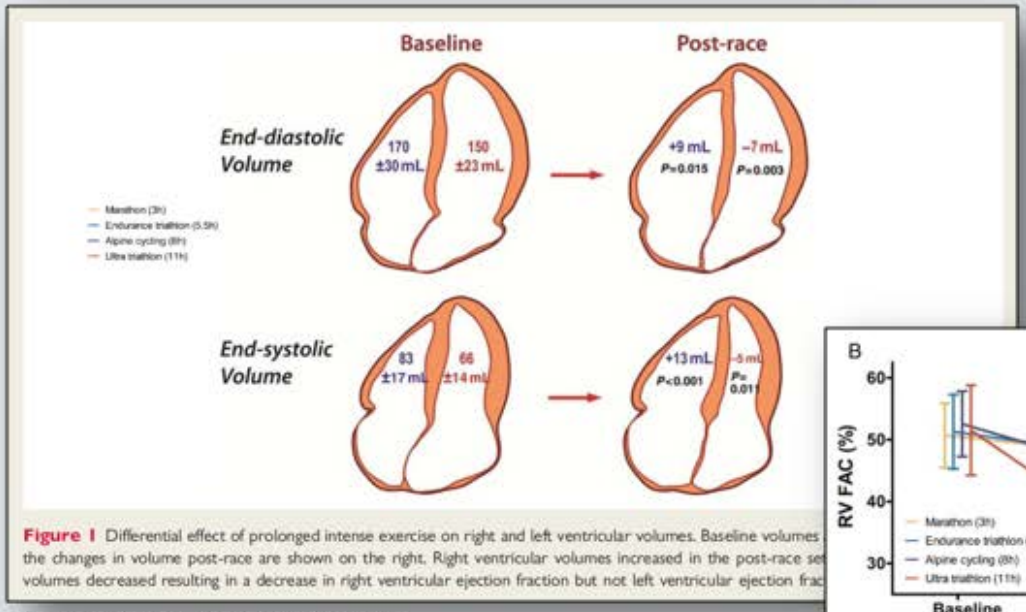
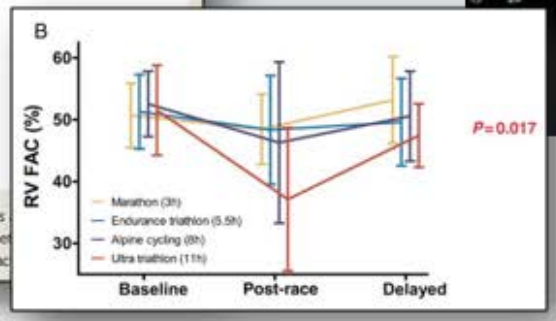
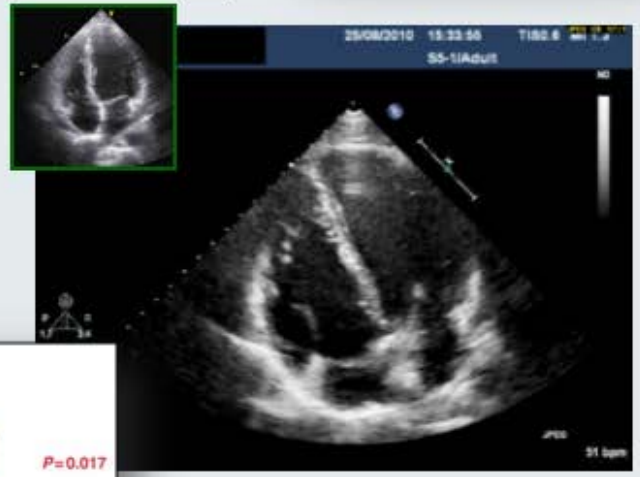


Figure 1 Differential effect of prolonged intense exercise on right and left ventricular volumes. Baseline volumes
the changes in volume post-race are shown on the right. Right ventricular volumes increased in the post-race se
volumes decreased resulting in a decrease in right ventricular ejection fraction but not left ventricular ejection frac

La Gerche, et al. Eur Heart J 2012;33:998-1006





«right ventricular fatigue»

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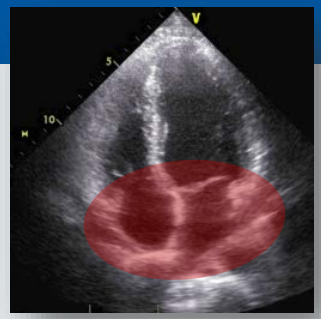
Die Vorhöfe

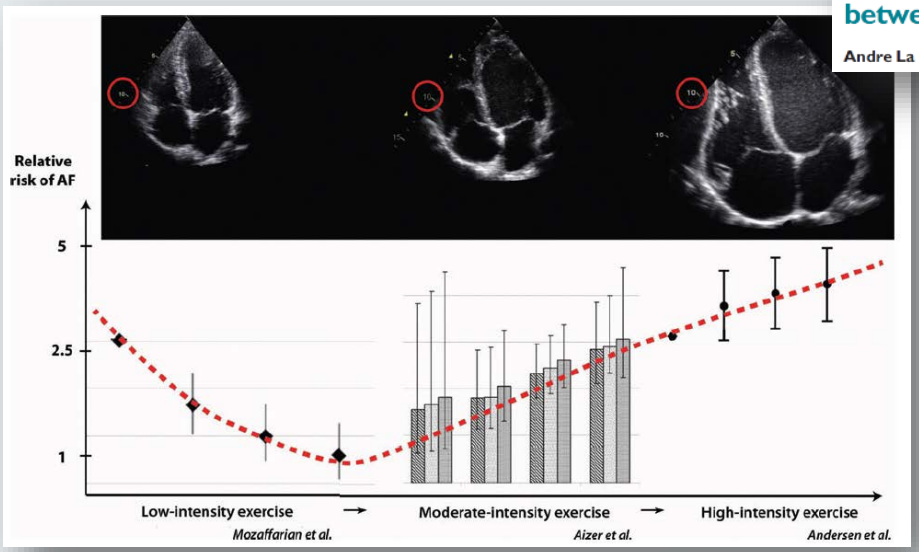
European Heart Journal (2013) 34, 3599–3602
doi:10.1093/eurheartj/eht265

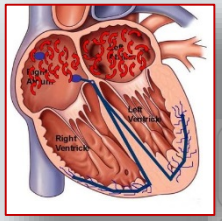
EDITORIAL

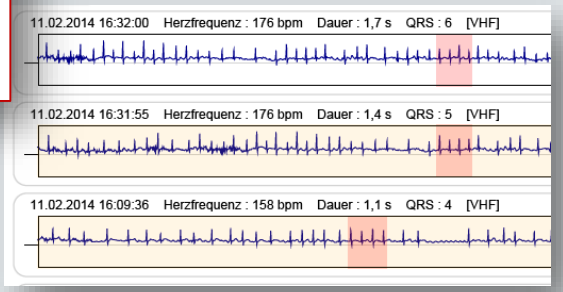
Atrial fibrillation in athletes and the interplay between exercise and health

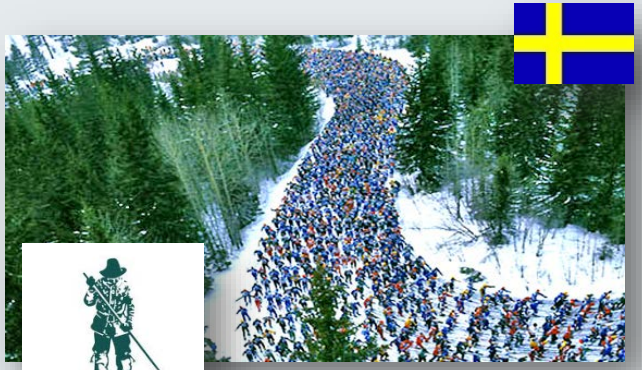
Andre La Gerche[1,2] and Christian Marc Schmied[3]*

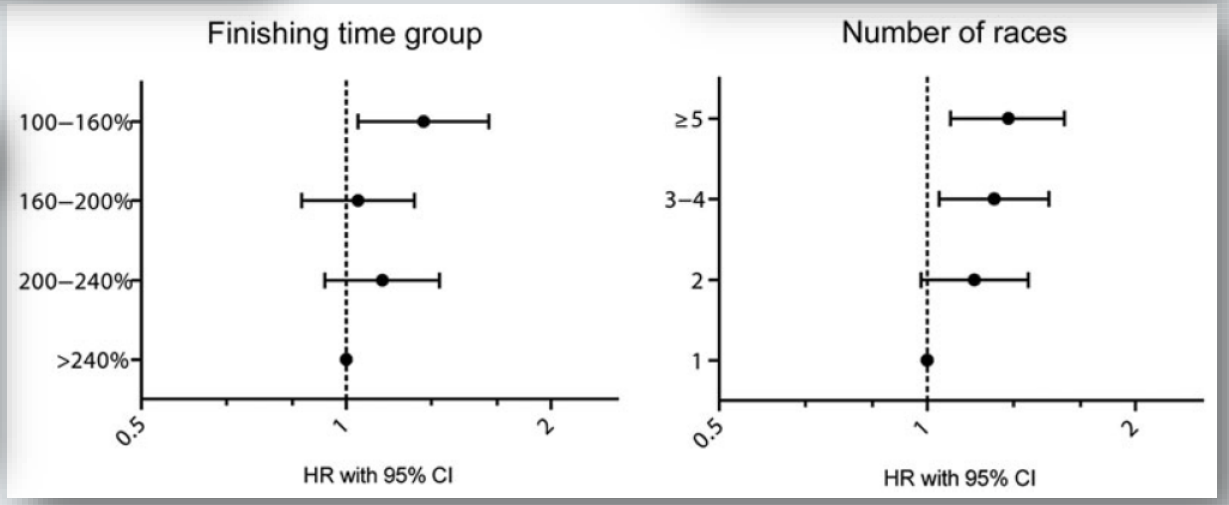












Andersen K, et al. Risk of arrhythmias in 52'755 long-distance cross-country skiers: a cohort study. Eur Heart J 2013;34:3624-31

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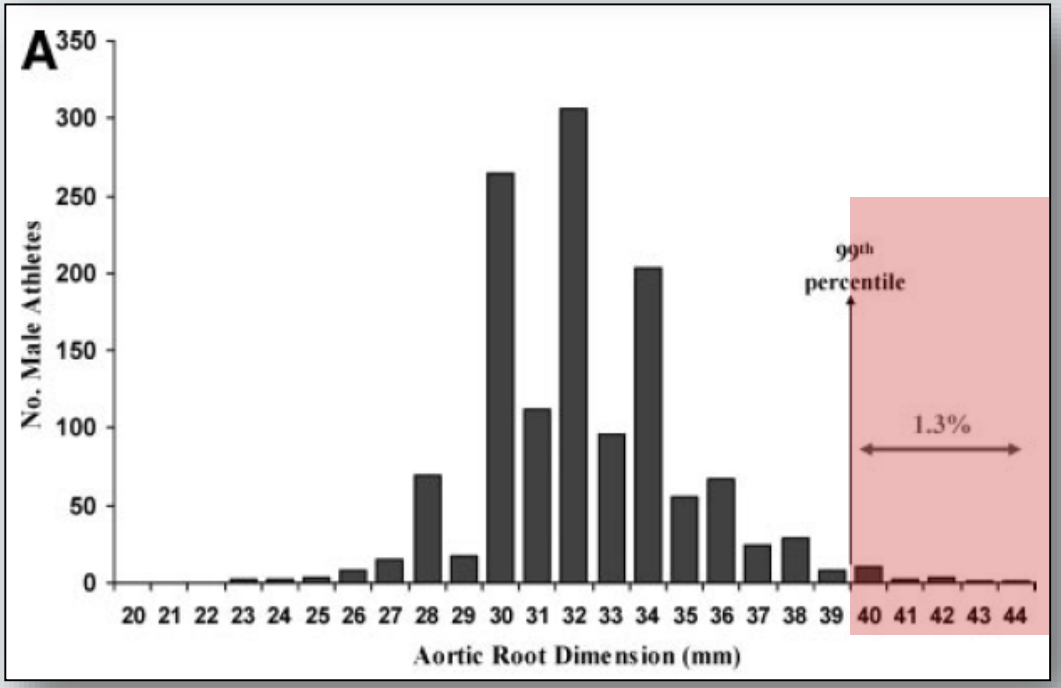
Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

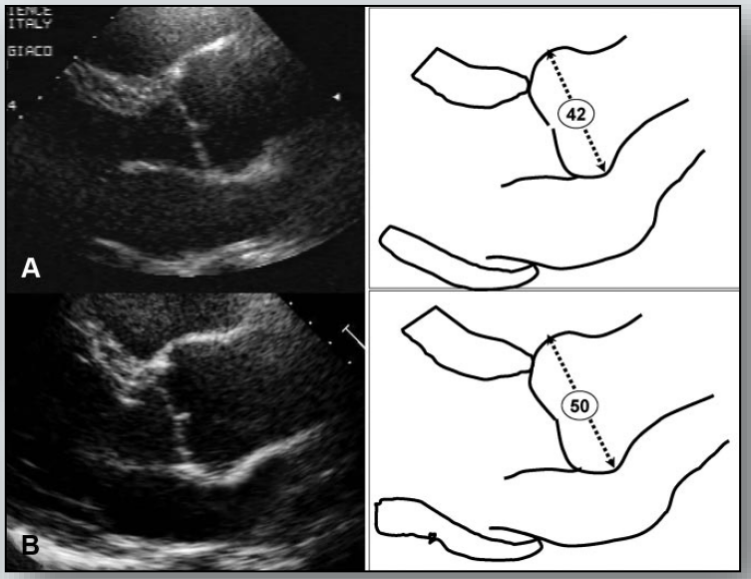
American Heart Association®

Prevalence and Clinical Significance of Aortic Root Dilation in Highly Trained Competitive Athletes

Antonio Pelliccia, Fernando M. Di Paolo, Elvira De Blasiis, Filippo M. Quattrini, Cataldo Pisicchio, Emanuele Guerra, Franco Culasso and Barry J. Maron

Circulation. 2010;122:698-706; originally published online August 2, 2010;





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American Heart Association

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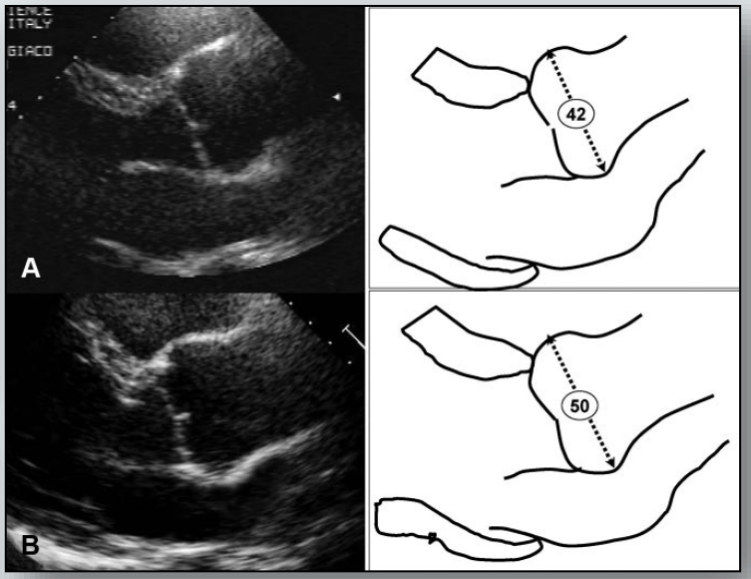
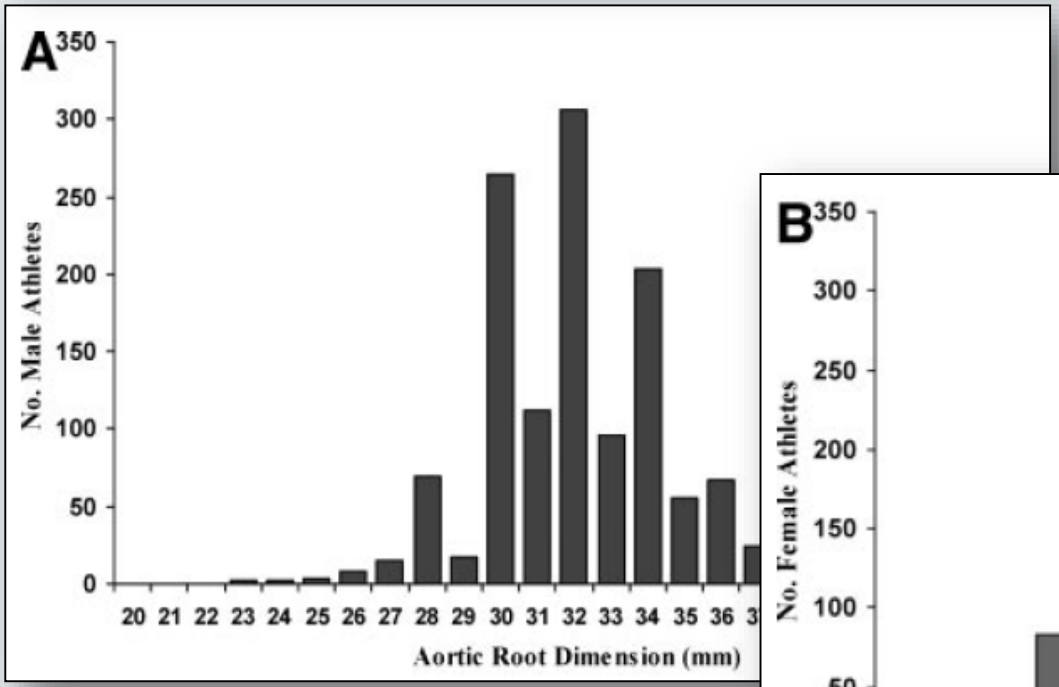
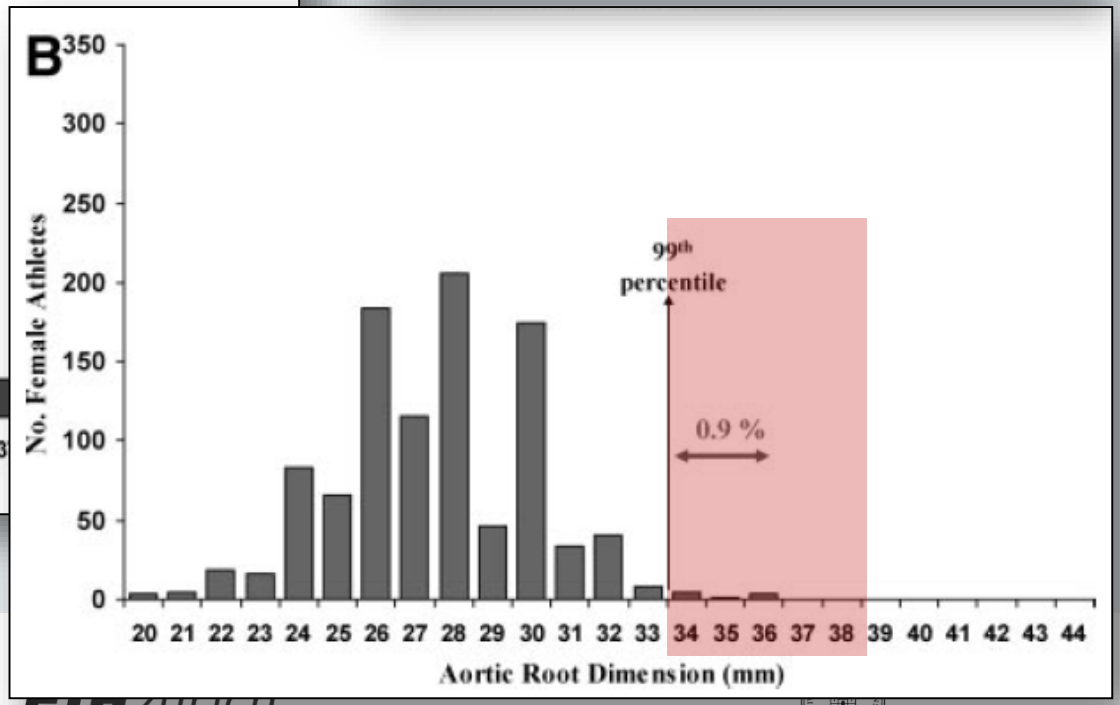
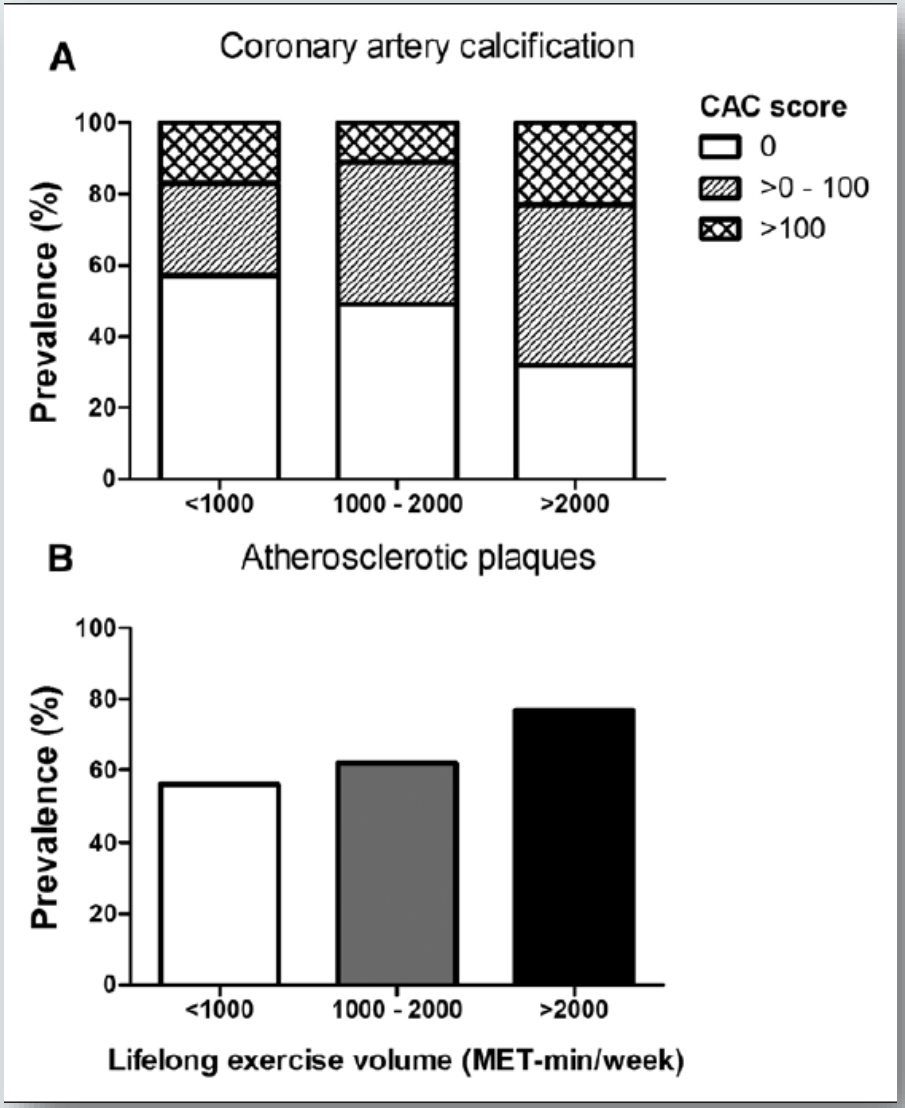






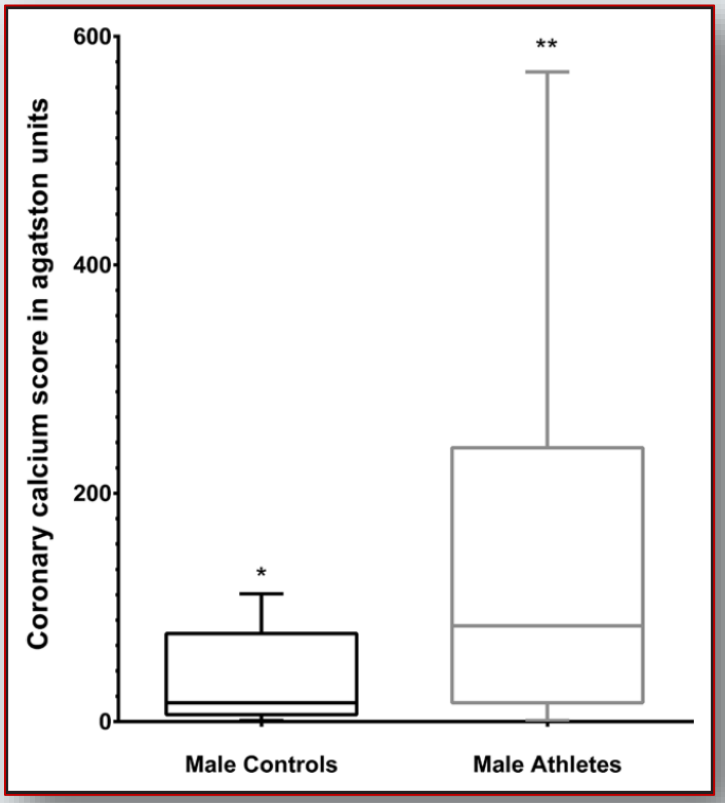
Relationship Between Lifelong Exercise Volume and Coronary Atherosclerosis in Athletes

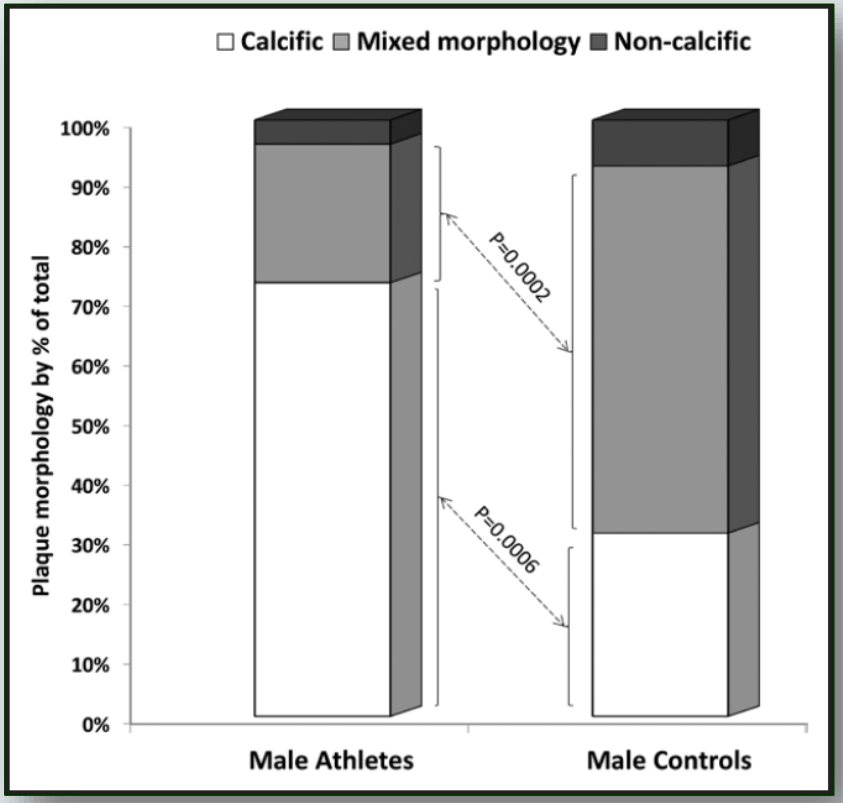
Circulation. 2017;136:138–148



Prevalence of Subclinical Coronary Artery Disease in Masters Endurance Athletes With a Low Atherosclerotic Risk Profile

Merghani A, et al. Circulation. 2017 Jul 11;136(2):126-137.





Arteriosklerose bei jüngeren Individuen – Krankheit und Prediktor

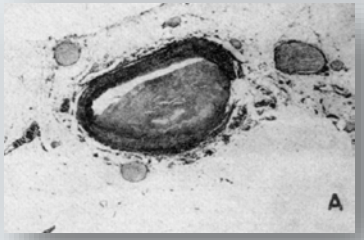
Coronary Disease Among United States Soldiers Killed in Action in Korea

Preliminary Report

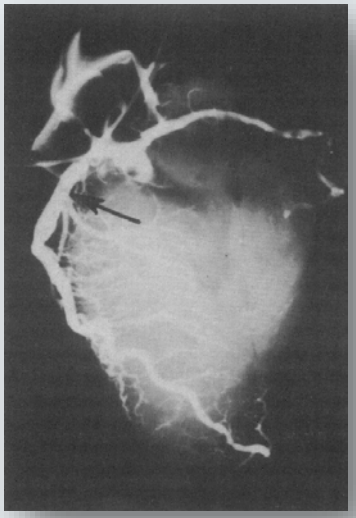
Major William F. Enos, Lieut. Col. Robert H. Holmes (MC), U.S. Army and Capt. James Beyer (MC), Army of the U.S.

Landmark Article
July 18, 1953
(JAMA 1953;152:1090-1093)

Enos WF, Holmes RH, Beyer J. JAMA 1953;152:1090-93



In 77.3% of the hearts, some gross evidence of coronary arteriosclerosis was found. The disease process varied from "fibrous" thickening to large atheromatous plaques causing complete occlusion of one or more of the major vessels (table 1).



The present study indicates that some degree of coronary atherosclerosis is present in 45% of young, healthy American males. Involvement of more than one vessel occurs in 26% of this group and apparently severe atherosclerosis occurs in 5%.

Coronary Artery Disease in Combat Casualties in Vietnam

MAJ J. Judson McNamara, MC, USA; MAJ Mark A. Molot, MC, USA; MAJ John F. Stremple, MC, USA; and COL Robert T. Cutting, MC, USA

McNamara JJ, Molot MA, Stremple JF, Cutting RT. JAMA 1971; 216(7):1185-1187.

Reduktion der Sterblichkeit bei erhöhtem Bewegungsumfang
in Taiwanesicher Kohortenstudie mit n=416‘175

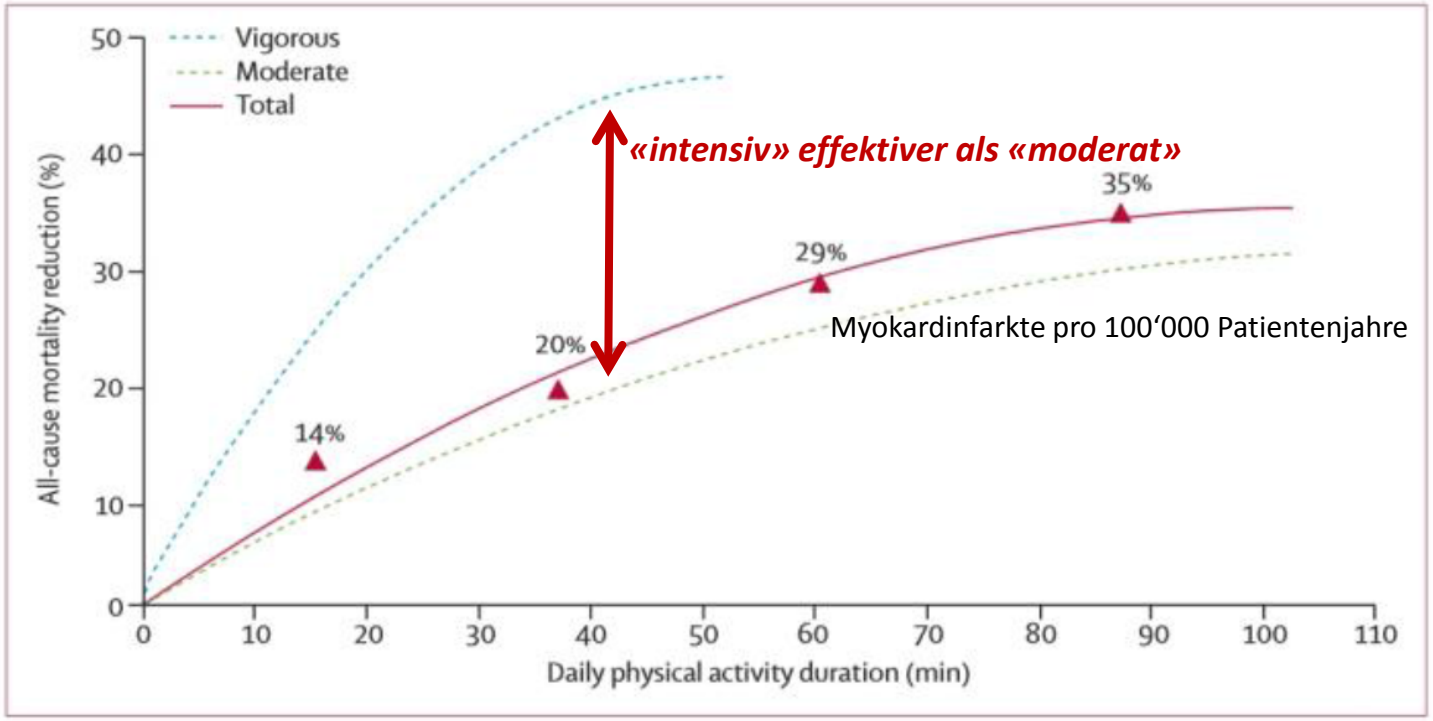


Figure 2: **Daily physical activity duration and all-cause mortality reduction**

Wen CP, Wai JP, Tsai MK, Yang YC, Cheng TY, Lee MC, Chan HT, Tsao CK, Tsai SP, Wu X. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet. 2011 Oct 1;378(9798):1244-53.

Reduktion der Sterblichkeit bei erhöhtem Bewegungsumfang
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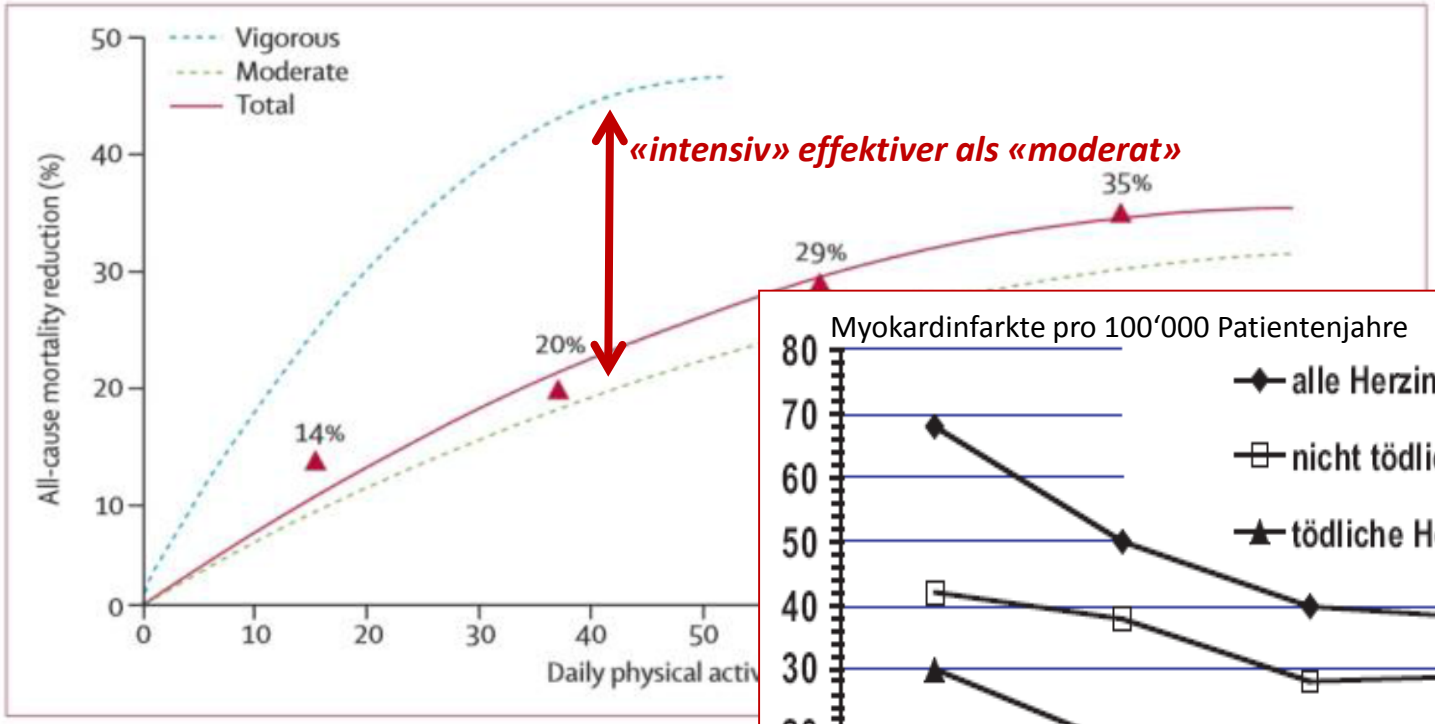
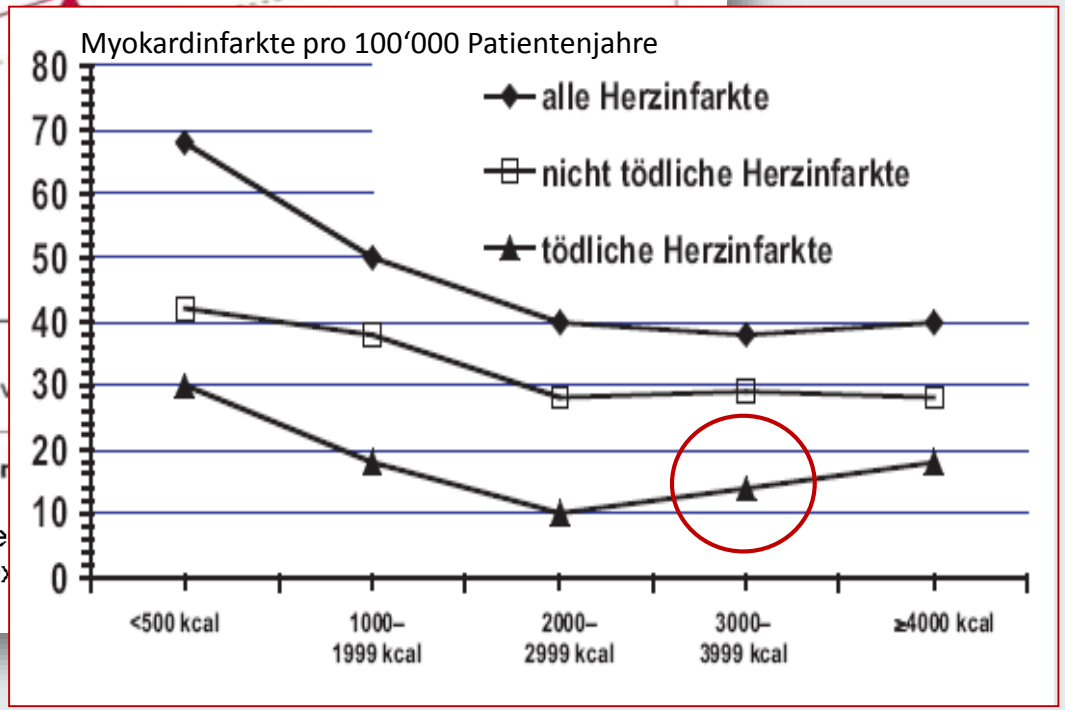


Figure 2: Daily physical activity duration and all-cause mor

Wen CP, Wai JP, Tsai MK, Yang YC, Cheng TY, Le
amount of physical activity for reduced mortality and ex



Paffenbarger et.al, Am J Epidemiol 1978; 108: 106-75

Plötzlicher Herztod im Sport

1:3'100 pro Jahr

Jährliche Inzidenz von
ca. ***2-3/100'000***
bei jungen, kompetitiven Sportlern.

Bei älteren Sportlern bis 15/100'000 (?)

"Geschlechter-Verteilung": *1 : 9 (♀:♂)*

	Ref:	Study design and reporting system	Incidence
US Military (age 18-35)	Eckart (2004)	Retrospective Mandatory	1:9,000
Italian Athletes (age 12-35)	Corrado (2006)	Prospective Mandatory	1:25,000
US Adolescents (age 12-19)	Atkins (2009)	Prospective EMS	1:27,000
US Children (age 10-14)	Chugh (2009)	Prospective EMS/Hospitals	1:58,000
US Athletes (age 12-35)	Maron (2009)	Retrospective Public media reports	1:160,000

Plötzlicher Herztod im Sport

In etwa ***90%*** der Fälle liegt eine Herzerkrankung zugrunde, welche durch (einfache) Vorsorgeuntersuchungen hätte diagnostiziert werden können.

Jährliche Inz
ca. ***2-3/100'***
bei jungen, kompetitiven Sportlern.

Bei älteren Sportlern bis 15/100'000 (?)

"Geschlechter-Verteilung": *1 : 9 (♀:♂)*

			Incidence
			1:9,000
			1:25,000
US Adolescents (age 12-19)	Atkins (2009)	Prospective EMS	1:27,000
US Children (age 10-14)	Chugh (2009)	Prospective EMS/Hospitals	1:58,000
US Athletes (age 12-35)	Maron (2009)	Retrospective Public media reports	1:160,000

Gesundheitlicher Nutzen durch regelmässiges körperliches Training und Sport

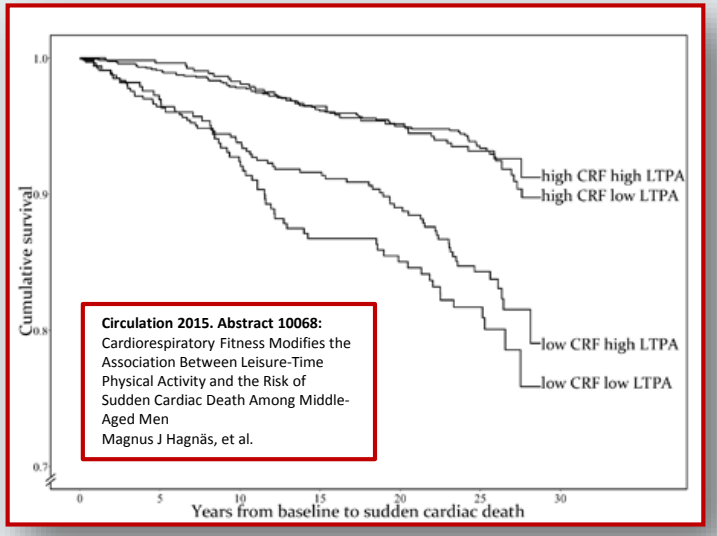
Ein „Paradoxon“…?!

Sport als Trigger für den plötzlichen Herztod

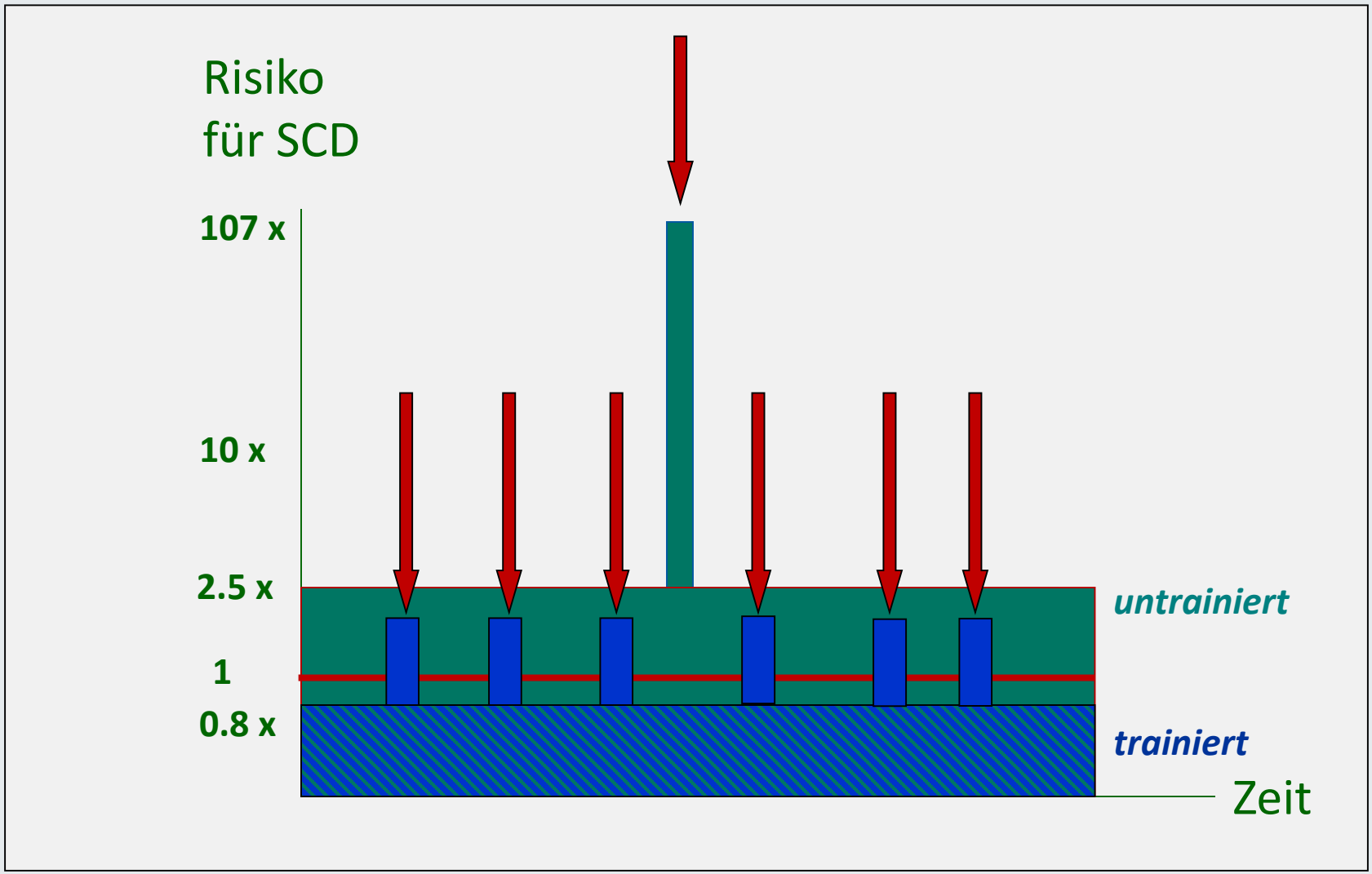
Mittleman et al. 1993: innerhalb 26 Std. gehäuft (Faktor 3 bis 107)

Risikofaktoren für plötzlichen Herztod im Sport

- *«low daily life/baseline activity»*
- *«kompetitiver Sport»*
- *hohe Intensität des Sports (evtl. Sportart)*
- *ältere Sportler, männliche Sportler*
- *«black/afro-carribean» ethnicity*



Ist der Begriff „Sport - Paradox“ korrekt?



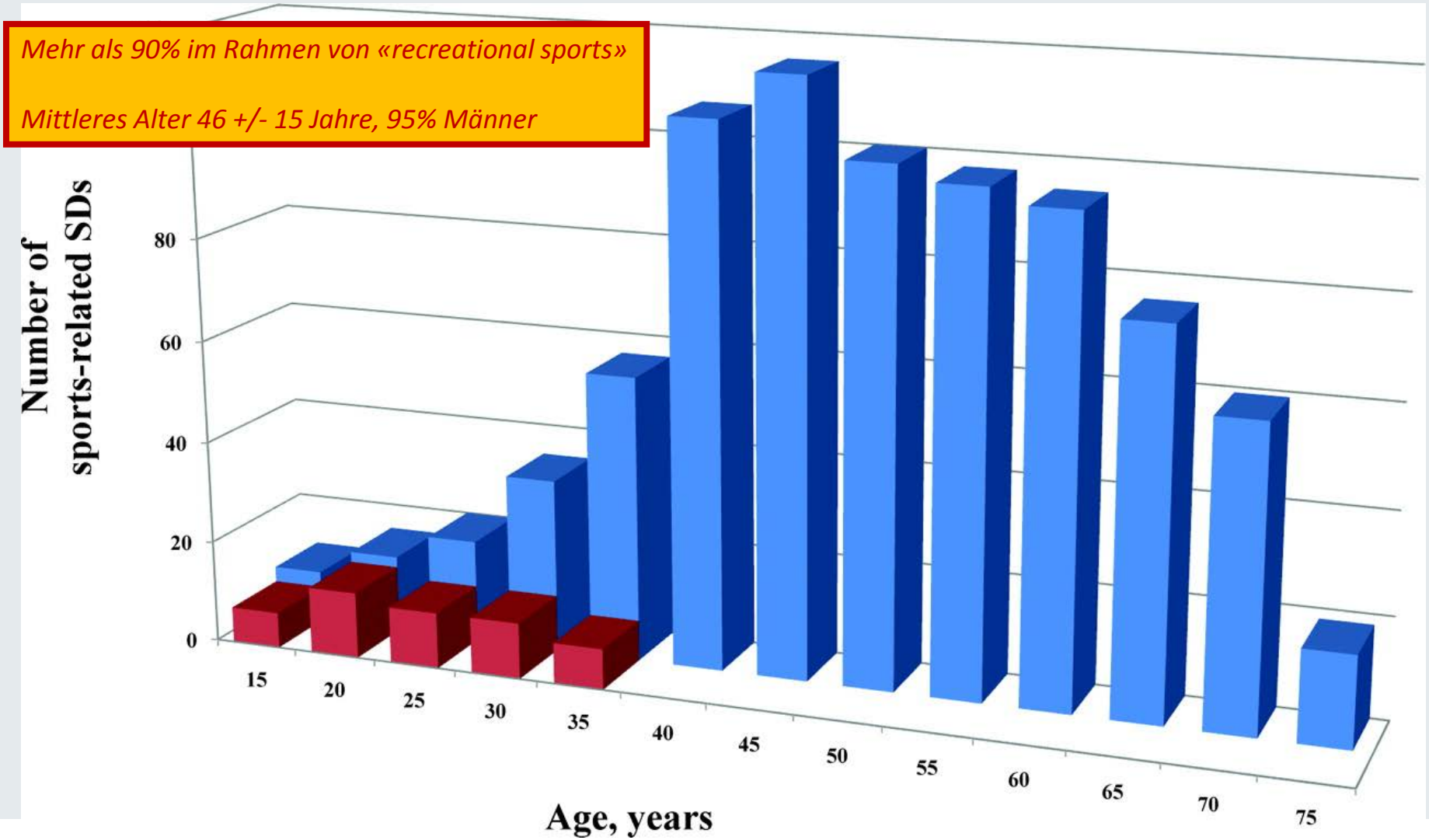
Welchen Einfluss hat das «Ausmass des Sports»?

Gibt es die/den (ungefährdeten) nicht-kompetitiven «Hobby-Sportler»?

Altersverteilung von sport-assoziierten plötzlichen Todesfällen in der Allgemeinbevölkerung (blau) und bei jungen kompetitiven Athleten (rot)

Mehr als 90% im Rahmen von «recreational sports»

Mittleres Alter 46 +/- 15 Jahre, 95% Männer



Marijon E et al. Circulation 2011;124:672-681

UniversitätsSpital Zürich

ETH zürich

Established in 1871

Swiss Medical Weekly

Formerly: Schweizerische Medizinische Wochenschrift

The European Journal of Medical Sciences

Original article | Published 31 May 2012, doi:10.4414/smw.2012.13575
Cite this as: Swiss Med Wkly. 2012;142:w13575

Cardiac pre-competition screening in Swiss athletes

Current situation in competitive athletes and short follow-up assessment of an exemplary local screening programme

Christian Schmied[a], Sara Notz[a], Marco Cribari[a], Roman Gähwiler[a], Dagmar I. Keller[b], Thomas F. Lüscher[a]

Methoden:

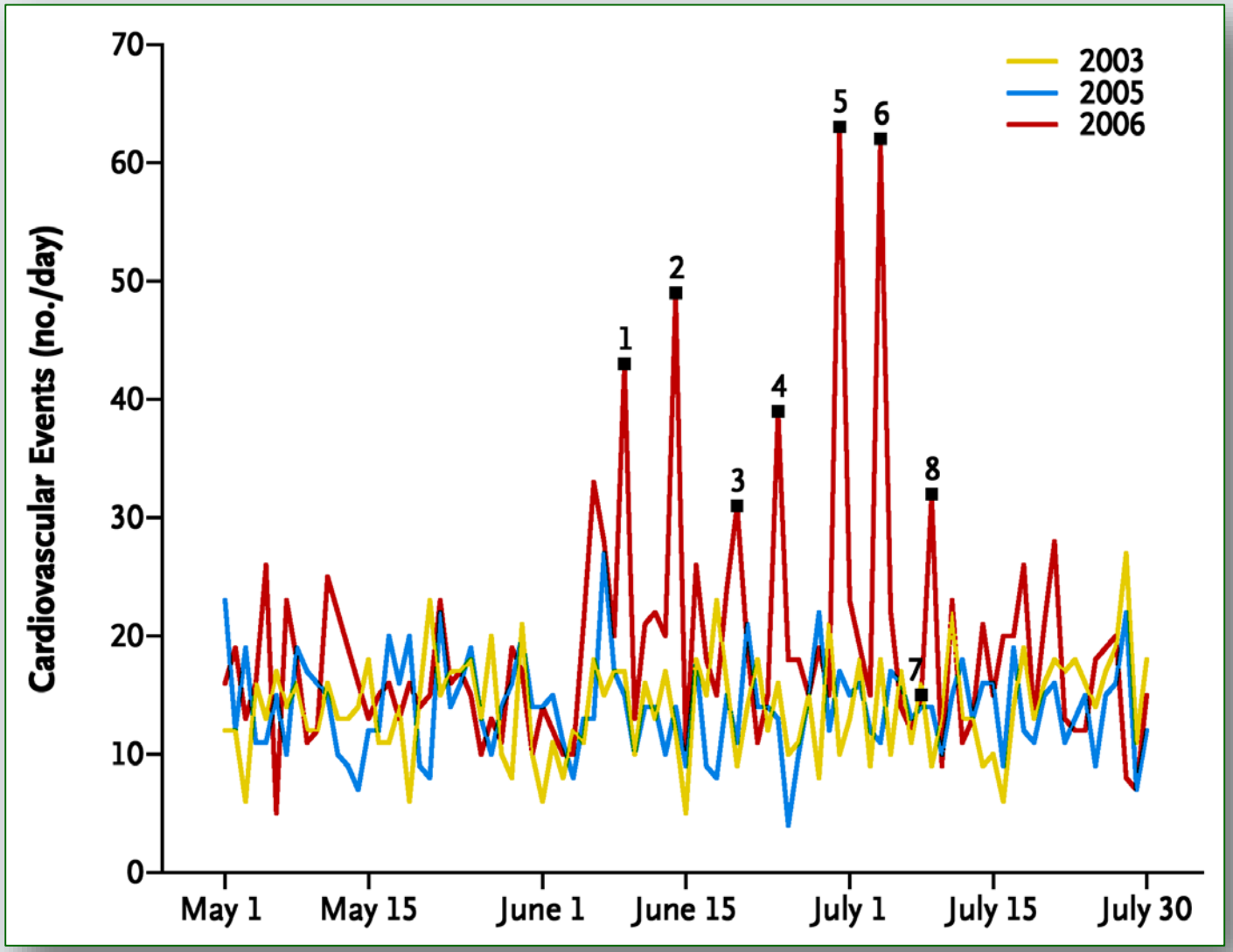
- 1047 kompetitive Breitensportler (Fragebogen)

Ergebnisse:

- nur 9% wurden bisher jemals kardial untersucht

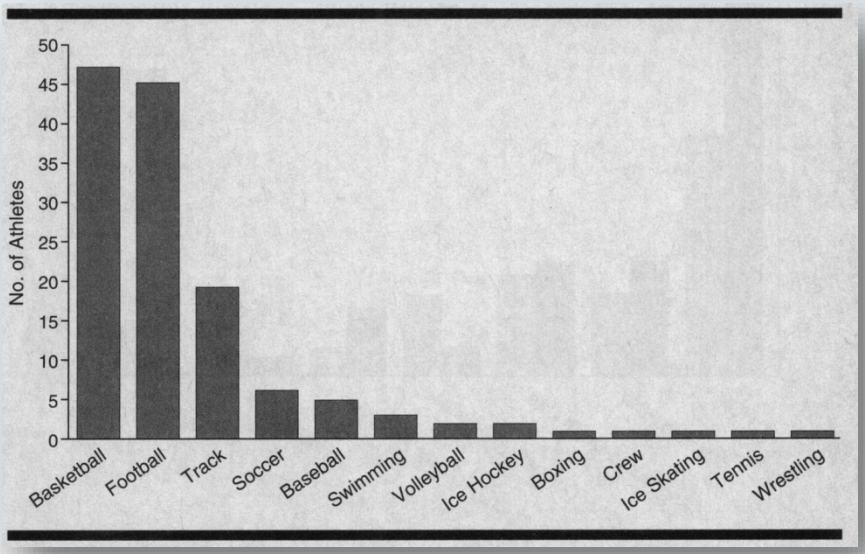
(lediglich 47% waren an Screening interessiert; v.a. Männer, ältere Sportler)

Häufigkeit der Herzinfarkte im Grossraum München

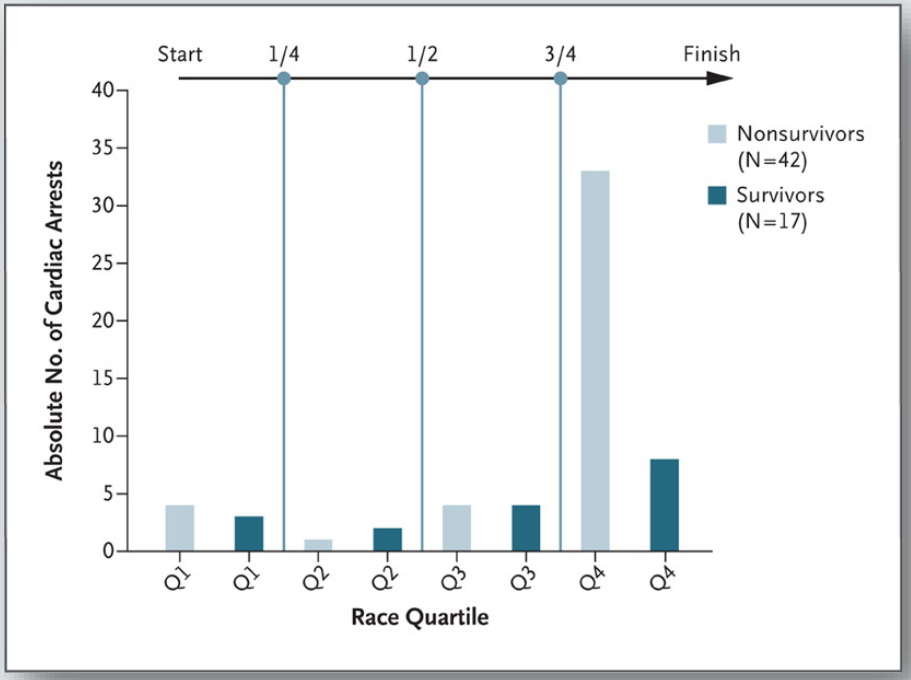


Wilbert-Lampen U, et al. N Engl J Med 2008; 358:475-483

SCD Risiko in Abhängigkeit von Sportintensität/Emotionaler Belastung



Maron BJ, et al. Sudden death in young competitive athletes. Clinical, demographic, and pathological profiles. JAMA. 1996 Jul 17;276(3):199-204.



Kim JH et al. N Engl J Med 2012;366:130-140.

Der plötzliche Herztod im Sport

Ursachen, Pathophysiologie und Prävention

Auslöser/“Trigger“

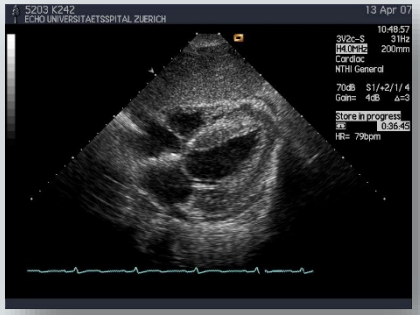
Sport

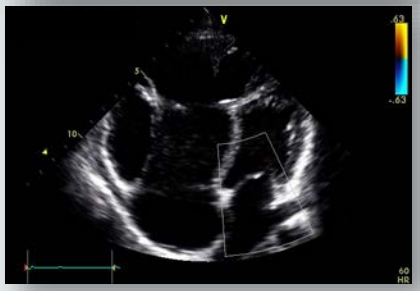
Kardiales Substrat/ Risikokonstellation

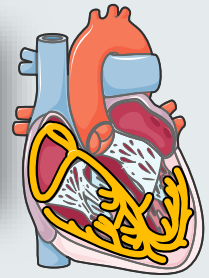
Strukturelle Herzerkrankung
Reizleitungsstörung
Bindegewebsschwäche

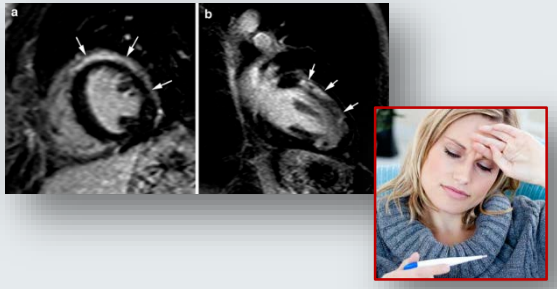
Ursachen des plötzlichen Herztods:

- **«jüngere Sportler» (< 30-35 Jahre):**
  - Angeborene Herzmuskelerkrankungen
  - Abgangsanomalien der Herzkranzgefässe
  - Herzerregungsstörungen
  - Commotio cordis
  - Marfan/Rupturiertes Aortenaneurysma
  - Myokarditis









Commotio Cordis

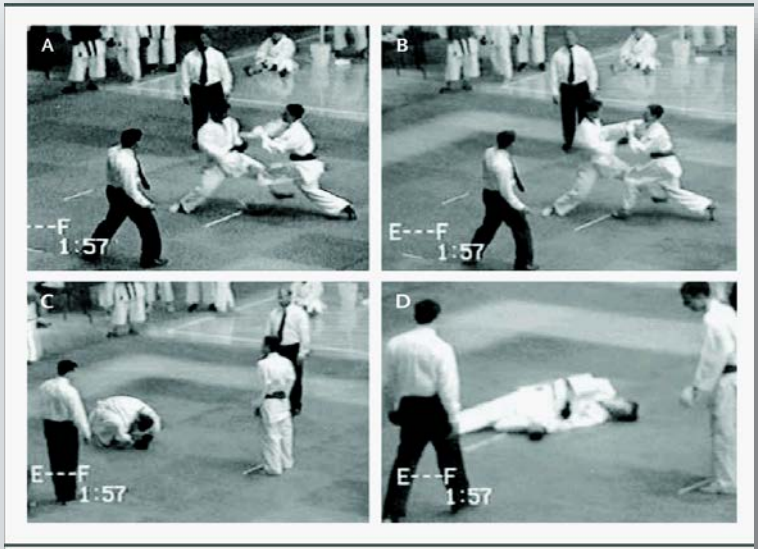
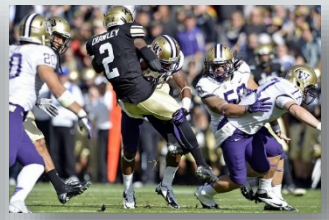
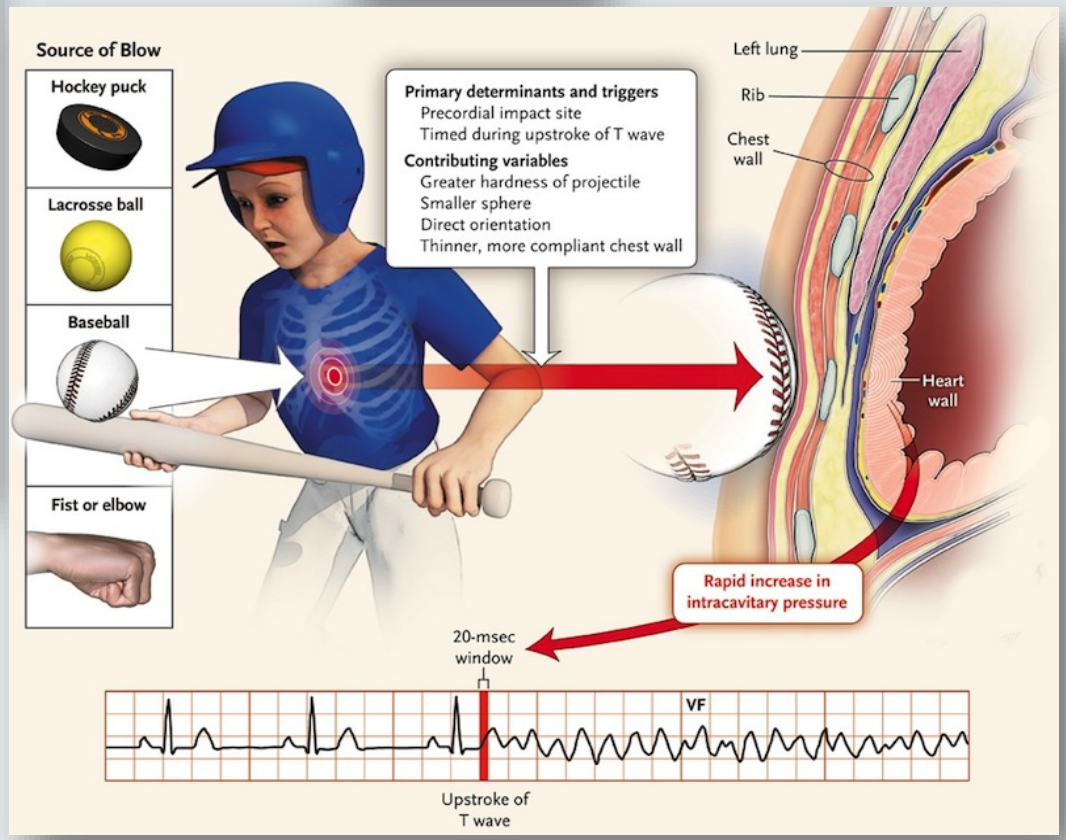


Figure 3. Stop-Frame Images of a Fatal Commotio Cordis Event in a 14-Year-Old-Boy during a Karate Match in Which the Unprotected Precordium Represented a Prescribed Scoring Target.

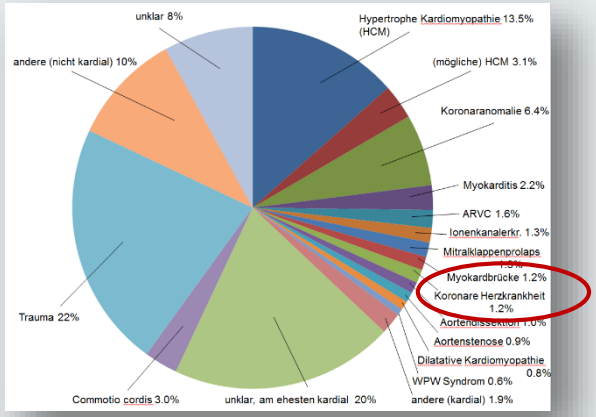
Panel A shows the fatal blow to the chest just before impact. Panel B shows the blow striking the left side of the boy's chest over his heart. Within a few seconds (after taking several steps), the boy falls to his knees (Panel C), presumably because of ventricular tachyarrhythmia, and then collapses (Panel D). Cardiopulmonary resuscitation was unsuccessful. Film provided by Cathy Hasipas.

Maron BJ, Estes, III N, N Engl J Med 2010; 362:917-927

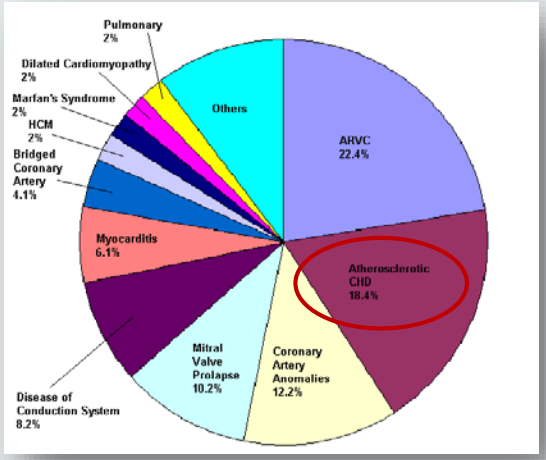




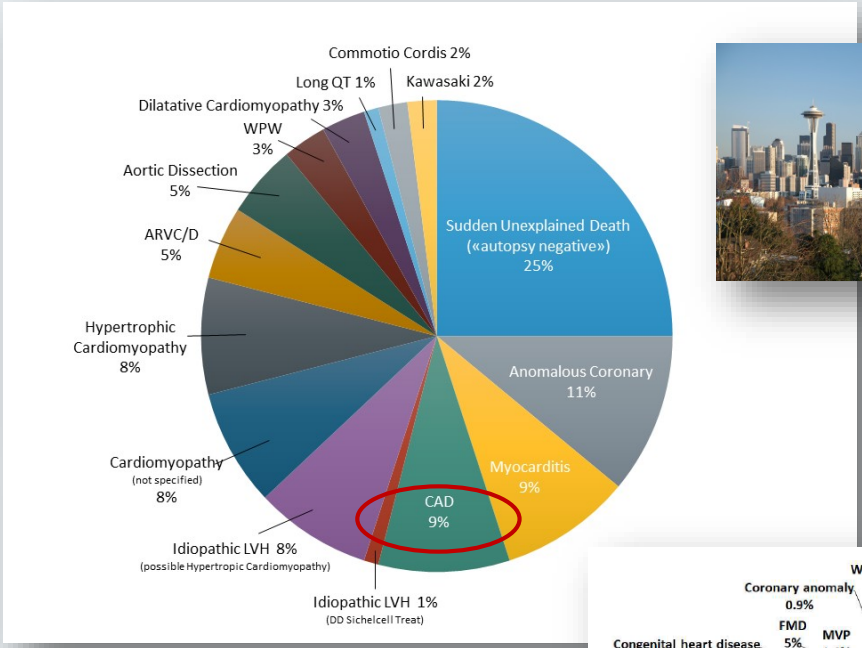
Ursachen für den plötzlichen Herztod in jungen kompetitiven Sportlern



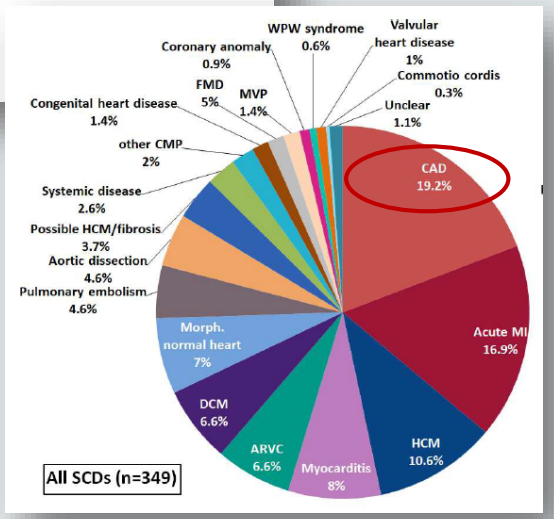
Analysis of 1866 deaths in the US, 1980–2006. Circulation 2009;119:1085–1092



Causes of Sudden Death in Athletes and Non-Athletes 35 years of age or less in the Veneto region of Italy 1979 to 1996 (Corrado, et al., New England Journal of Medicine, Volume 339:364-369):

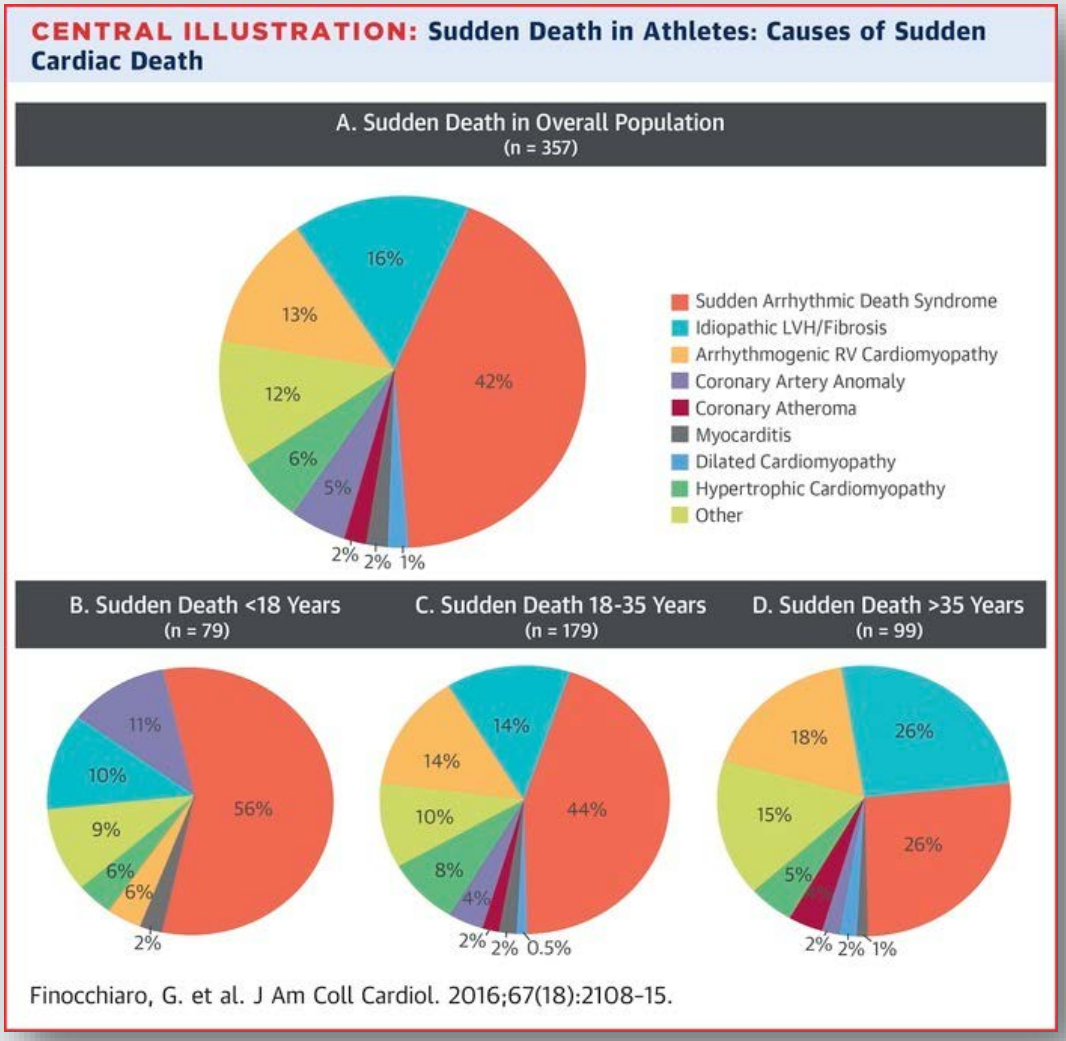


Circulation. 2015;132:10-19



PLoS ONE 12(3):e0174434

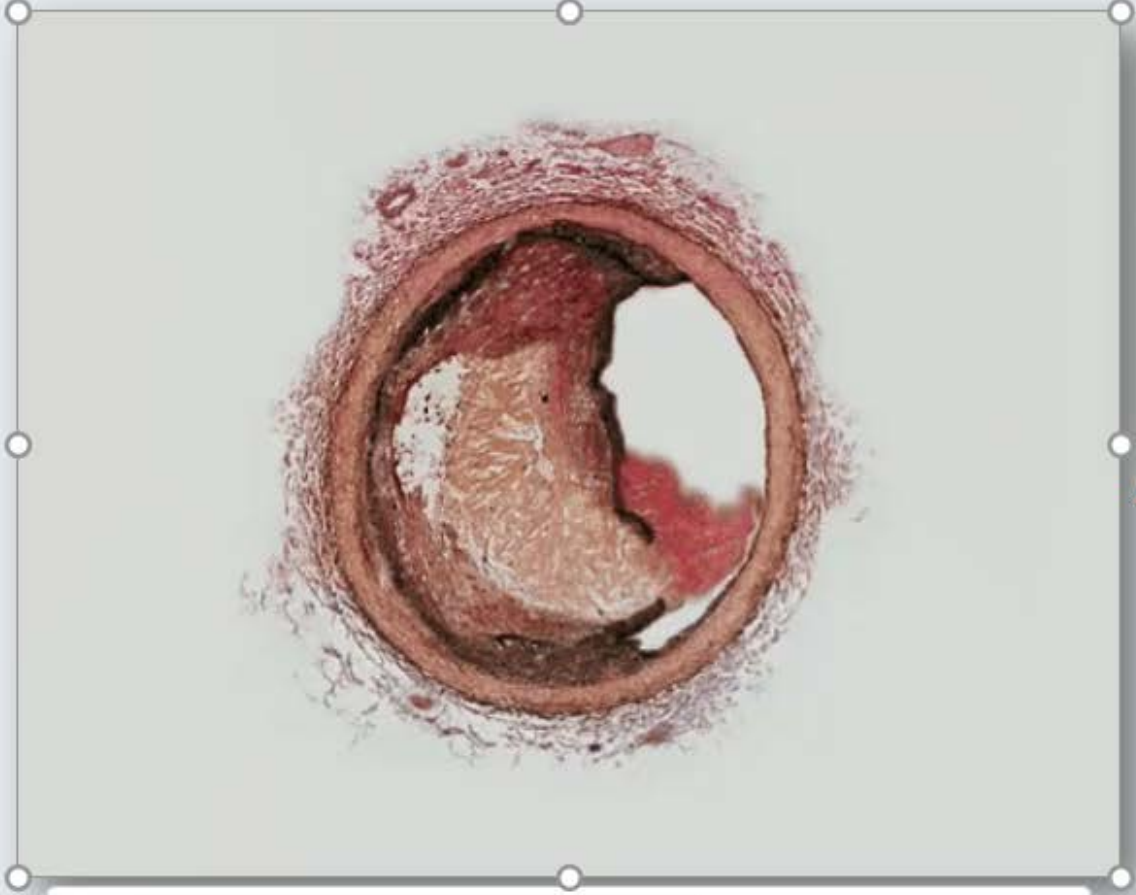
Ursachen für den plötzlichen Herztod in jungen kompetitiven Sportlern



Finocchiaro, G. et al. J Am Coll Cardiol. 2016;67(18):2108-15.

Ursachen des plötzlichen Herztods:

- **«ältere Sportler» (>30-35 Jahre):** > 80% Koronare Herzkrankheit



Koronare Plaques und Plaque-Rupturen

Aktuelle Screening-Konzepte zur Prävention des plötzlichen Herztods im Sport

Kardiales Screening bei jungen Sportlern

…zur Detektion von angeborenen Kardiopathien

ANAMNESE

«Lausanne Recommendations» (IOC)

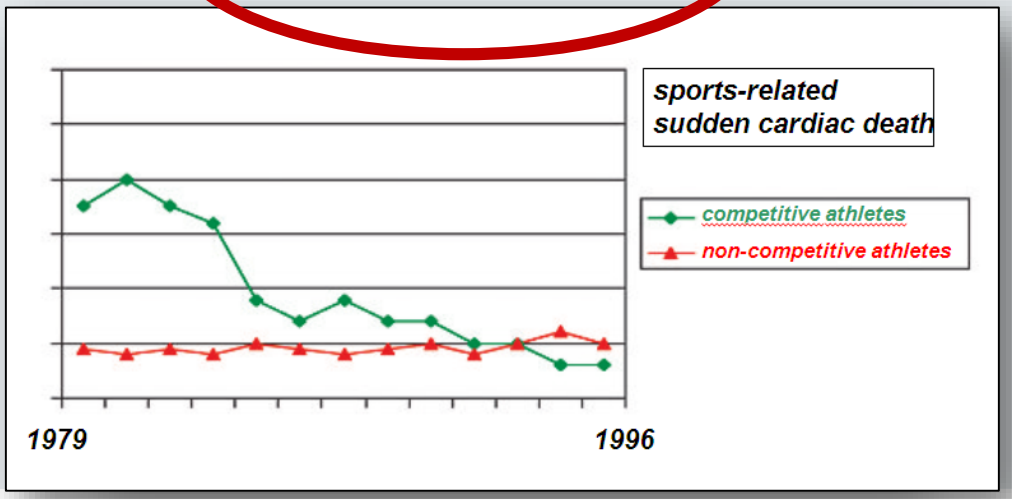
- Persönliche Anamnese, Familienanamnese
- cave AthletInnen

STATUS

fokussiert:

- Auskultation
- Blutdruckmessung
- Marfan-Stigmata (Ghent Criteria)

RUHE EKG



Corrado D, et al. JAMA 2006 Oct 4;296(13):1593-601.

TABLE. The 12-Element AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes

American Heart Association. Learn and Live

Medical history*

Personal history

1. Exertional chest pain/discomfort
2. Unexplained syncope/near-syncope†
3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure

Family history

6. Premature death (sudden and unexpected, or otherwise) before age 50 years due to heart disease, in ≥1 relative
7. Disability from heart disease in a close relative <50 years of age
8. Specific knowledge of certain cardiac conditions in family members: hypertrophic or dilated cardiomyopathy, long-QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias

Physical examination

9. Heart murmur‡
10. Femoral pulses to exclude aortic coarctation
11. Physical stigmata of Marfan syndrome
12. Brachial artery blood pressure (sitting position)§

Maron B, et al. Circulation, 2007;115(12):1643-455

Sensitivität,: 45.5% [95% CI, 16.8% to 76.2%]
Spezifität, 94.4% [CI, 92.0% to 96.2%]

(Altes) Europäisches Konzept:
Sensitivität 90.9% (CI, 58.7% to 99.8%)
Spezifität 82.7% (CI, 79.1% to 86.0%)
falsch-positiv: 16.9%

Baggish AL, et al. Ann Intern Med. 2010;152(5):269-75

«No - you can't!»

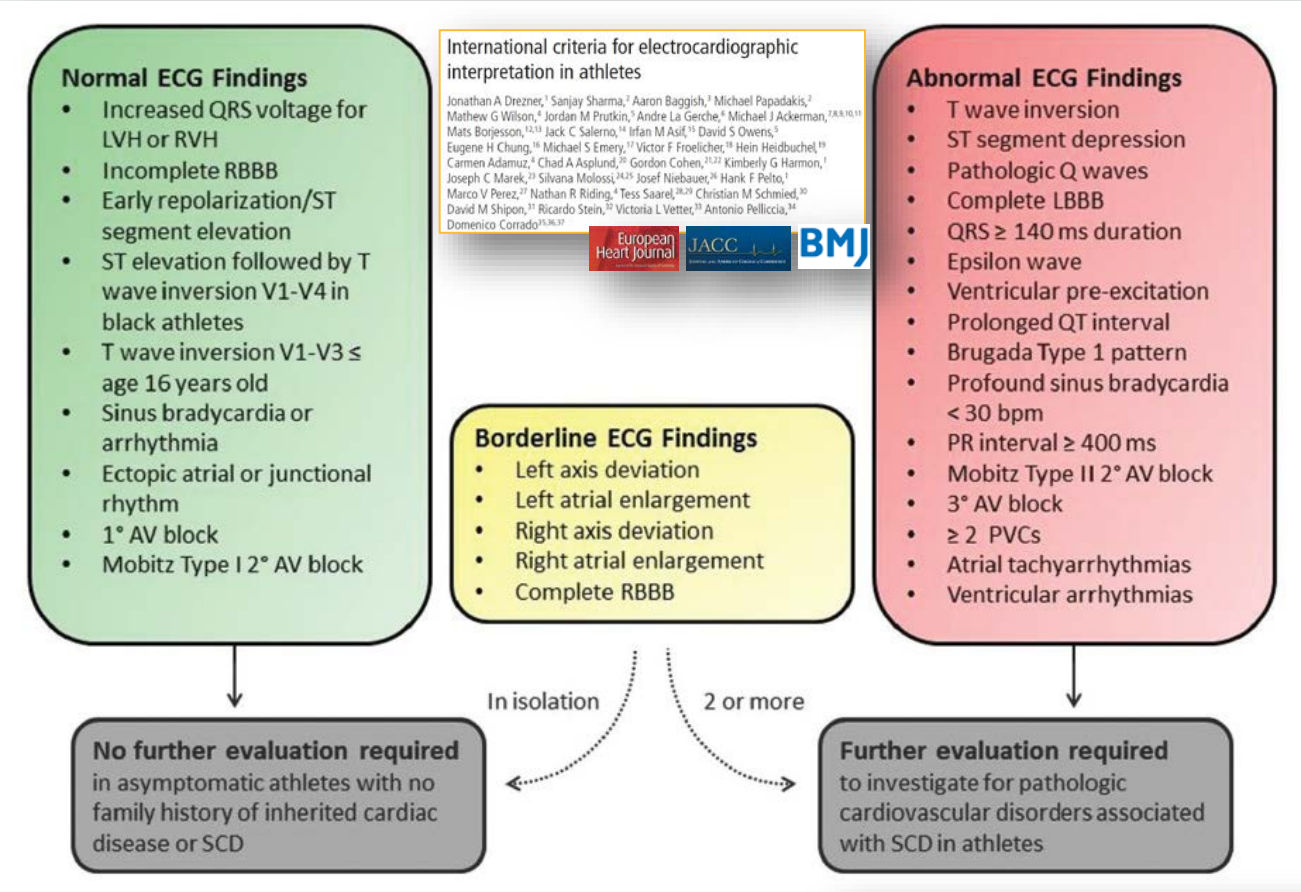
Seattle Conference 2012, Seattle/WA

«Yes – we can!»

Normale Sportler-EKG Befunde
Häufige, durch den Sport/ein "Sportherz" bedingte, physiologische EKG-Veränderungen.
Keine weiteren Abklärungen notwendig.

Abnormale EKG Befunde
Seltene, nicht durch ein regelmässiges Training bedingte, pathologische EKG-Veränderungen.
Weitere Abklärungen zwingend notwendig.

EKG Screening bei Sportlern – Die «International» (Seattle) Criteria



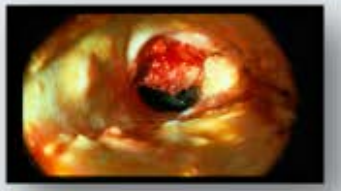
Eur Heart J (2017) 00, 1–19

International revised Seattle Criteria

Sensitivity/Specificity > 90% !!

Kardiales Screening bei älteren Sportlern

...zur Detektion der Koronaren Herzkrankheit



ANAMNESE

STATUS

RUHE EKG

Kardiovaskulärer
RISK SCORE
(inkl. Blutentnahme)

BILDGEBENDE VERFAHREN

BELASTUNGSTEST

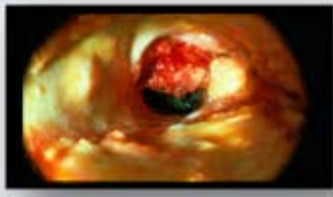
UniversitätsSpital Zürich

ETH zürich

Universität Zürich[UZH]

Kardiales Screening bei älteren Sportlern

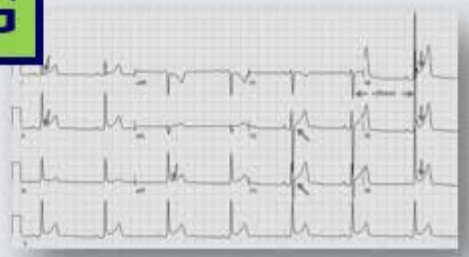
...zur Detektion der Koronaren Herzkrankheit



ANAMNESE

STATUS

EKG



Kardiovaskulärer
RISK SCORE
(inkl. Laboruntersuchung)

Test	N	Sensitivity	Specificity
Exercise treadmill test	24,074	68	77
Exercise nuclear MPI	2,360	88	70
Vasodilator nuclear MPI	4,582	89	77
Dobutamine nuclear MPI	1,359	84	79
Exerci			
Dobut			

Overall, combined stress testing with imaging yields similar diagnostic performance for either SPECT or echocardiography, with sensitivity and specificity of approximately **80–90%** and **70–80%**, respectively.
Arbab-Zadeh A. Heart Int. 2012; 7(1):e2.

Sensitivity 68%
Specificity 77%

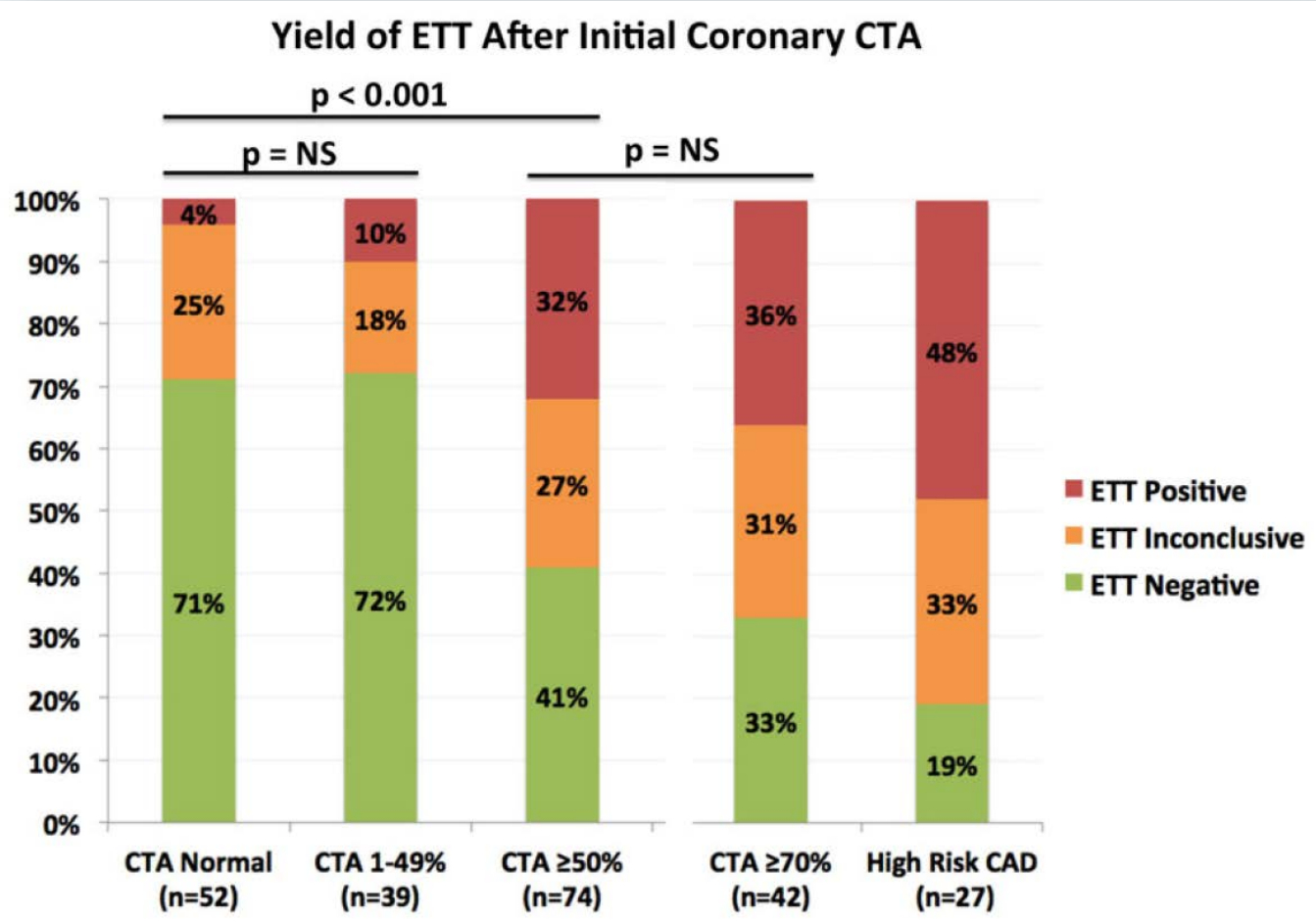
BELASTUNGSTEST

UniversitätsSpital Zürich

ETH zürich

Universität Zürich[UZH]

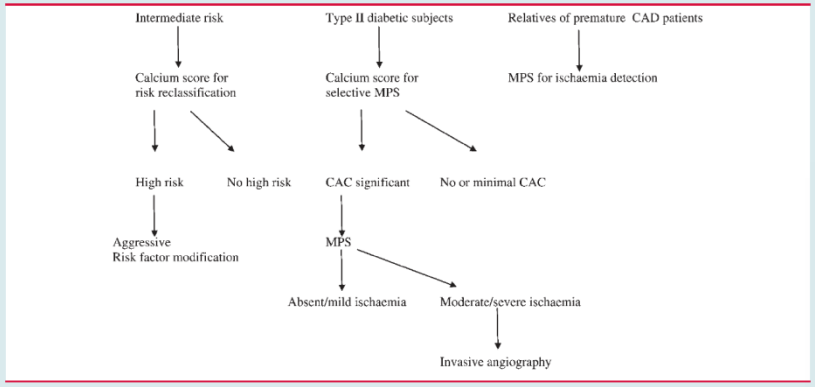
Screening bei älteren Sportlern – **Koronares CT vs. Ergometrie**



Cheezum MK, et al. Prognostic value of coronary CTA vs. exercise treadmill testing: results from the Partners registry. Eur Heart J Cardiovasc Imaging. 2015 Dec;16(12):1338-46.

Screening bei älteren Sportlern – KHK Detection über multimodalen Ansatz

Table 2 Applications of CCT and myocardial perfusion scintigraphy in asymptomatic subjects without previous cardiovascular events



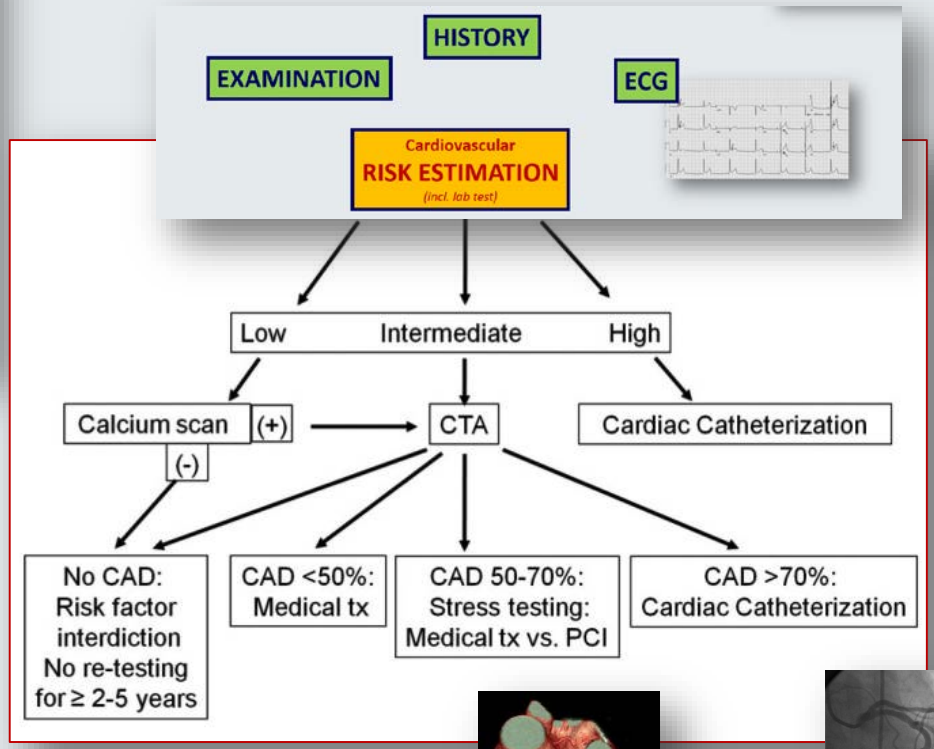
Pasquale Perrone-Filardi, et al. Eur Heart J. 2011 Aug;32(16):1986-93, 1993a, 1993b

Recommendations for imaging methods

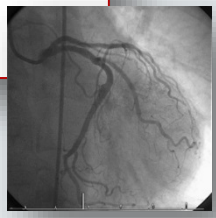
Recommendations	Class[a]	Level[b]	Ref[c]
Coronary artery calcium scoring may be considered as a risk modifier in CV risk assessment.	IIb	B	120–125
Atherosclerotic plaque detection by carotid artery scanning may be considered as a risk modifier in CV risk assessment.	IIb	B	126–128
ABI may be considered as a risk modifier in CV risk assessment.	IIb	B	129–132
Carotid ultrasound IMT screening for CV risk assessment is not recommended.	III	A	128, 133

ABI = ankle–brachial index; CV = cardiovascular; IMT = intima–media thickness.
[a]Class of recommendation.
[b]Level of evidence.
[c]Reference(s) supporting recommendations.

Eur Heart J (2016) 37,2315-2381



Arbab-Zadeh A. Heart Int. 2012; 7(1):e2.



«Screening perspectives» – Vorschlag für einen modernen Ansatz

Wer: Sportler «mit erhöhtem Risiko» (ältere Sportler, hoher cvRF, pos. FA, Risiko für pathologisches Sportherz)

Wie, was und wann:

0 – 12 years

Risk estim.: Clinics, history
Screening: Specified (clinical examination, imaging)

↓

12-14 years (beginning of regular «competitive» athletics (12-14 years)

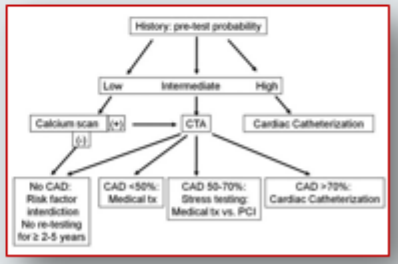
Risk estim.: («mass screening»?)
Screening: History, clinical examination, ECG

↓ ***Screening every 1-2 years*** ***Echocardiography once***

25-35 years (beginning of the age of an «older athlete»)

Risk estim.: Individually - based on established score (e.g. SCORE) plus risk modifiers
Screening: History, clinical examination, ECG
Exercise testing

↓ ***Regular risk estimation***



from 45-50 years

(beginning of the age of a «master athlete»)

Risk estim.: Individually - based on established score (e.g. SCORE) plus risk modifiers plus training intensity
Screening: History, clinical examination, ECG, Exercise testing, plaque detection, ***Echocardiography***

Outcomes of Cardiac Screening in Adolescent Soccer Players

N Engl J Med 2018;379:524-34

11’168 adolescent football players (mean age 16.4 +/-1.2 years; 95% male)

2.4% with cardiac disorders in screening. 8 deaths from cardiac disease (75% had normal cardiac screening but mean time from screening was 6.8 years

Table 3. Characteristics of Athletes with Sudden Cardiac Death.

Athlete No.	Sex and Age	Race*	Years from Screening to Death	Diagnosis	Initial Screening Result	Blind Reading (Reviewer 1)	Blind Reading (Reviewer 2)
1	M, 16.8 yr	Black	0.1	Idiopathic left ventricular hypertrophy	Negative	Negative	Negative
2	M, 16.6 yr	Mixed	1.0	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
3	M, 16.6 yr	Black	3.3	Hypertrophic cardiomyopathy	Negative	Negative	Negative
4	M, 16.3 yr	Black	7.7	Dilated cardiomyopathy	Negative	Negative	Negative
5	M, 17.0 yr	White	7.9	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
6	M, 17.2 yr	White	9.7	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
7	M, 15.7 yr	White	11.5	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
8	M, 16.8 yr	White	13.2	Sudden arrhythmic death syndrome	Negative	Negative	Negative

Outcomes of Cardiac Screening in Adolescent Soccer Players

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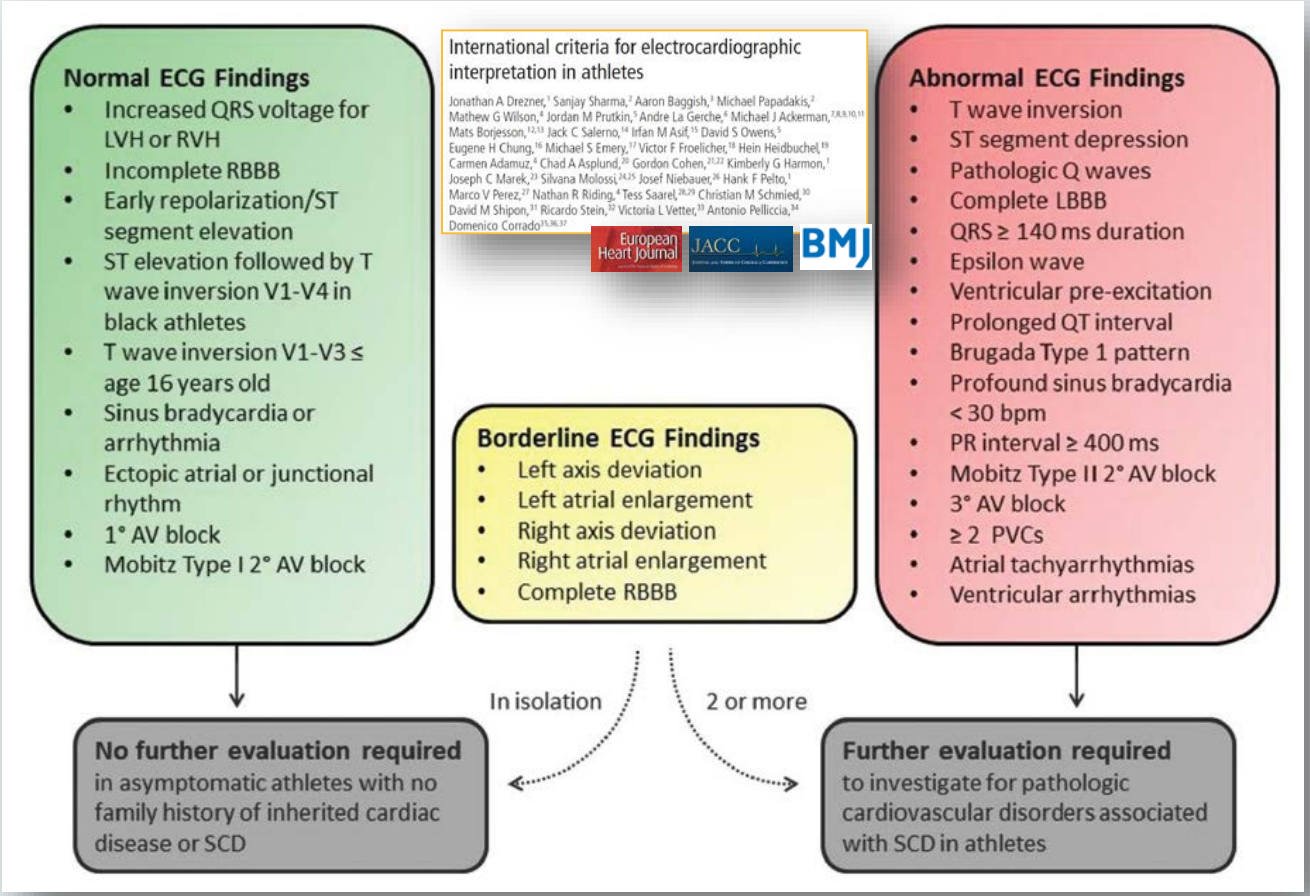
4	M, 16.3 yr	Black	7.7	Dilated cardiomyopathy	Negative	Negative	Negative
5	M, 17.0 yr	White	7.9	Arrhythmogenic right ventricular	Negative	Negative	Negative
				ar	Negative	Negative	Negative
7	M, 15.7 yr	White	11.5	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
8	M, 16.8 yr	White	13.2	Sudden arrhythmic death syndrome	Negative	Negative	Negative

Incidence of SCD 6.8 per 100’000 athletes per year.

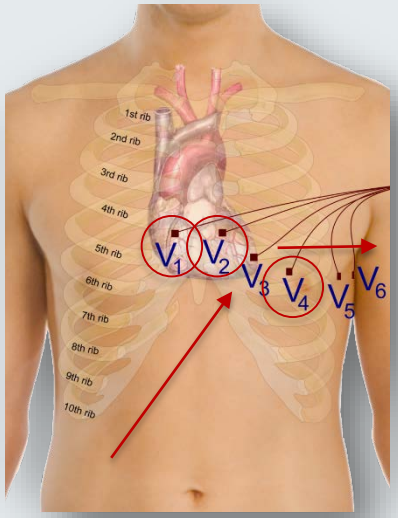
EKG Screening bei Sportlern – International (Seattle) Criteria



Eur Heart J (2017) 00, 1–19

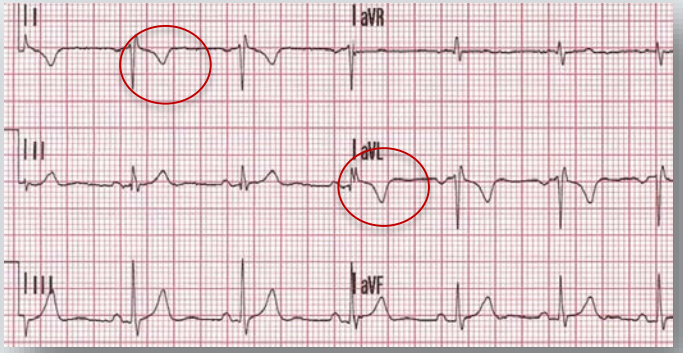
EKG Screening bei Sportlern – «Basics» sind oftmals entscheidend

Die Positionierung der Elektroden ist simpel aber entscheidend!

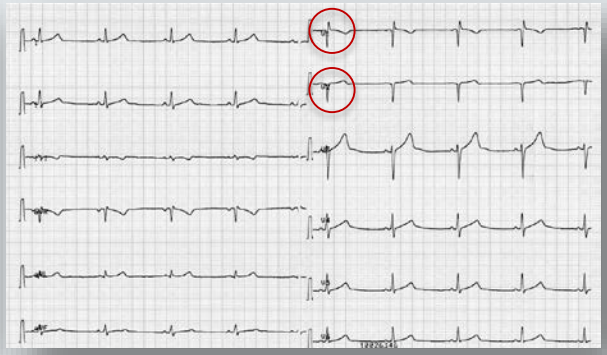


https://en.wikipedia.org/wiki/Electrocardiography

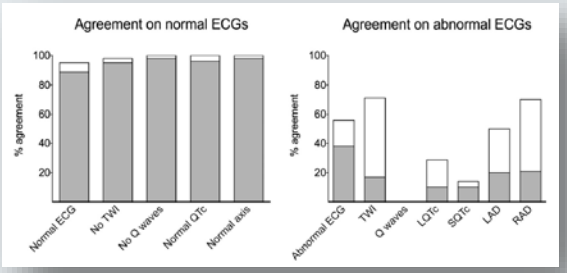
«Limb Lead Reversal»



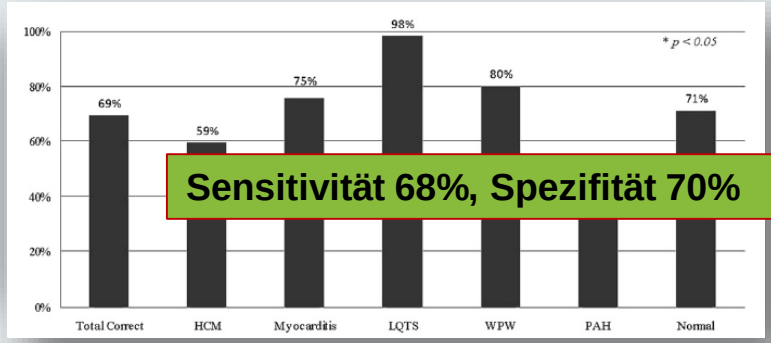
«Pseudo Q waves» (downward misplacement)



http://sixlettervariable.blogspot.ch/2011/02/limb-lead-reversal-preliminary-findings.html



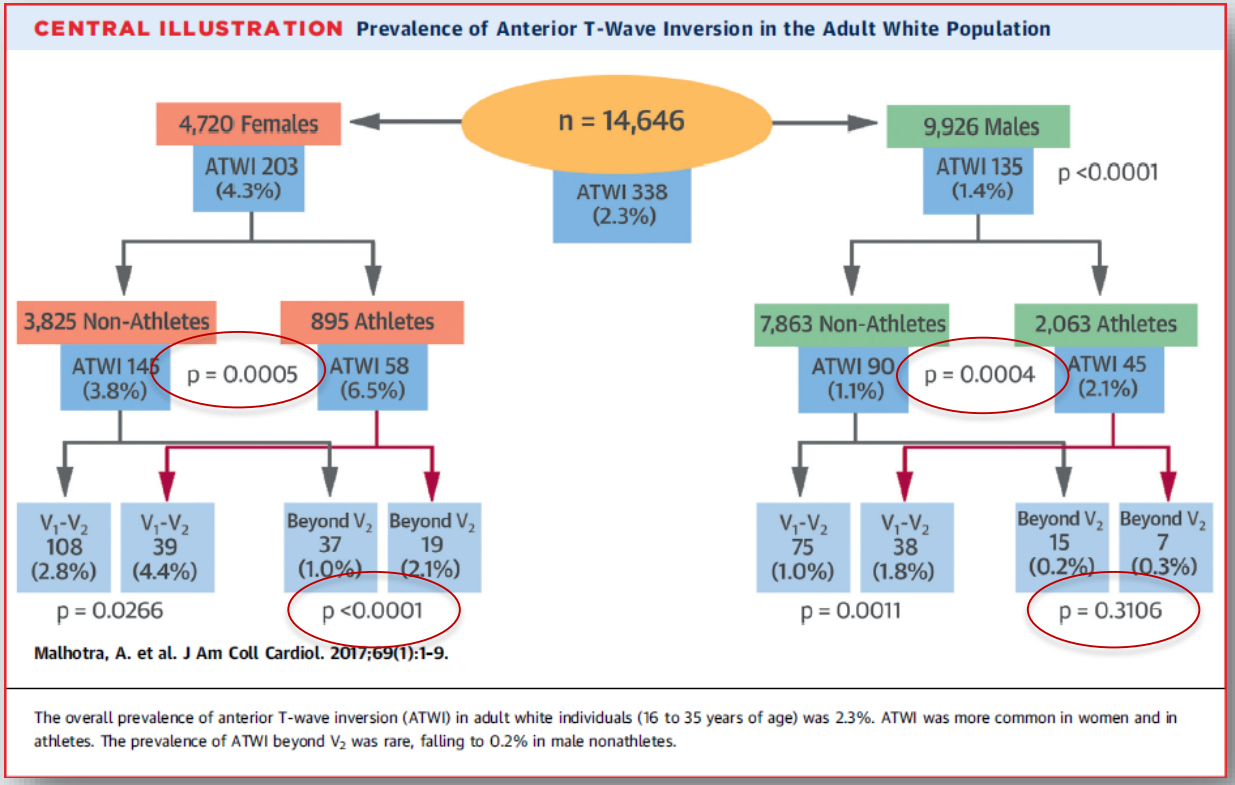
Heart Rhythm2015;12:130–136 (sports cardiologist, sports medicine physician, electrophysiologist)



J Pediatr 2011;159:783-8

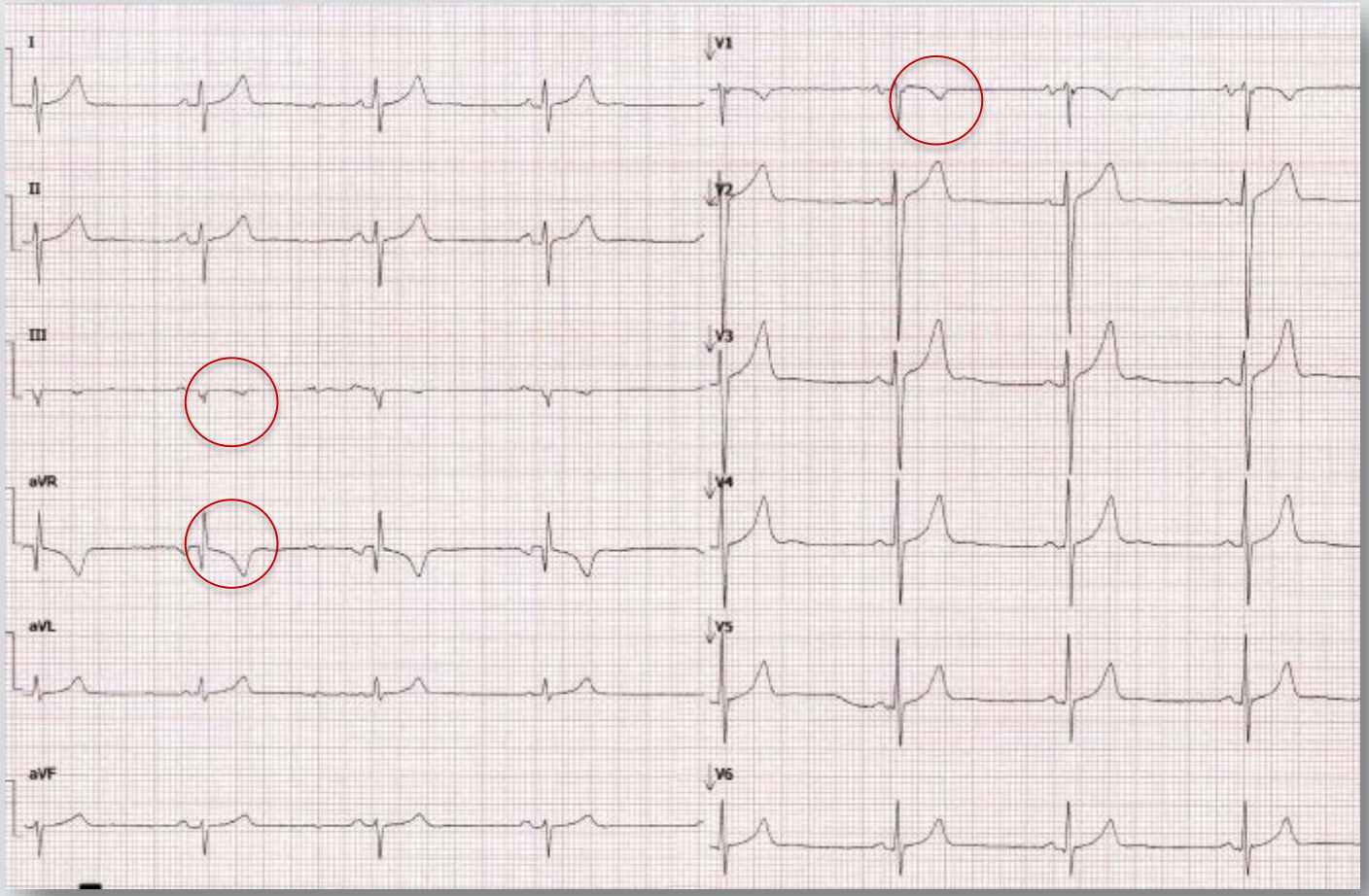
Die «Interobserver-Variabilität» ist relativ hoch (v.a. wenn keine spezifischen Richtlinien benutzt werden).

T Wellen Inversionen – *the good, the bad and the ugly*

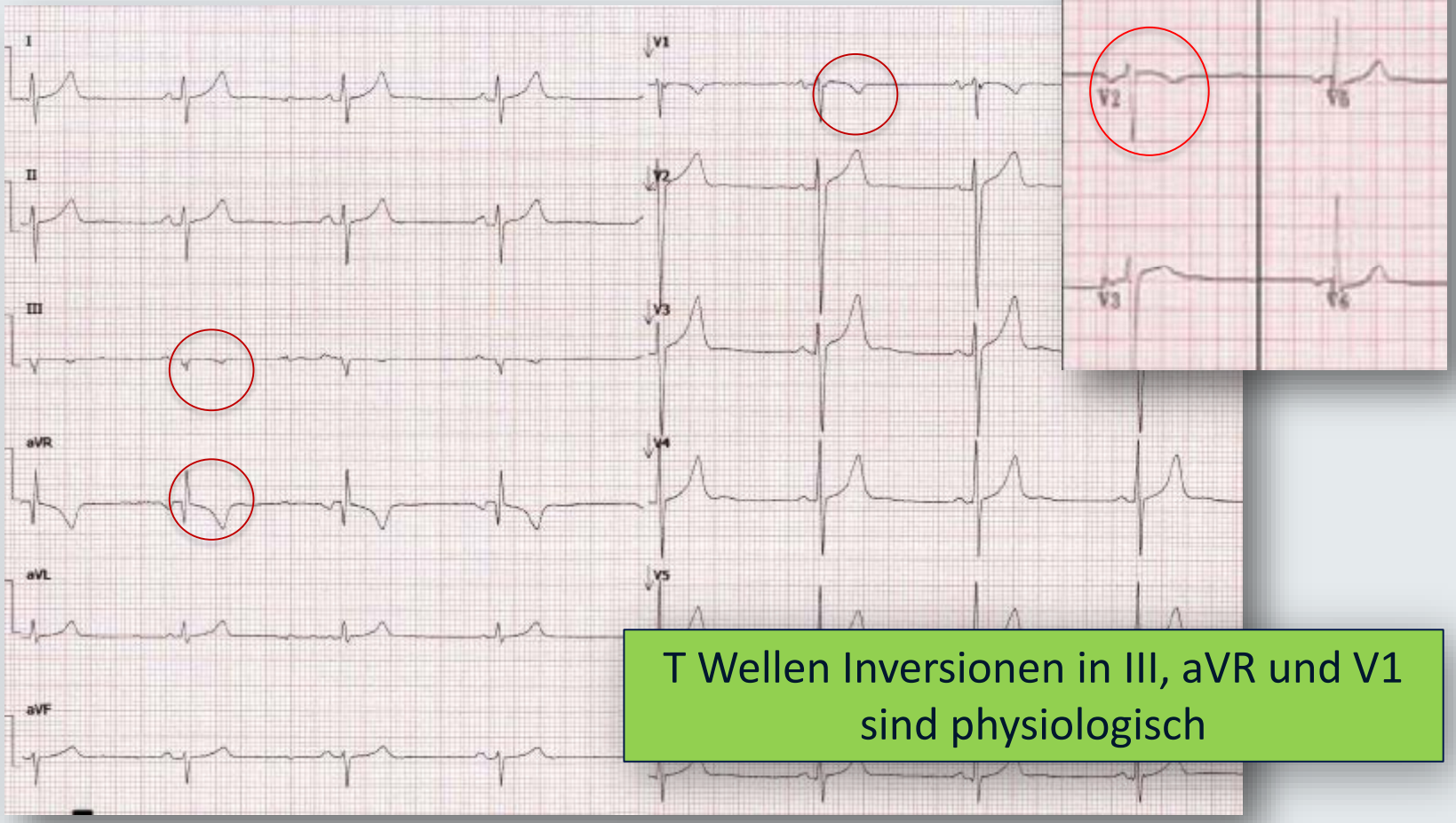


Malhotra A, Dhutia H, Gati S, et al. Prevalence and significance of anterior T wave inversion in young white Athletes and non Athletes. J Am Coll Cardiol 2016;69:1–9.

T Wellen Inversionen – *the good…*



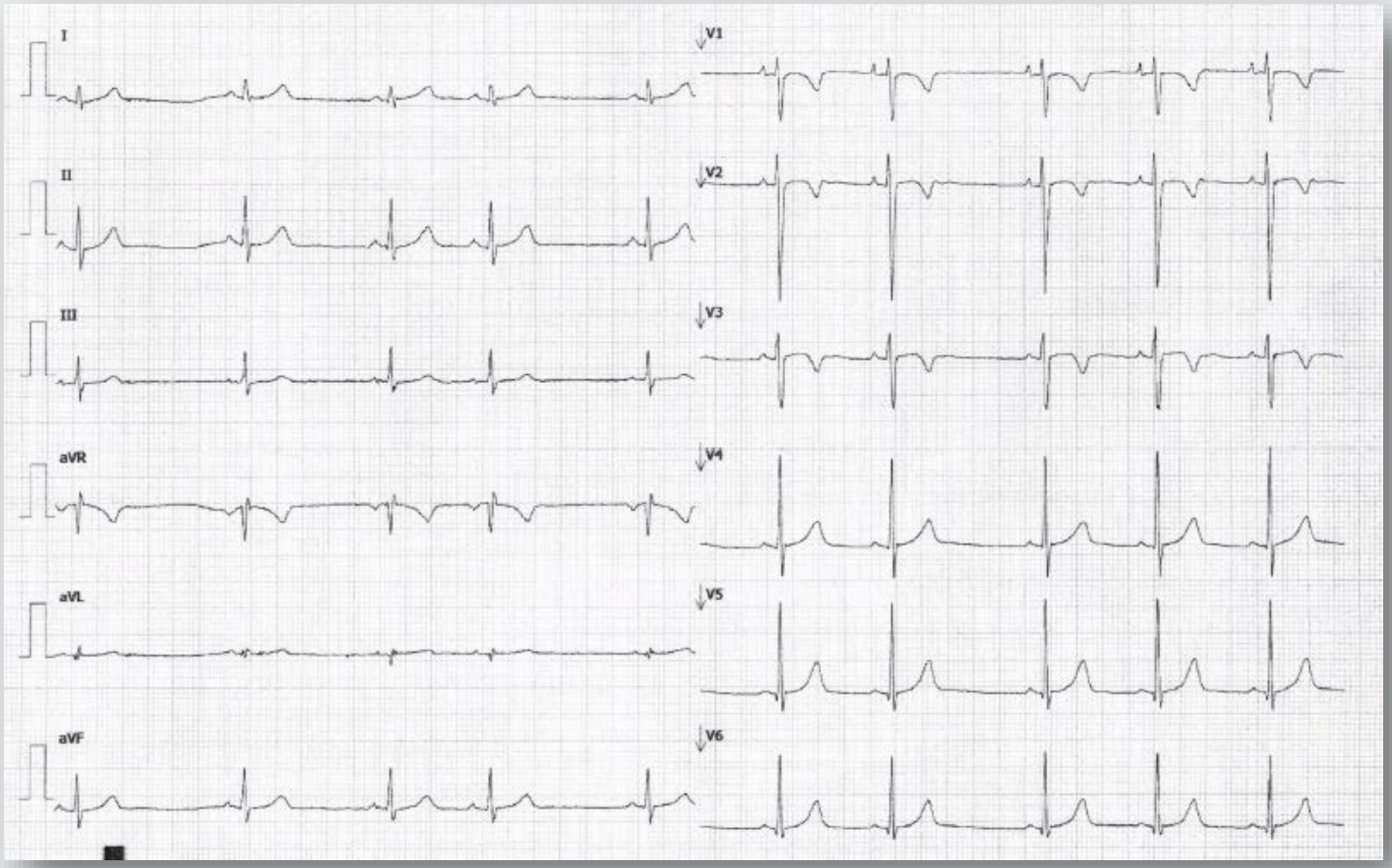
T Wellen Inversionen – *the good…*



T Wellen Inversionen in III, aVR und V1 sind physiologisch

T Wellen Inversionen – *the good…*

«Juveniles» EKG



T Wellen Inversionen – *the good…*

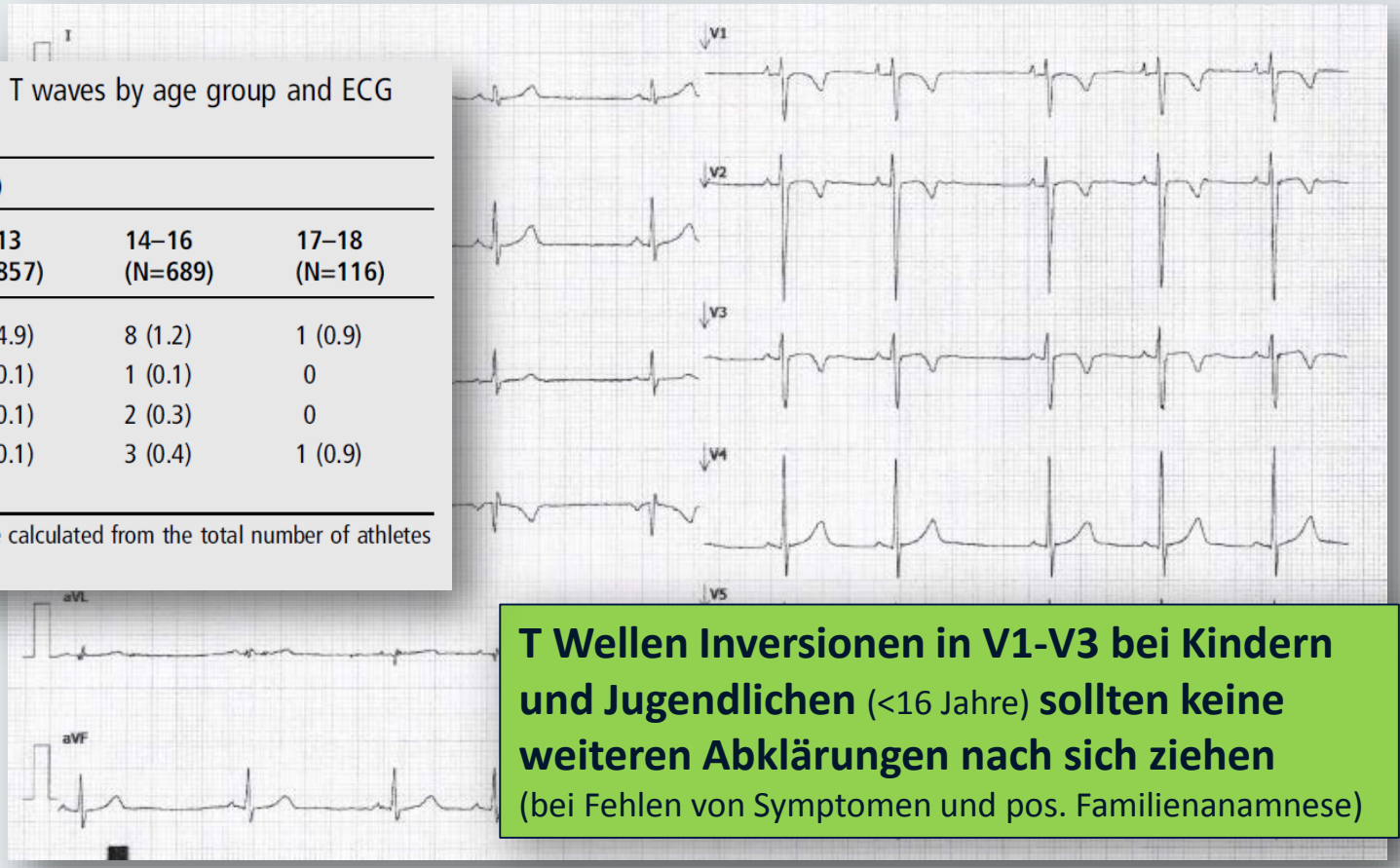
«Juveniles» EKG

Table 3 Athletes with negative T waves by age group and ECG lead localisation

	Age groups (years)			
	8–10 (N=599)	11–13 (N=857)	14–16 (N=689)	17–18 (N=116)
V1–V3	75 (12.5)	42 (4.9)	8 (1.2)	1 (0.9)
V1–V4	0	1 (0.1)	1 (0.1)	0
DII–aVF	0	1 (0.1)	2 (0.3)	0
DII–aVF/V4–V6/ DI–aVL	0	1 (0.1)	3 (0.4)	1 (0.9)

Values are numbers (%). Percentages are calculated from the total number of athletes in any age group.

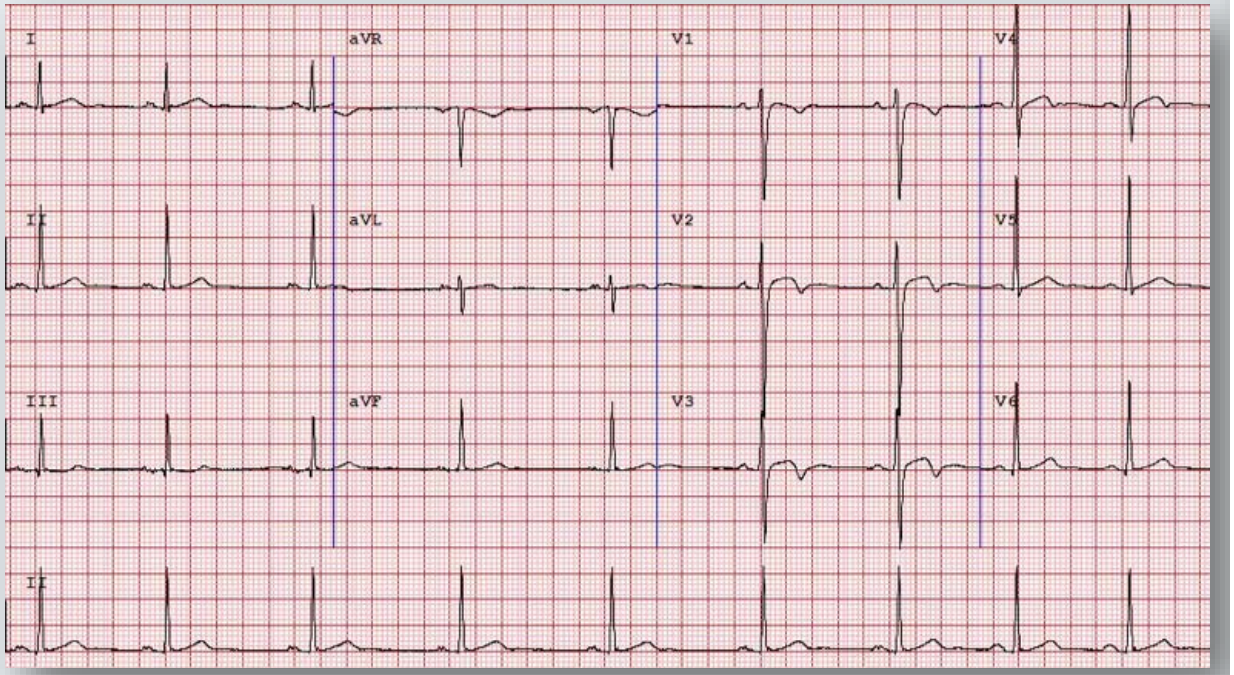
Calò L, et al. Heart 2015;101:193–200

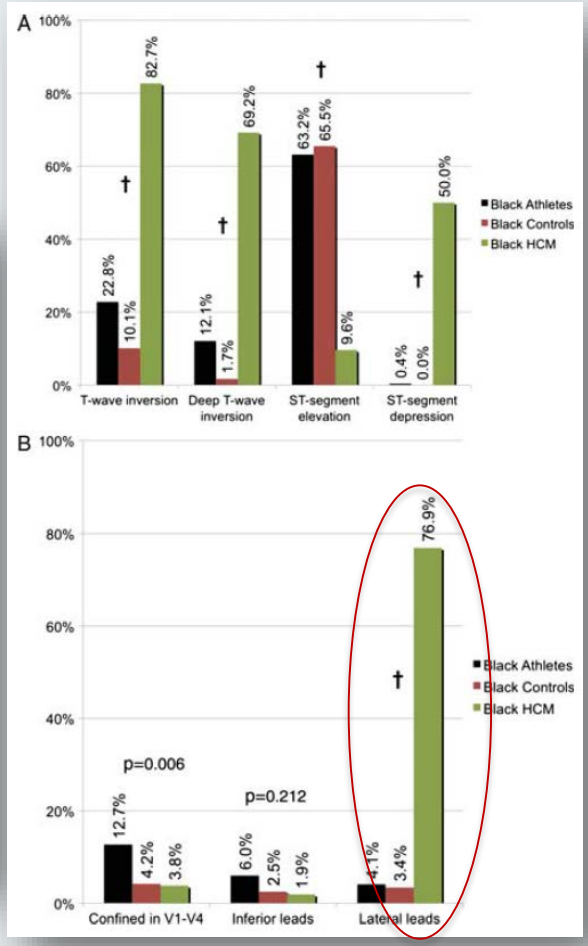


T Wellen Inversionen in V1-V3 bei Kindern und Jugendlichen (<16 Jahre) **sollten keine weiteren Abklärungen nach sich ziehen**
(bei Fehlen von Symptomen und pos. Familienanamnese)

T Wellen Inversionen – *the good…*

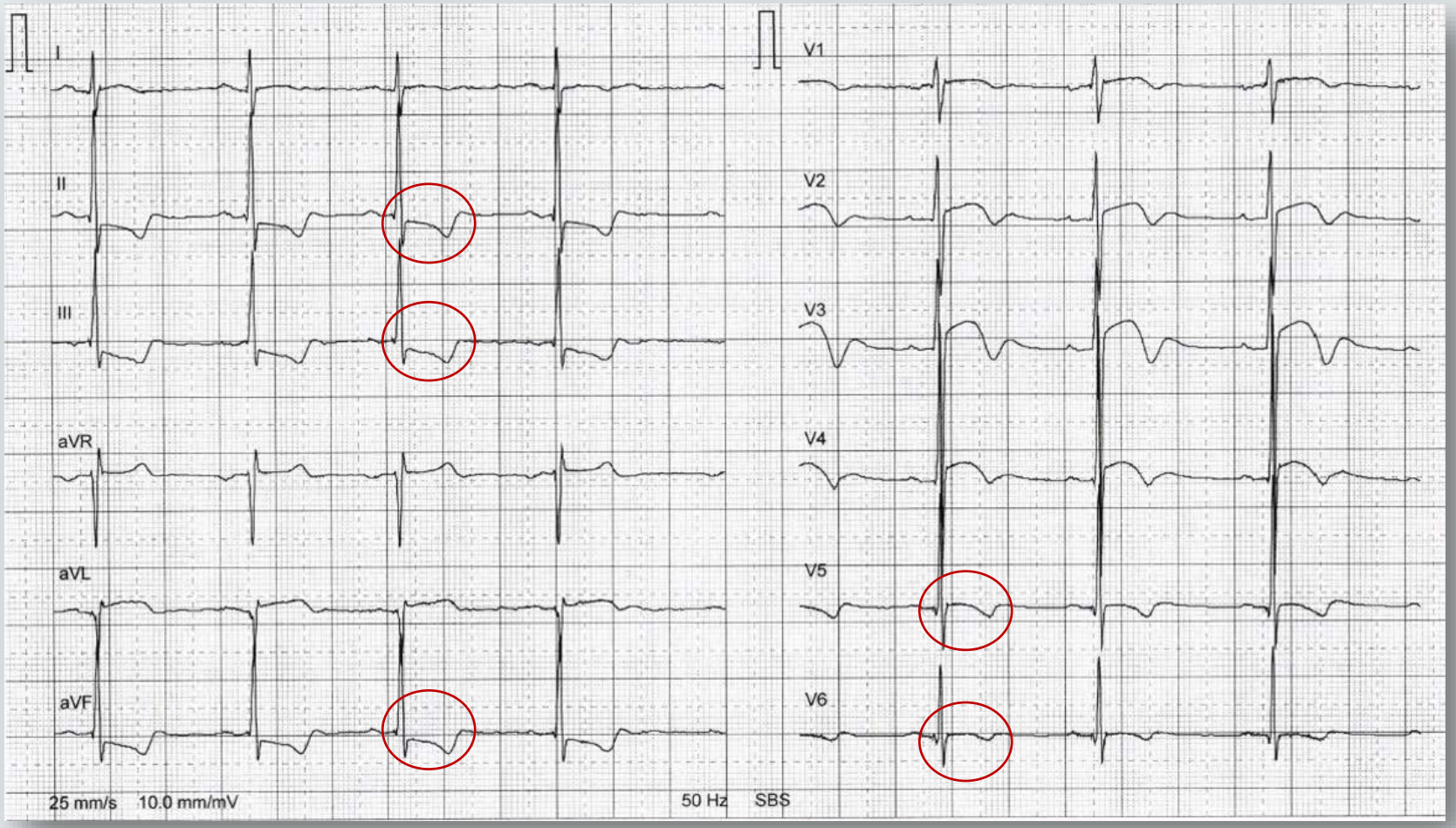
Das «afro-karibische» early repolarization pattern





Papadakis M, et al. The prevalence, distribution, and clinical outcomes of electrocardiographic repolarization patterns in male Athletes of African/Afro-Caribbean origin. Eur Heart J 2011;32:2304–13

T Wellen Inversionen – *the bad…*



J Am Coll Cardiol 2014;64:119–25

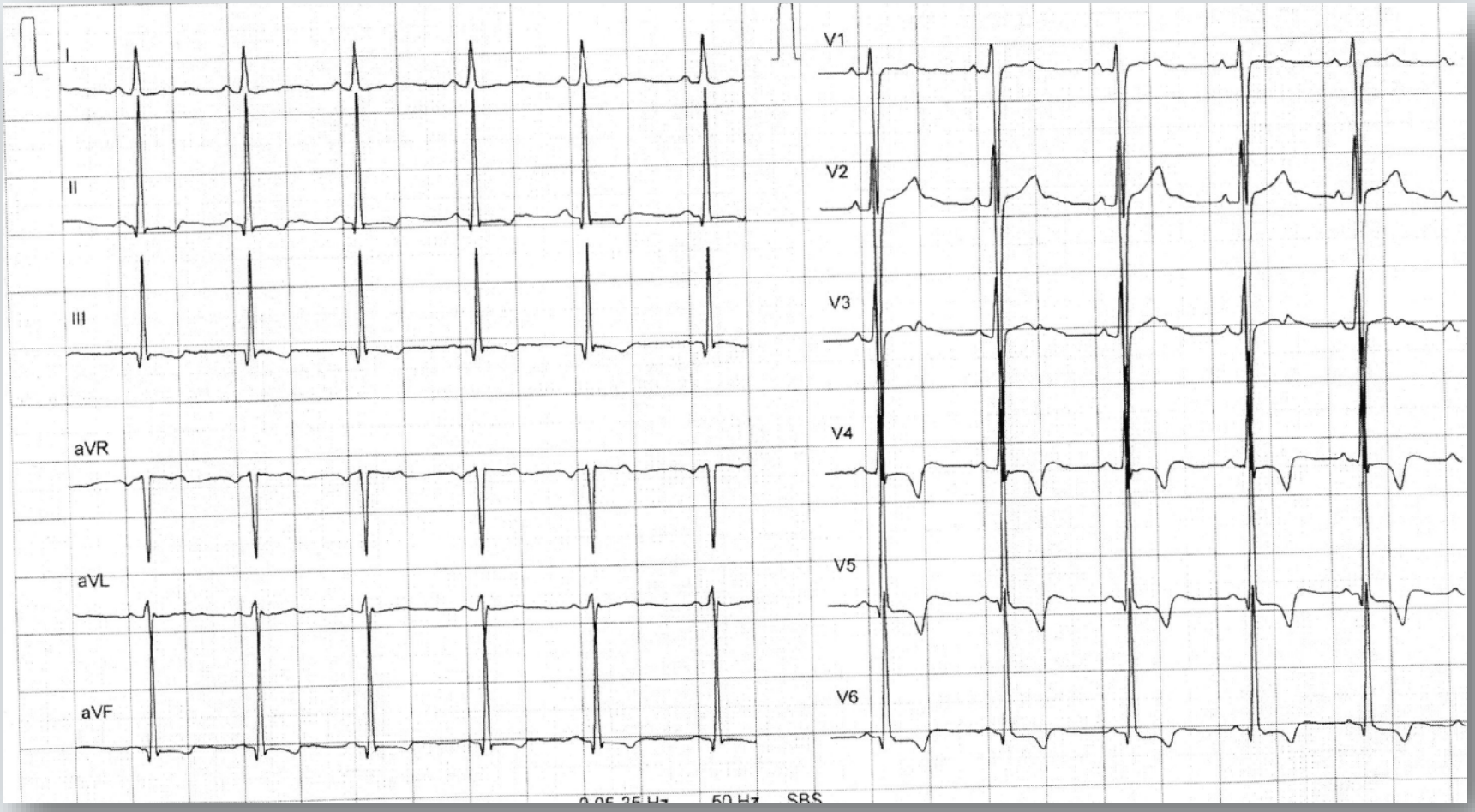
T Wellen Inversionen – *the bad…*

TABLE 2 Predictors of Ventricular Arrhythmias in the 108 Patients With ICDs

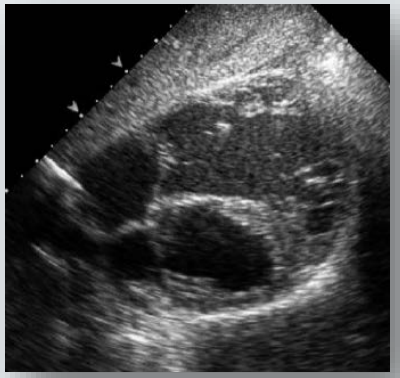
Clinical Characteristics	No Arrhythmia (n = 60)	Arrhythmia (n = 48)	p Value
Age at enrollment, yrs	41 ± 14	38 ± 14	0.413
Age at earliest symptom, yrs	37 ± 14	35 ± 15	0.609
Female	27 (45)	16 (33)	0.218
Affected (by Task Force Criteria)	37 (62)	40 (83)	0.013
Diagnostic criteria points (1994 criteria)	4.2 ± 1.0	4.3 ± 1.2	0.84
Arrhythmic events (VT/VF) before enrollment	34 (57)	45 (94)	<0.001
Syncope before enrollment	14 (23)	14 (29)	0.492
Syncope or VT/VF before enrollment	36 (60)	46 (96)	<0.001
Family history of sudden death	22 (42)	16 (36)	0.960
Follow-up, yrs	3.0 ± 1.8	3.5 ± 1.5	0.114
Heart transplant	2 (3)	1 (2)	1.000
Death	1 (2)	1 (2)	1.000
Antiarrhythmic drug treatment	19 (39)	34 (72)	<0.001
Beta-blockers	41 (84)	39 (83)	0.927
RVEF (%) by MRI, mean	43 ± 11	43 ± 13	0.334
LVEF (%) by MRI, mean	59.74 ± 6.42	55.65 ± 4.79	0.009
Negative T-wave in leads II, III, aVF	19 (32)	33 (69)	<0.001
QRS duration in V_2, mean	0.103 ± 0.023	0.108 ± 0.021	0.055
fQRS40, mean	116.9	126.5	0.011
fQRS40 >120	16 (33)	21 (55)	0.041
VPBs (ventricular total >1,000/24 h)	25 (58)	18 (51)	0.553
Any induced VT or VF	30 (50)	33 (69)	0.050

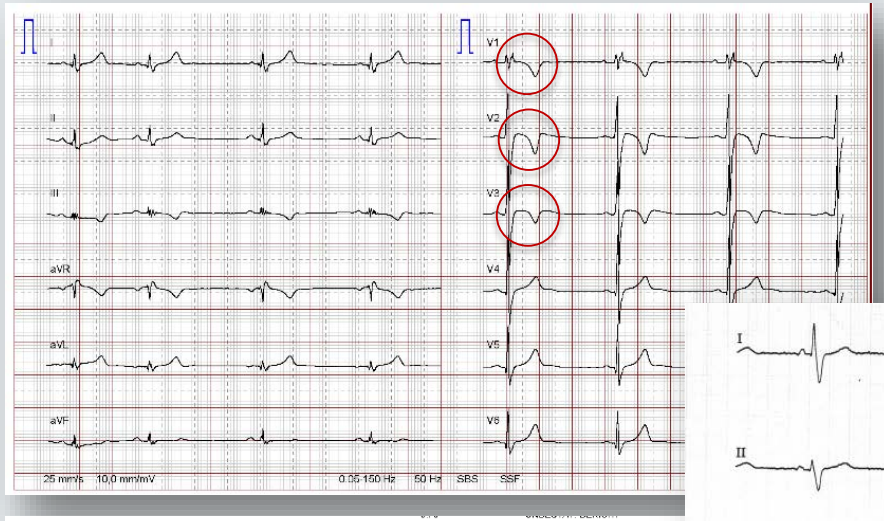
J Am Coll Cardiol 2014;64:119–25

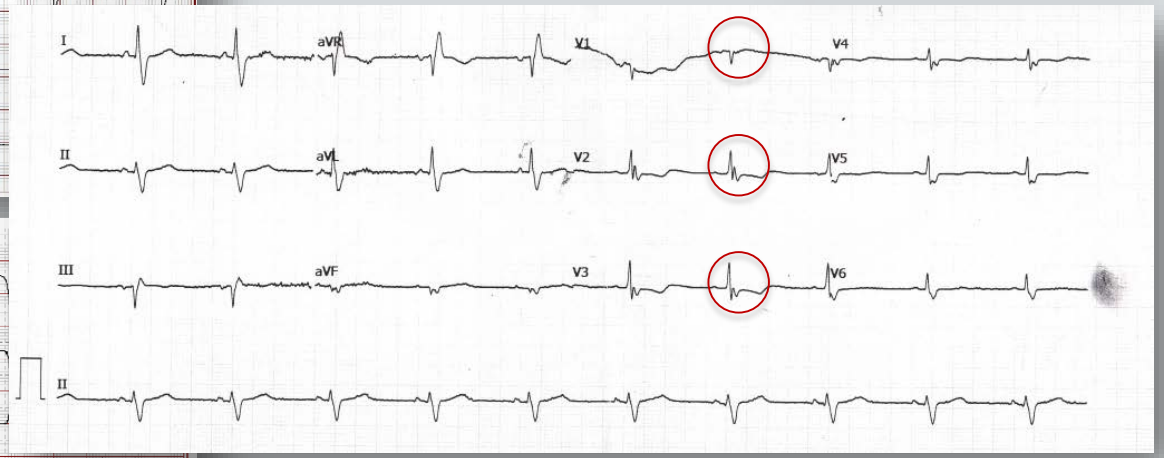
T Wellen Inversionen – *the bad…*

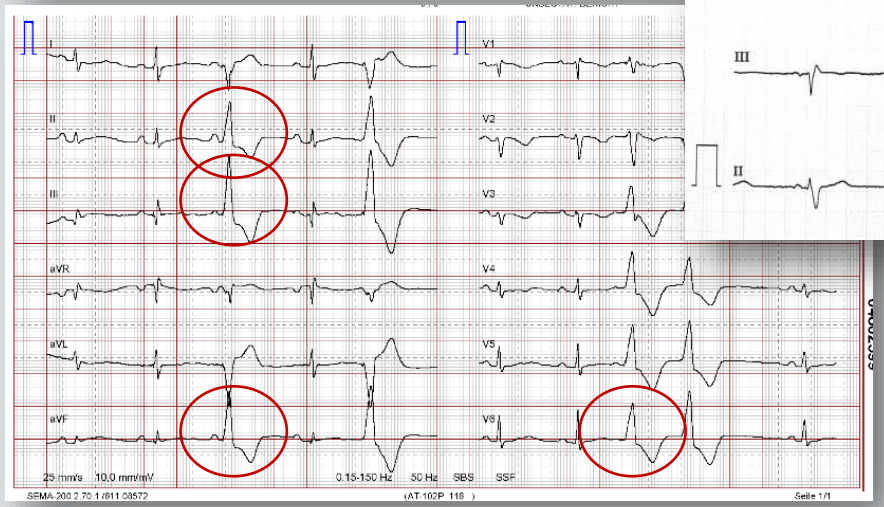


T Wellen Inversionen – *the bad…*

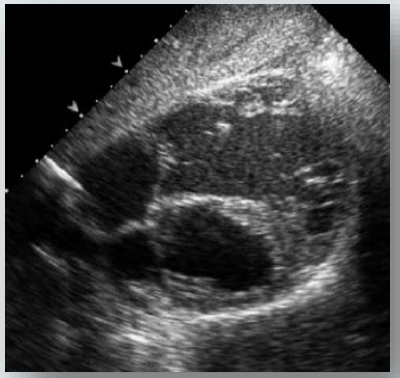


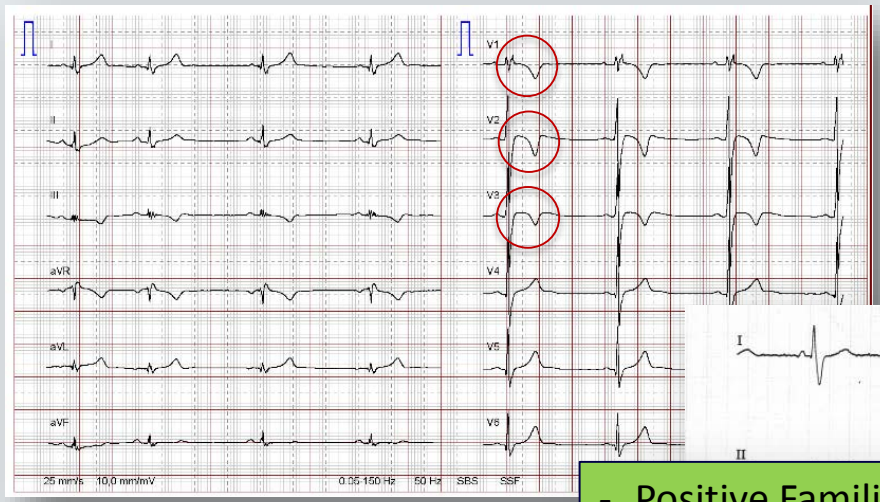


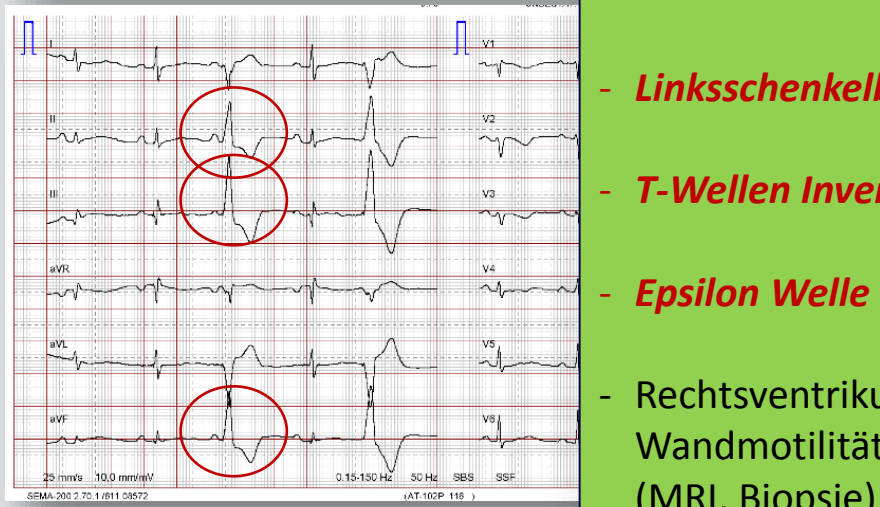


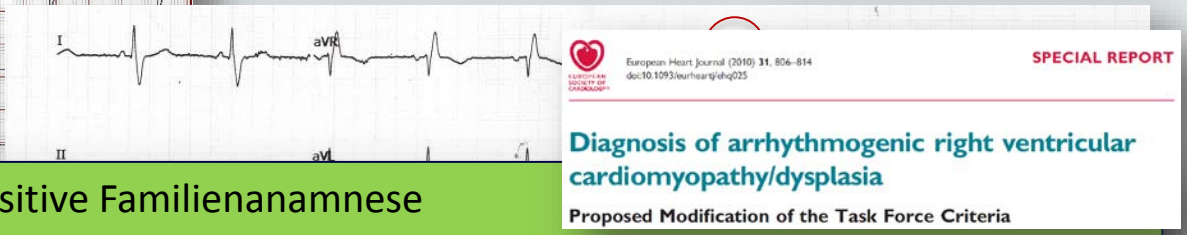


T Wellen Inversionen – *the bad…*









European Heart Journal (2010) 31, 806–814
doi:10.1093/eurheartj/ehq025

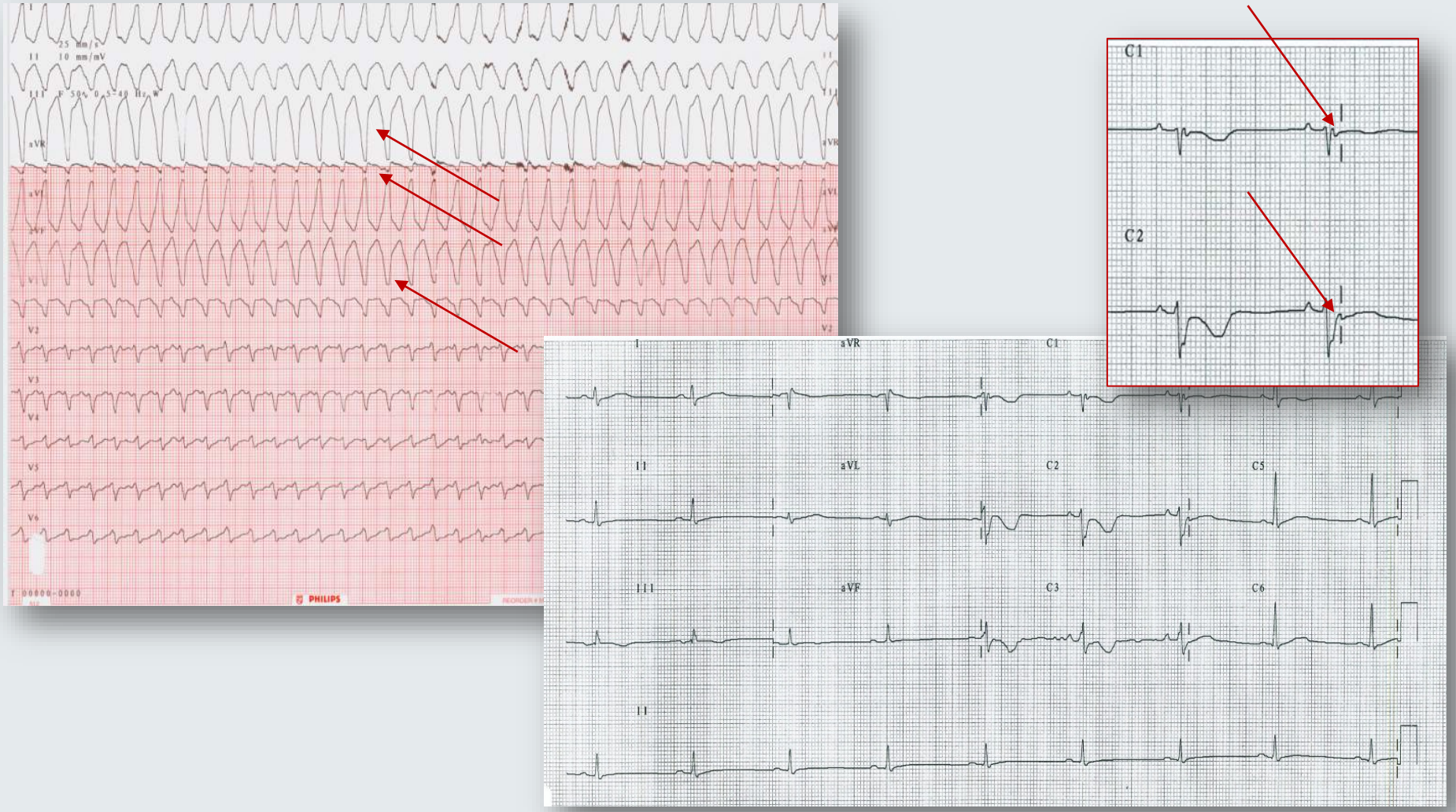
SPECIAL REPORT

Diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia

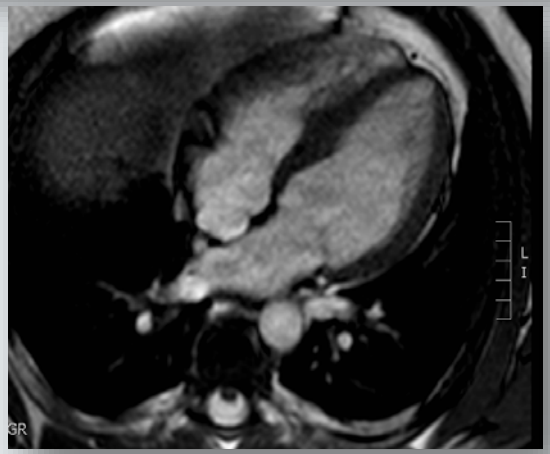
Proposed Modification of the Task Force Criteria

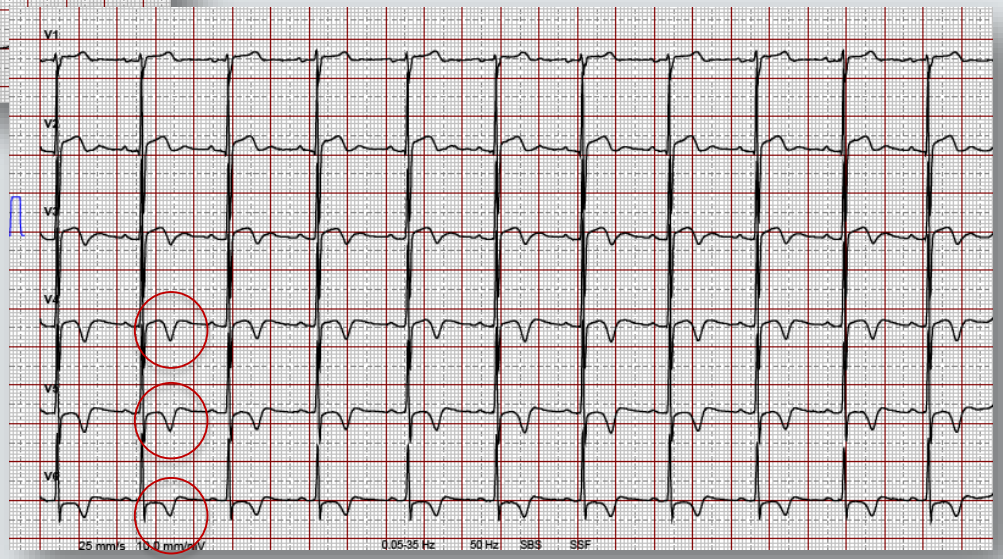
- Positive Familienanamnese
- ***Linksschenkelblock-artige ventrikuläre Tachyarrhythmien***
- ***T-Wellen Inversion in den präkordialen Ableitungen (V1-V3)***
- ***Epsilon Welle***
- Rechtsventrikuläre Dilatation oder regionale Wandmotilitätsstörungen, Aneurysmabildung, fettige Degeneration (MRI, Biopsie)

T Wellen Inversionen – *the bad…*



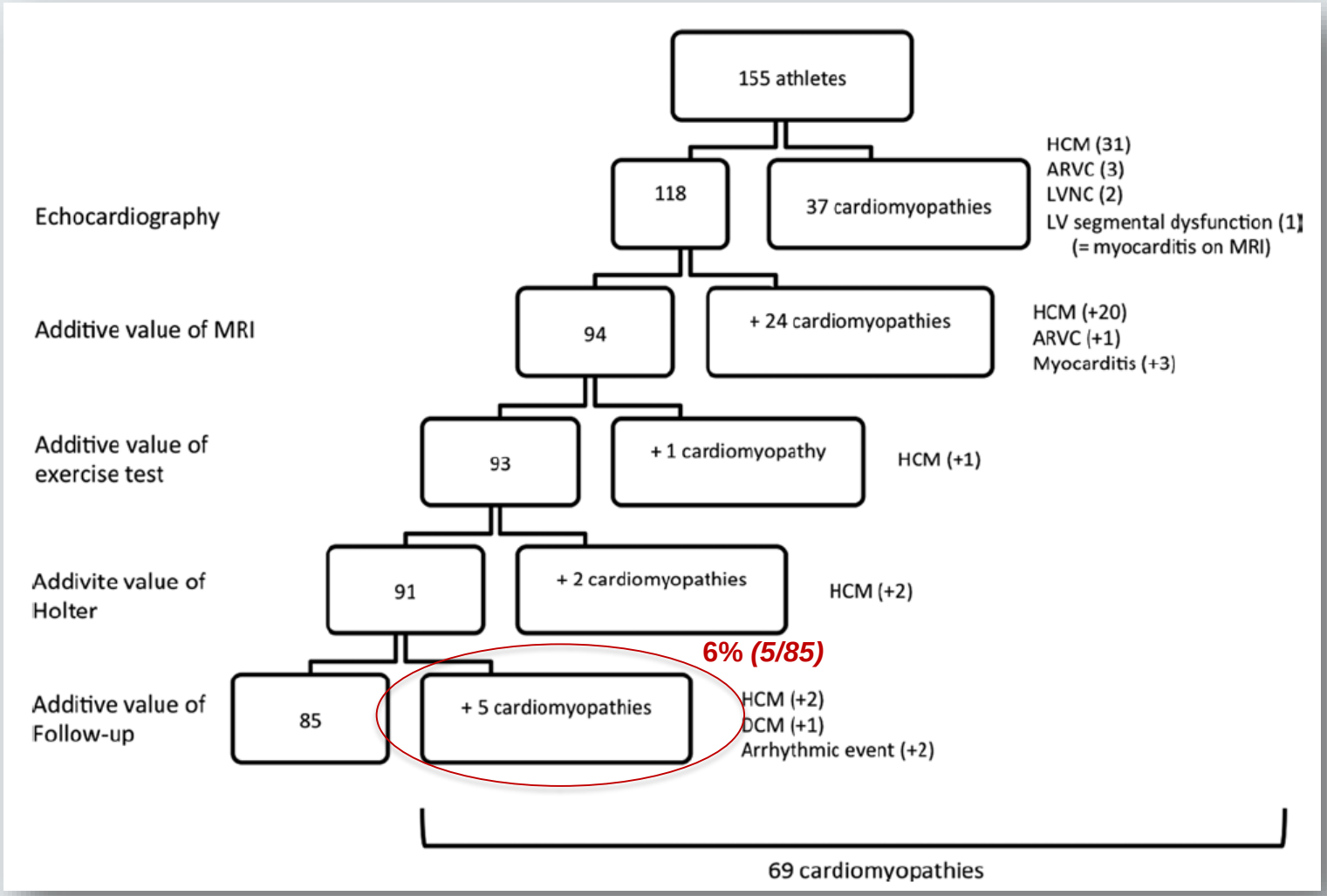
T Wellen Inversionen – *the ugly…*





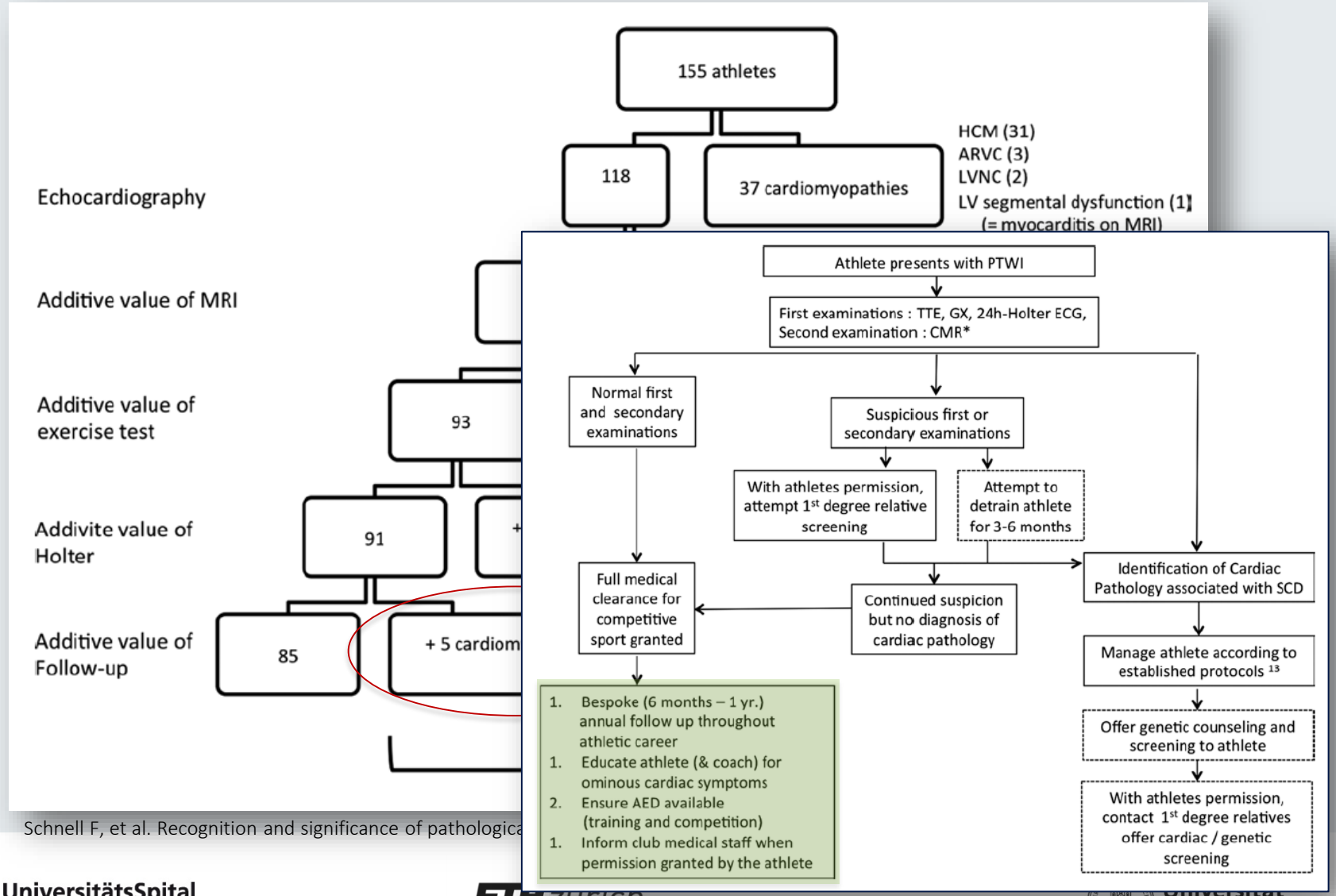
…normale Bildgebung.

T Wellen Inversionen – *the good, the bad and the ugly…*



Schnell F, et al. Recognition and significance of pathological T-wave inversions in Athletes. Circulation 2015;131:165–73

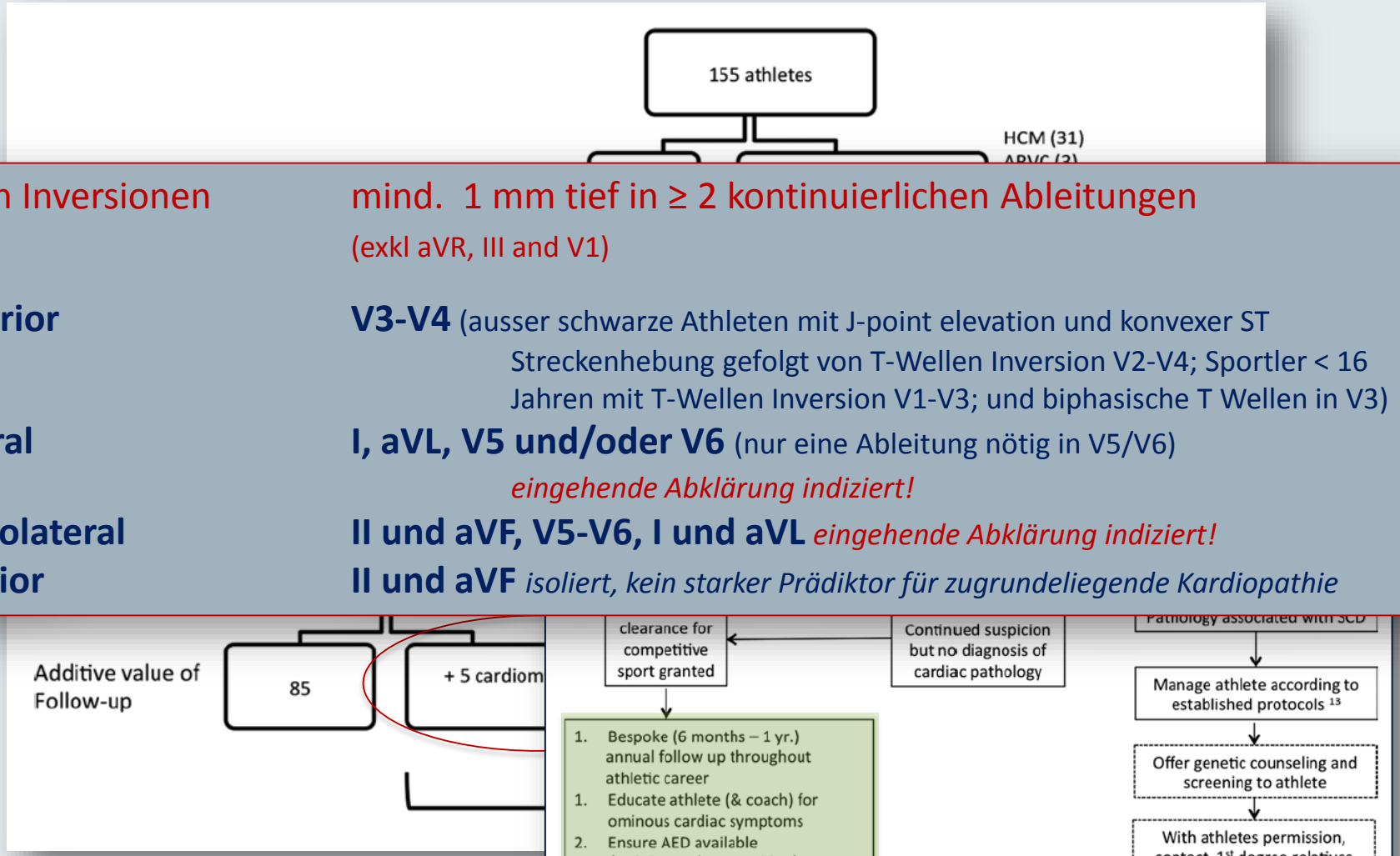
T Wellen Inversionen – *the good, the bad and the ugly…*



Schnell F, et al. Recognition and significance of pathologica

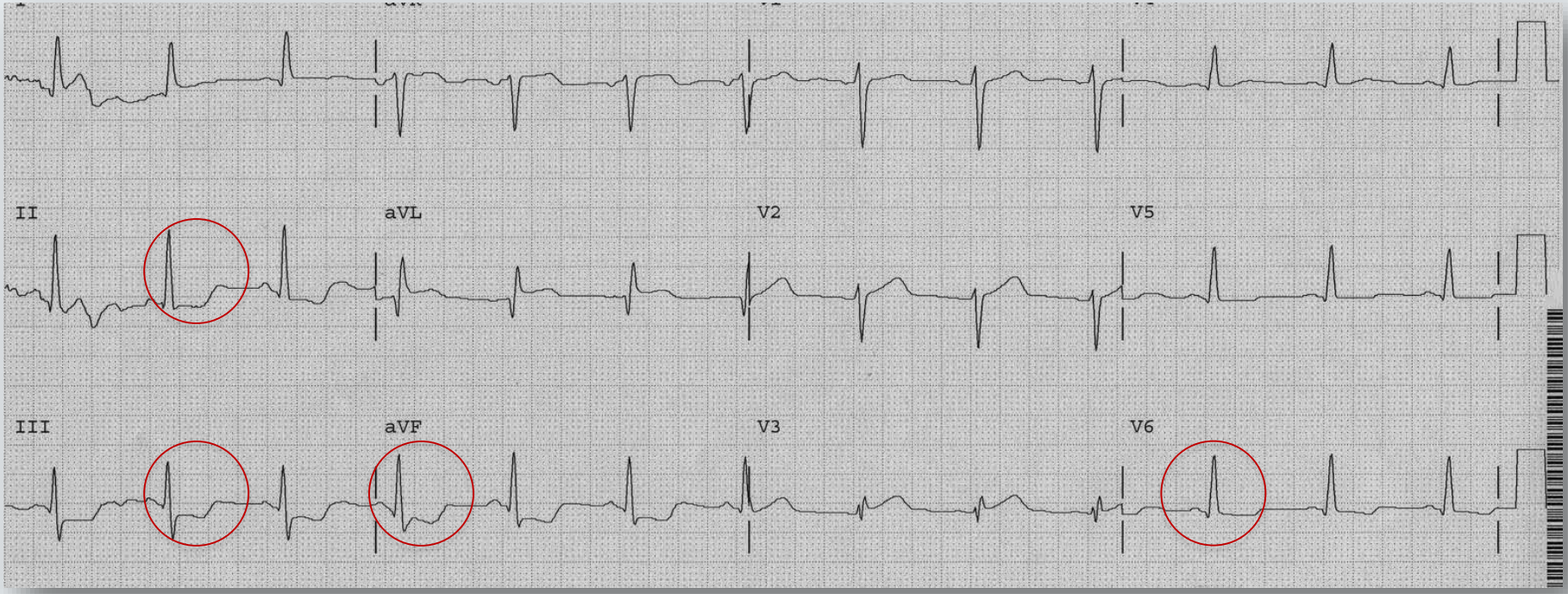
T Wellen Inversionen – *the good, the bad and the ugly…*

T Wellen Inversionen	mind. 1 mm tief in ≥ 2 kontinuierlichen Ableitungen (exkl aVR, III and V1)
- **Anterior**	**V3-V4** (ausser schwarze Athleten mit J-point elevation und konvexer ST Streckenhebung gefolgt von T-Wellen Inversion V2-V4; Sportler < 16 Jahren mit T-Wellen Inversion V1-V3; und biphasische T Wellen in V3)
- **Lateral**	**I, aVL, V5 und/oder V6** (nur eine Ableitung nötig in V5/V6) *eingehende Abklärung indiziert!*
- **Inferolateral**	**II und aVF, V5-V6, I und aVL** *eingehende Abklärung indiziert!*
- **Inferior**	**II und aVF** *isoliert, kein starker Prädiktor für zugrundeliegende Kardiopathie*



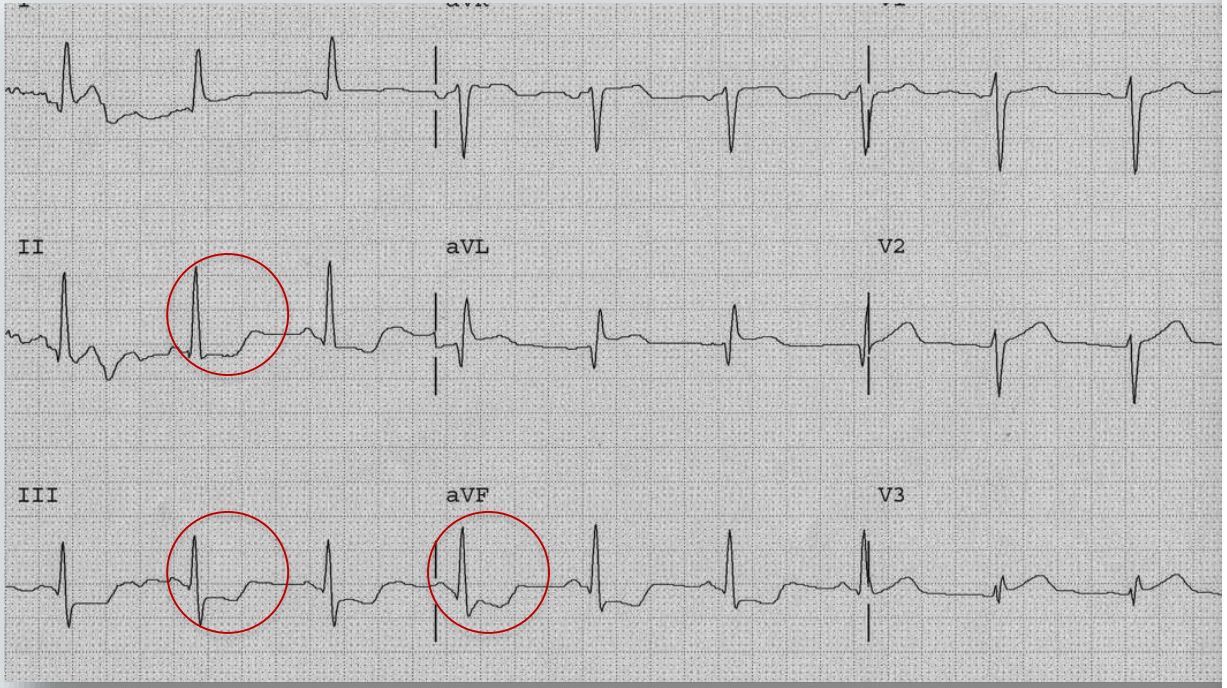
Schnell F, et al. Recognition and significance of pathologica

ST Strecken Senkung – *noch mehr Schurken…*



http://hqmeded-ecg.blogspot.ch/2015/05/isolated-st-segment-depression-not-sign.html

ST Strecken Senkung – *noch mehr Schurken…*



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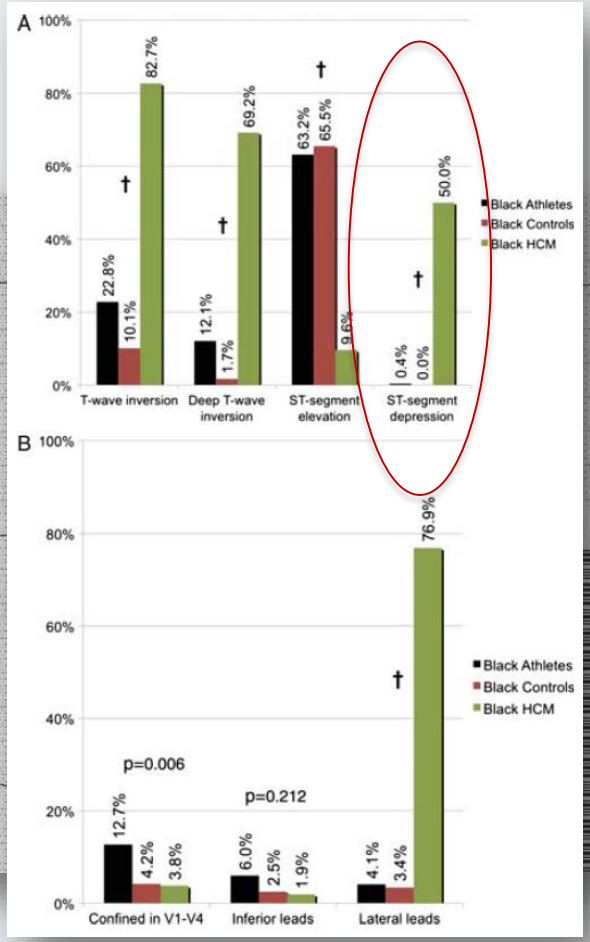
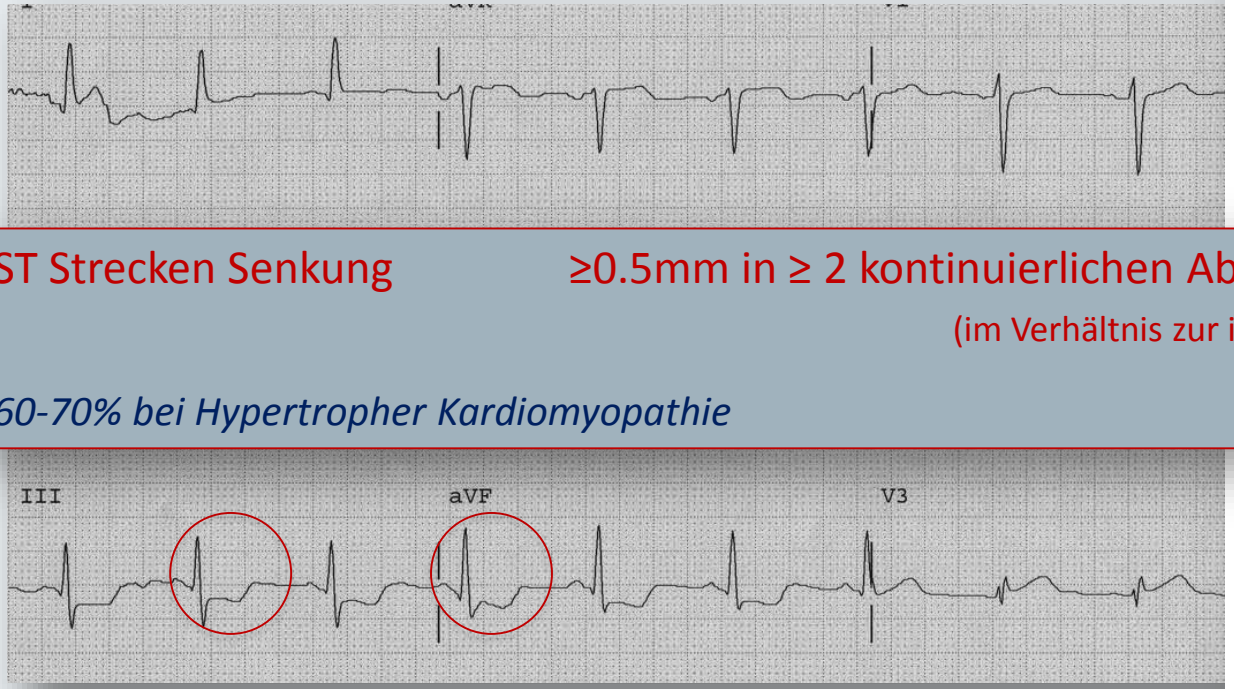


Papadakis M, et al. The prevalence, distribution, and clinical outcomes of electrocardiographic repolarization patterns in male Athletes of African/Afro-Caribbean origin. Eur Heart J 2011;32:2304–13

ST Strecken Senkung – *noch mehr Schurken…*



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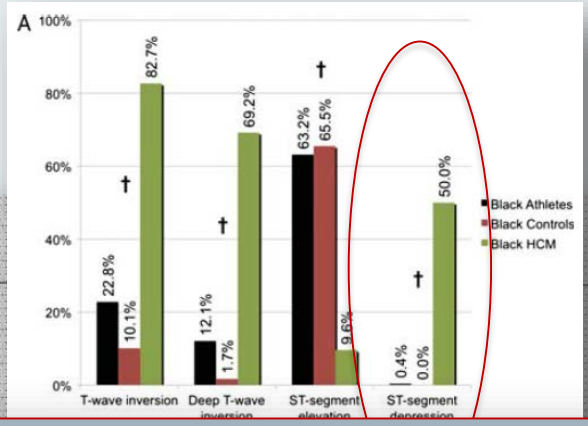
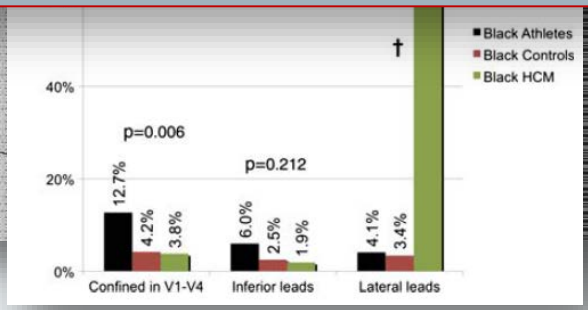


ST Strecken Senkung ≥0.5mm in ≥ 2 kontinuierlichen Ableitungen

(im Verhältnis zur isoelektrischen PQ Strecke)

60-70% bei Hypertropher Kardiomyopathie



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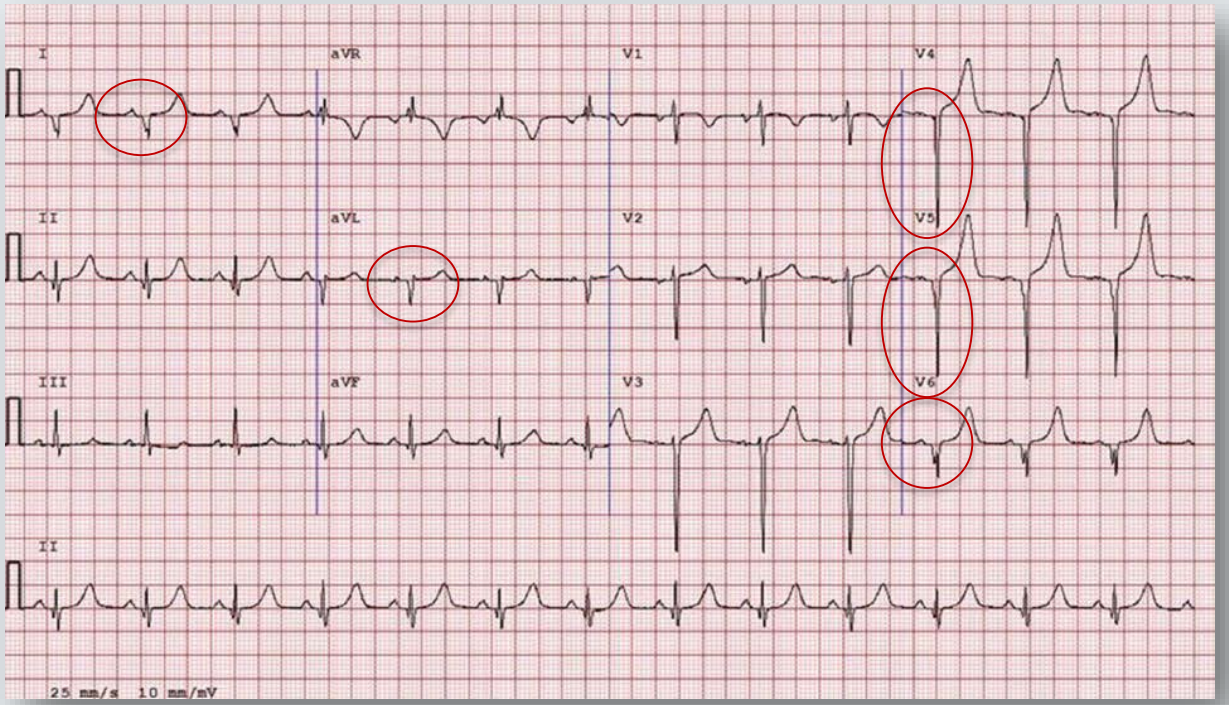
Q Zacken – *«when size matters»*

Ältere Definitionen führten zu unverhältnismässig vielen «falsch-positiven» Befunden und Diagnosen:

Nur 1.5% der Athleten mit einer Q Zacke *>3mm tief* zeigten eine Kardiopathie
(unpublished data, (n = 206/13335)



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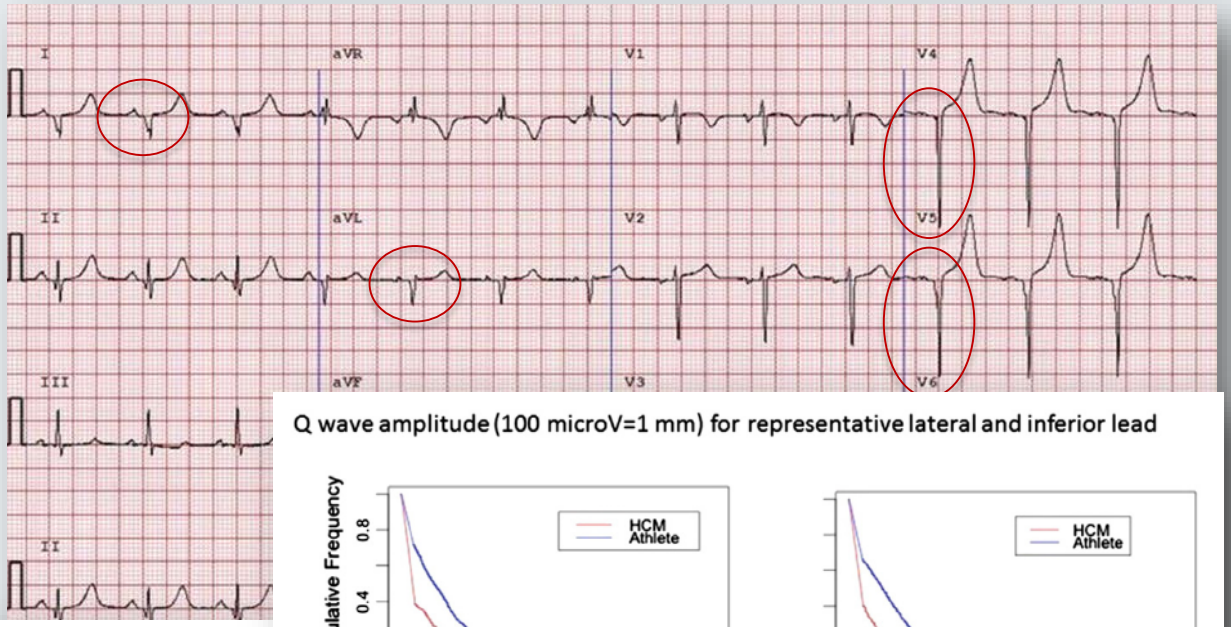

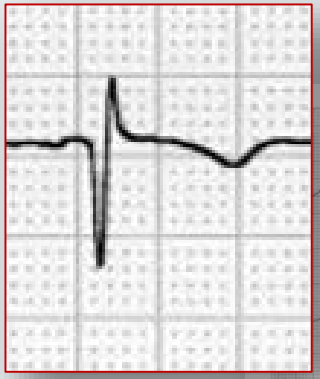

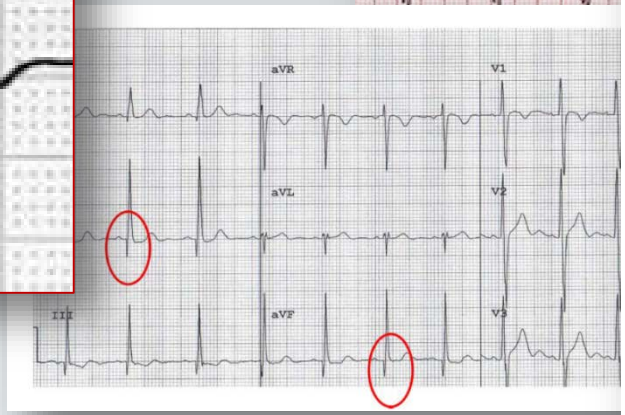

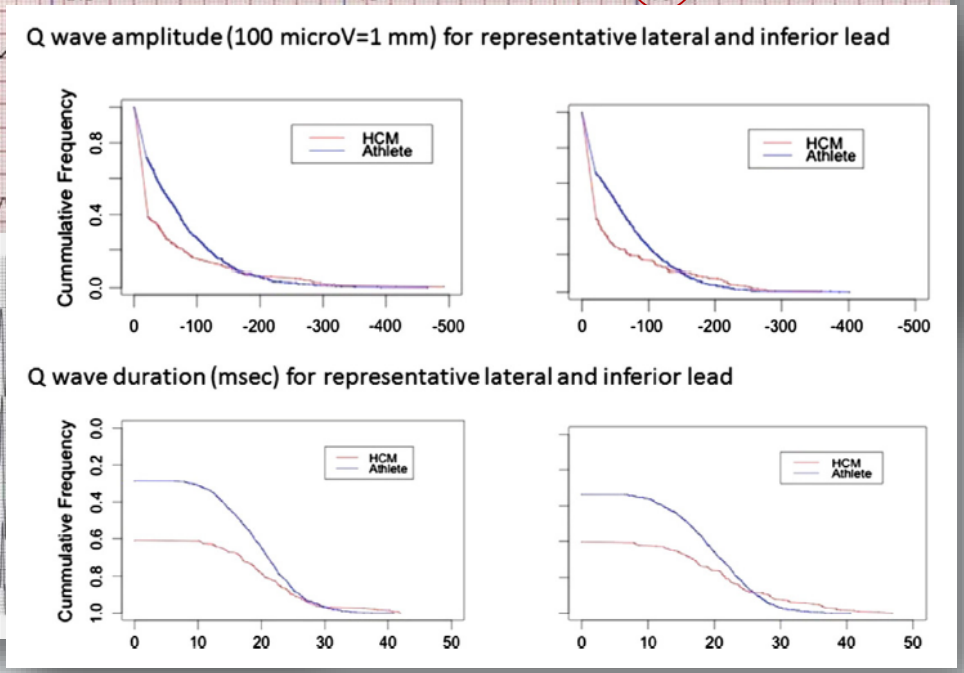

.J Electrocardiol 2015;48:362–7

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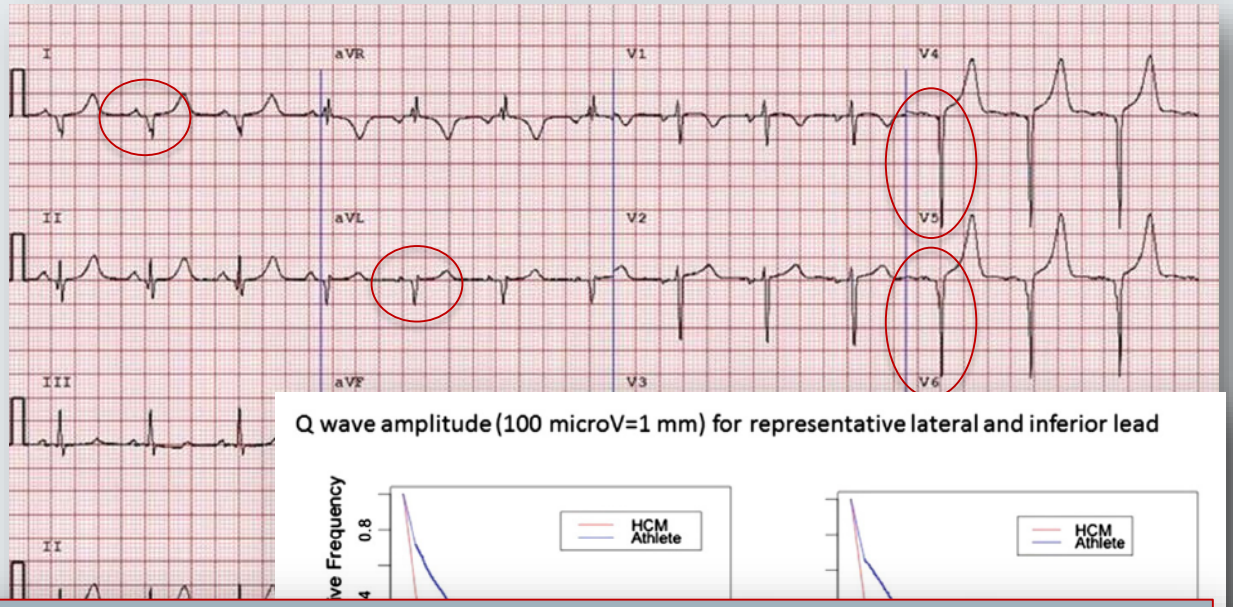
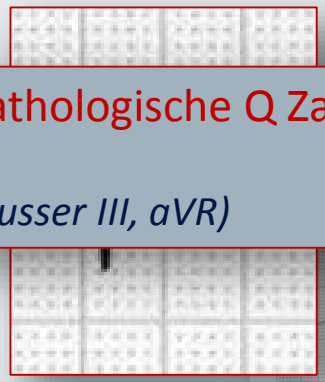
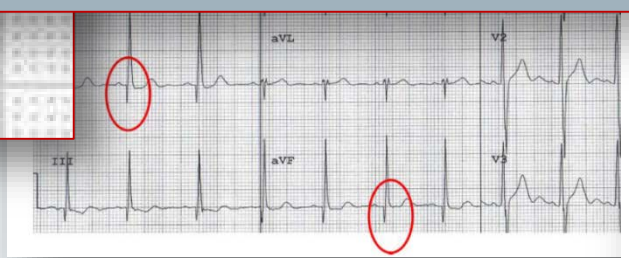
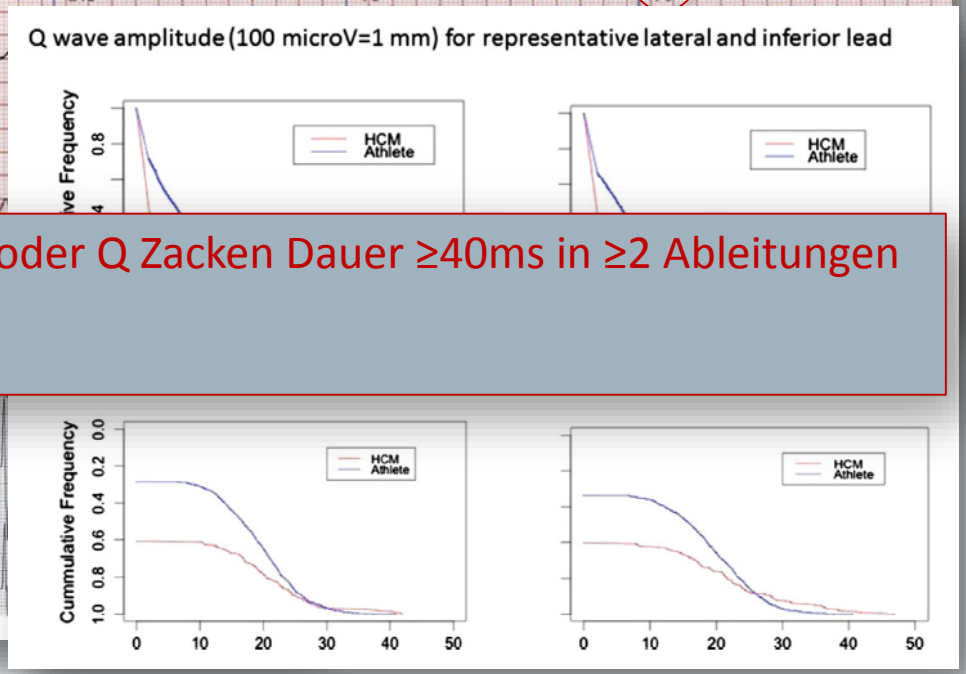






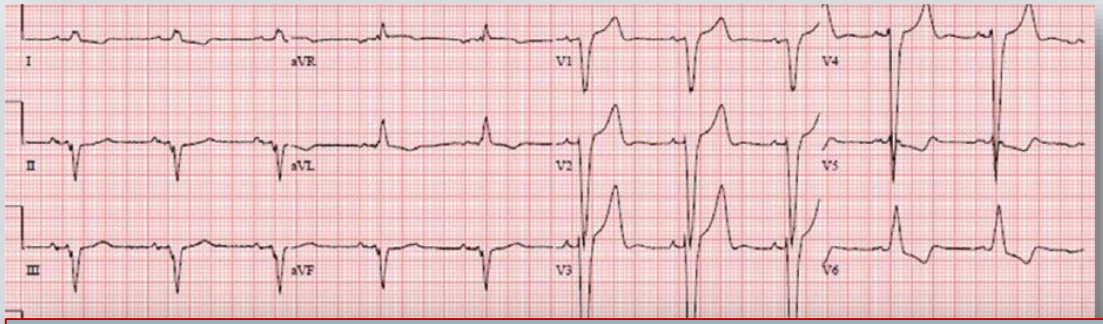


Pathologische Q Zacken Q/R ratio ≥0.25 oder Q Zacken Dauer ≥40ms in ≥2 Ableitungen

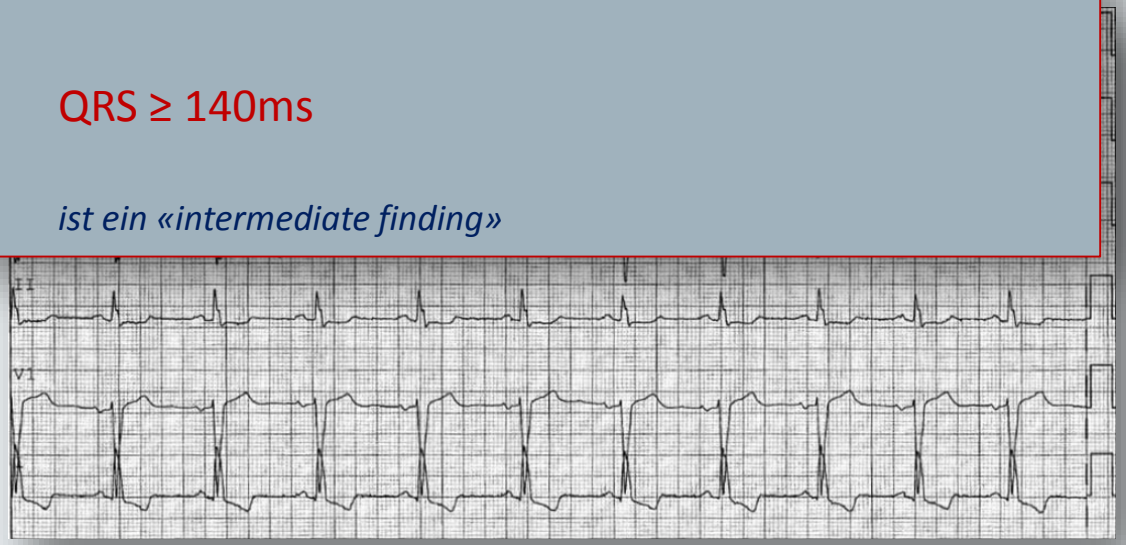
(ausser III, aVR)

.J Electrocardiol 2015;48:362–7

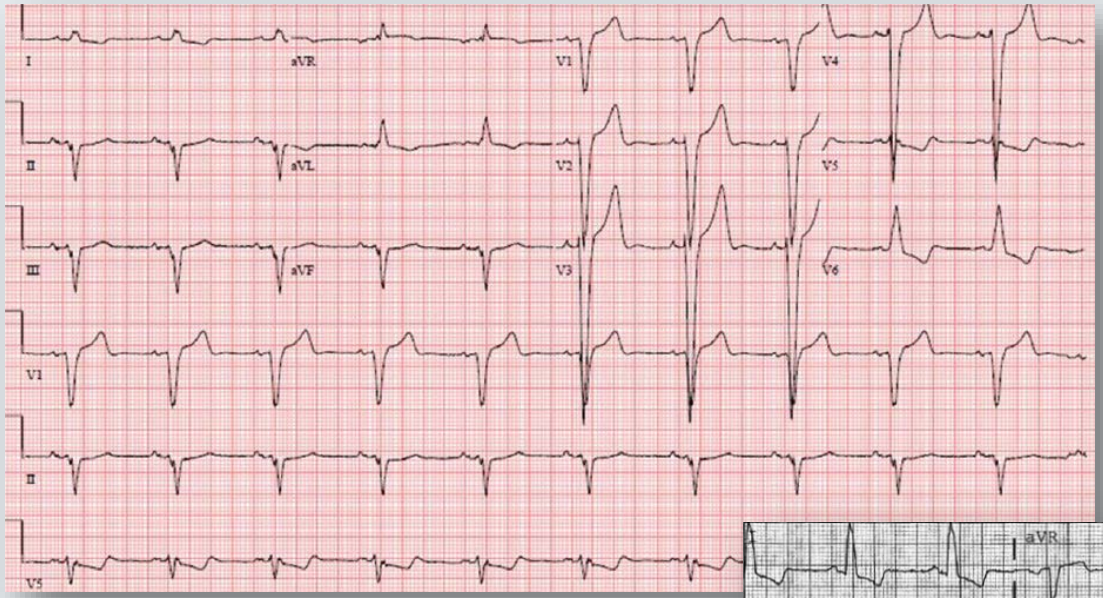
Schenkelblock – *Kompletter Links-SB und ausgeprägter unspezifischer SB*

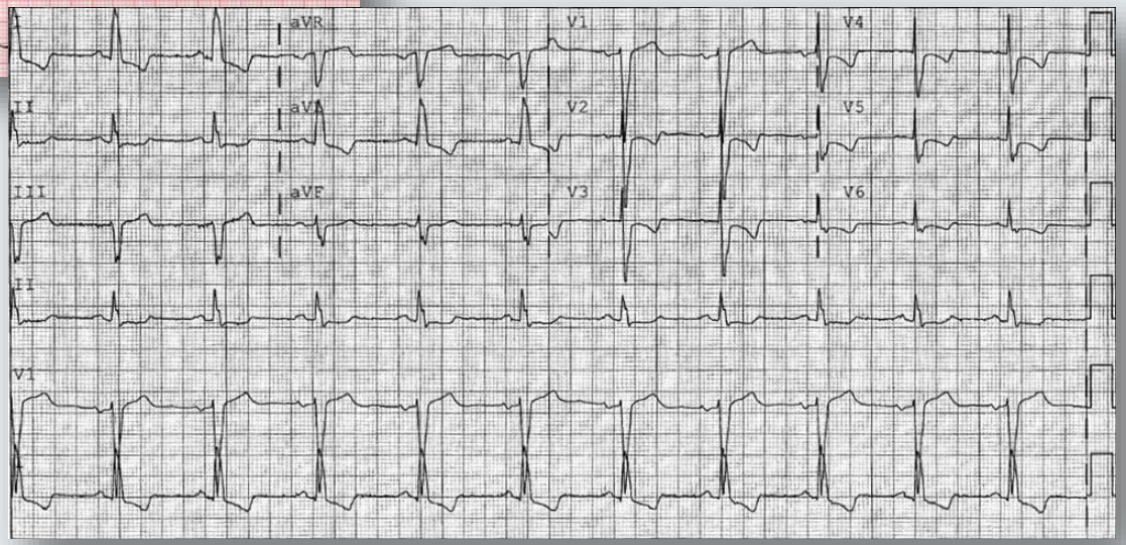


Kompletter Linksschenkelblock	QRS ≥120ms
Mehrheitlich negativer QRS Komplex in Ableitung V1 («QS oder rS») und aufrechte «notched or slurred» R Zacke in Ableitung I und V6	
Hochgradiger, unspezifischer Block	QRS ≥ 140ms
Kompletter Rechtsschenkelblock	*ist ein «intermediate finding»*

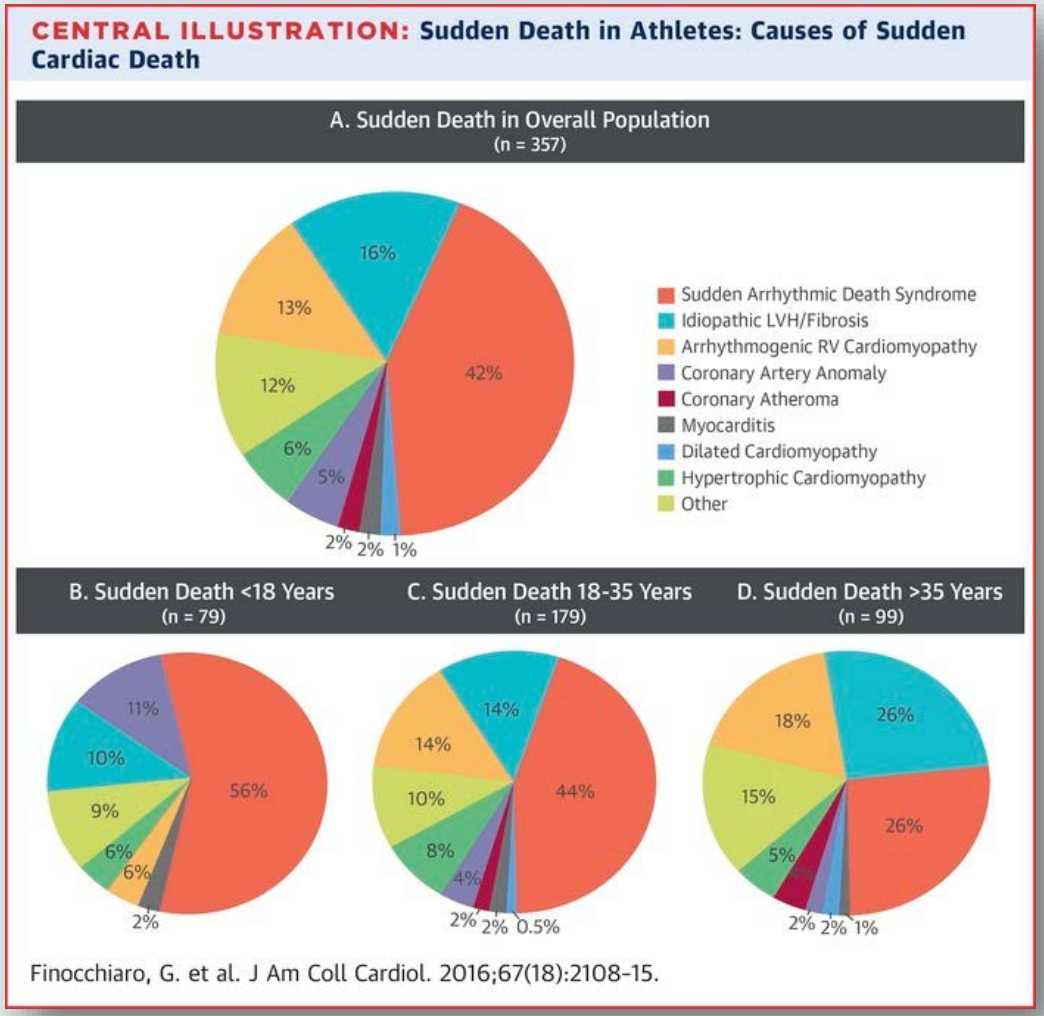


Schenkelblock – *Kompletter Links-SB und ausgeprägter unspezifischer SB*



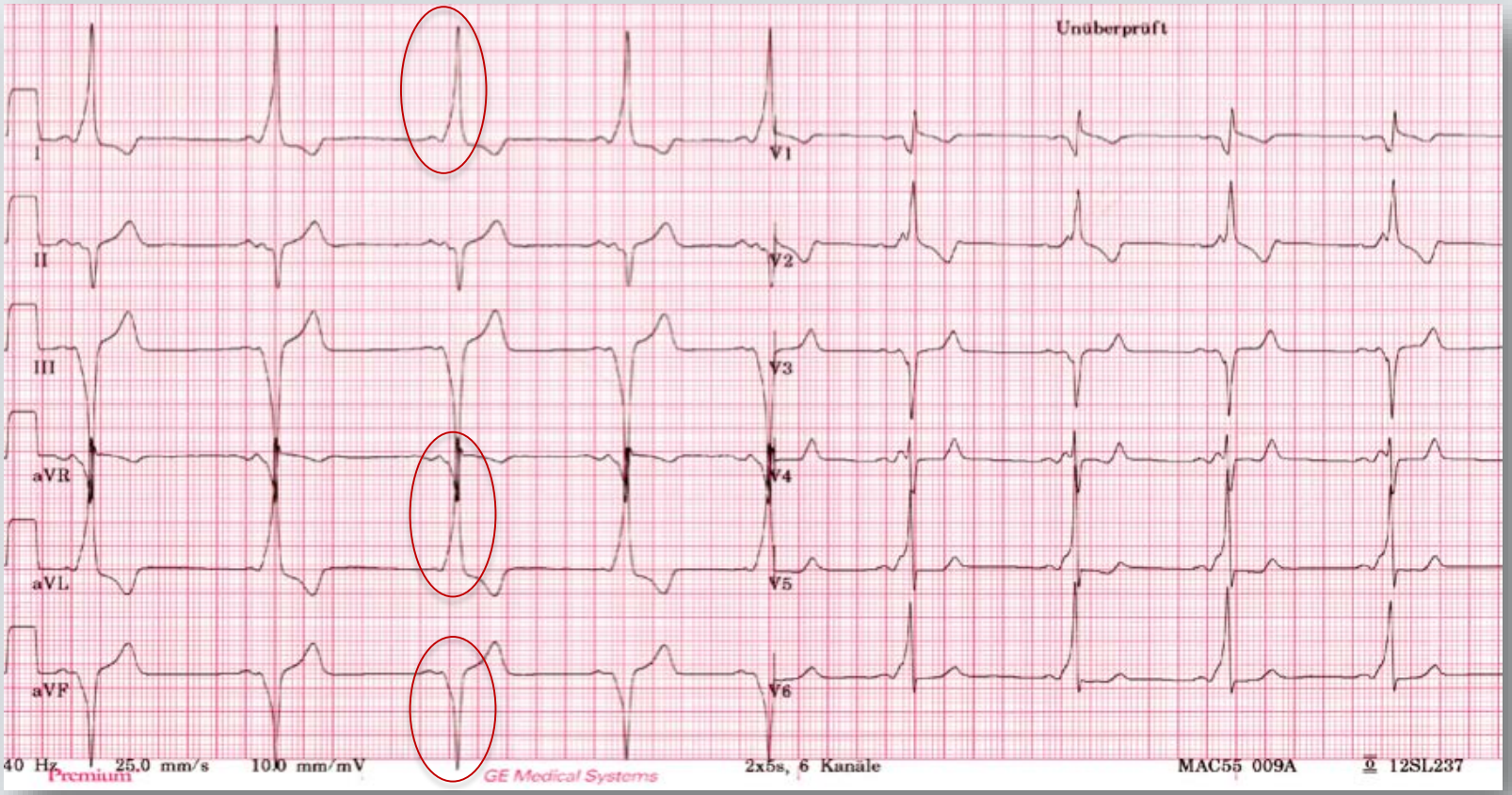


Ionenkanalerkrankungen und ventrikuläre Prä-Exzitation

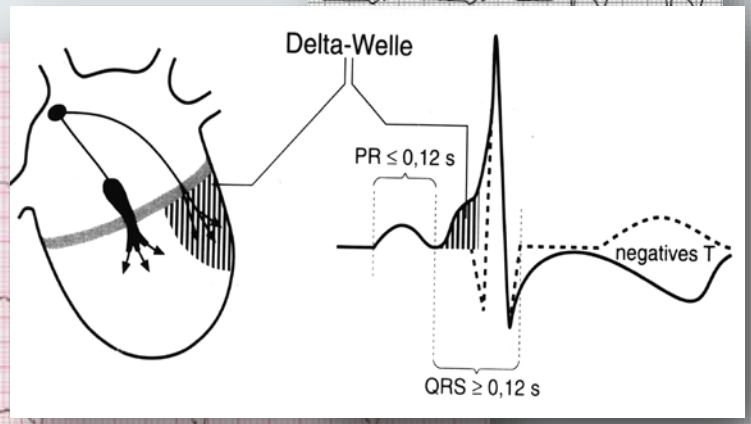


Finocchiaro, G. et al. J Am Coll Cardiol. 2016;67(18):2108-15.

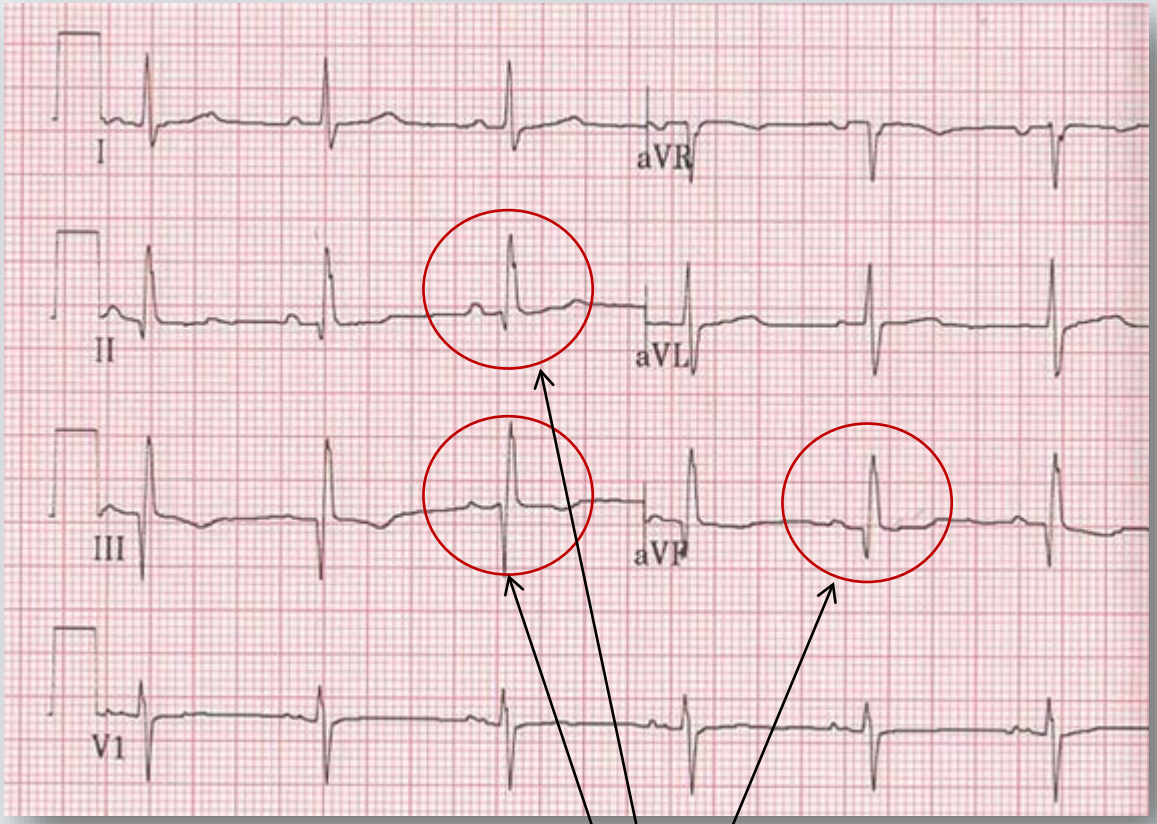
Ventrikuläre Prä-Exzitation – v.a. «WPW-Pattern»



Ventrikuläre Prä-Exzitation – v.a. «WPW-Pattern»

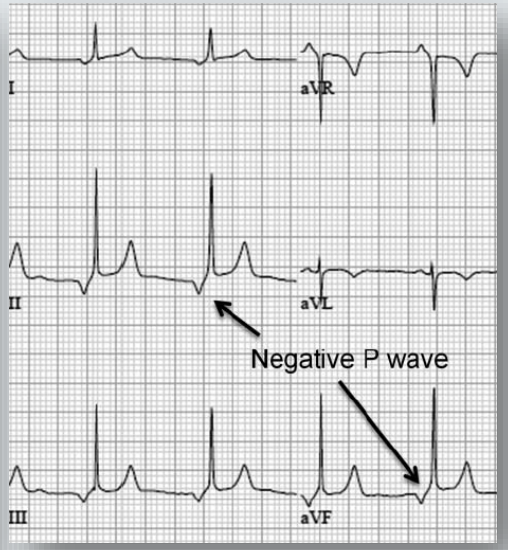


sinus rhythm vs. “non-sinus rhythm”



sinus rhythm

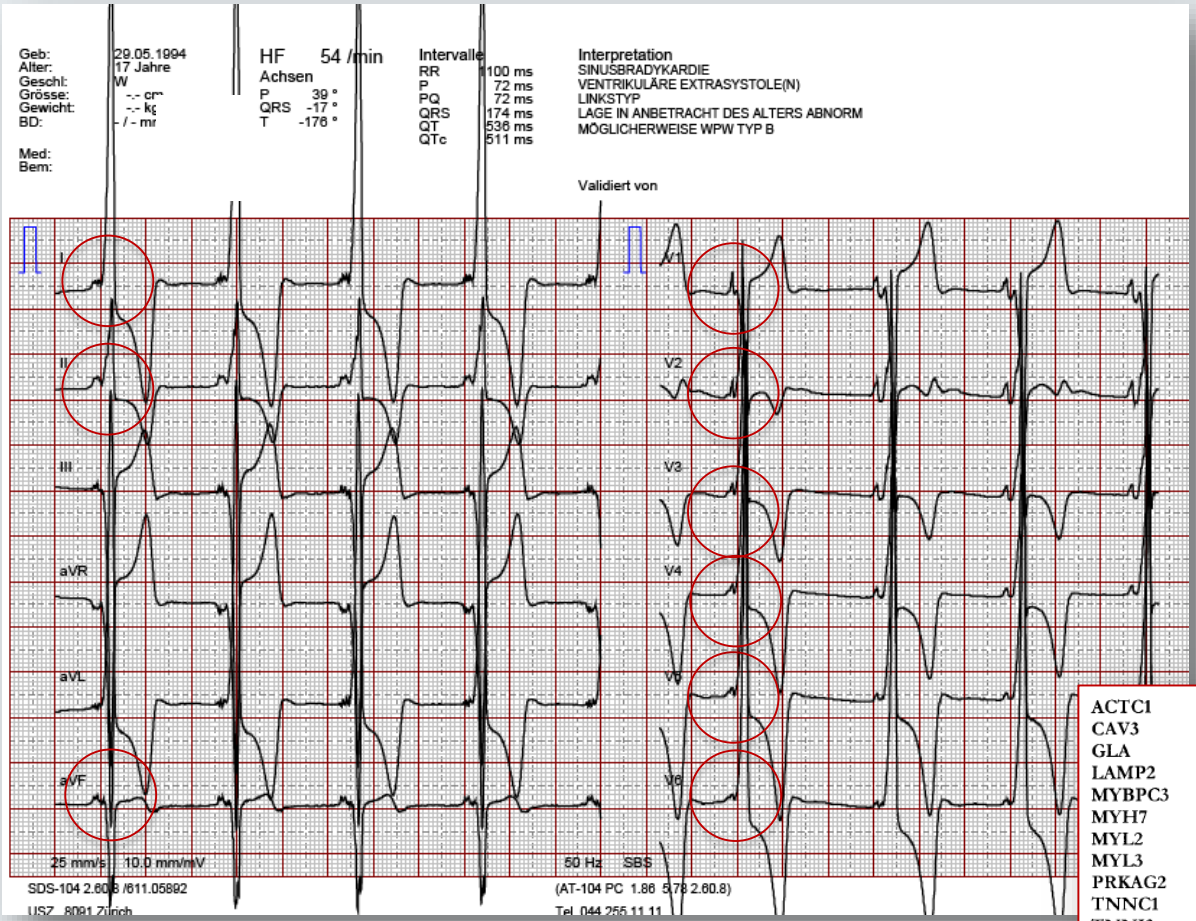
positive p waves

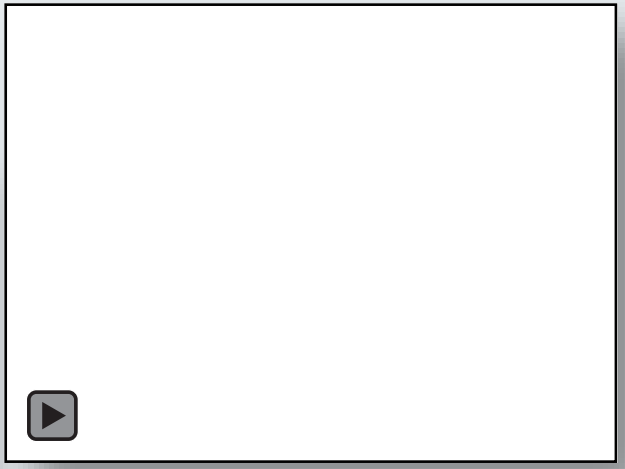


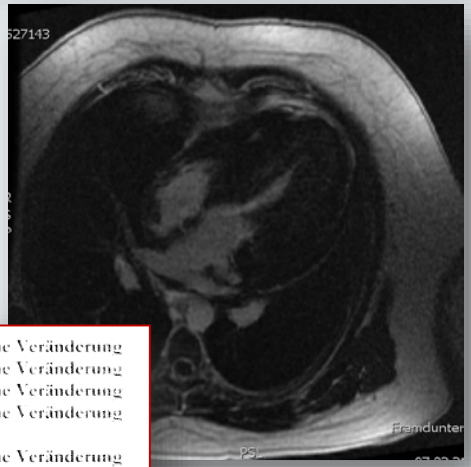
ectopic rhythm

pacemaker rhythm

Ventrikuläre Prä-Exzitation



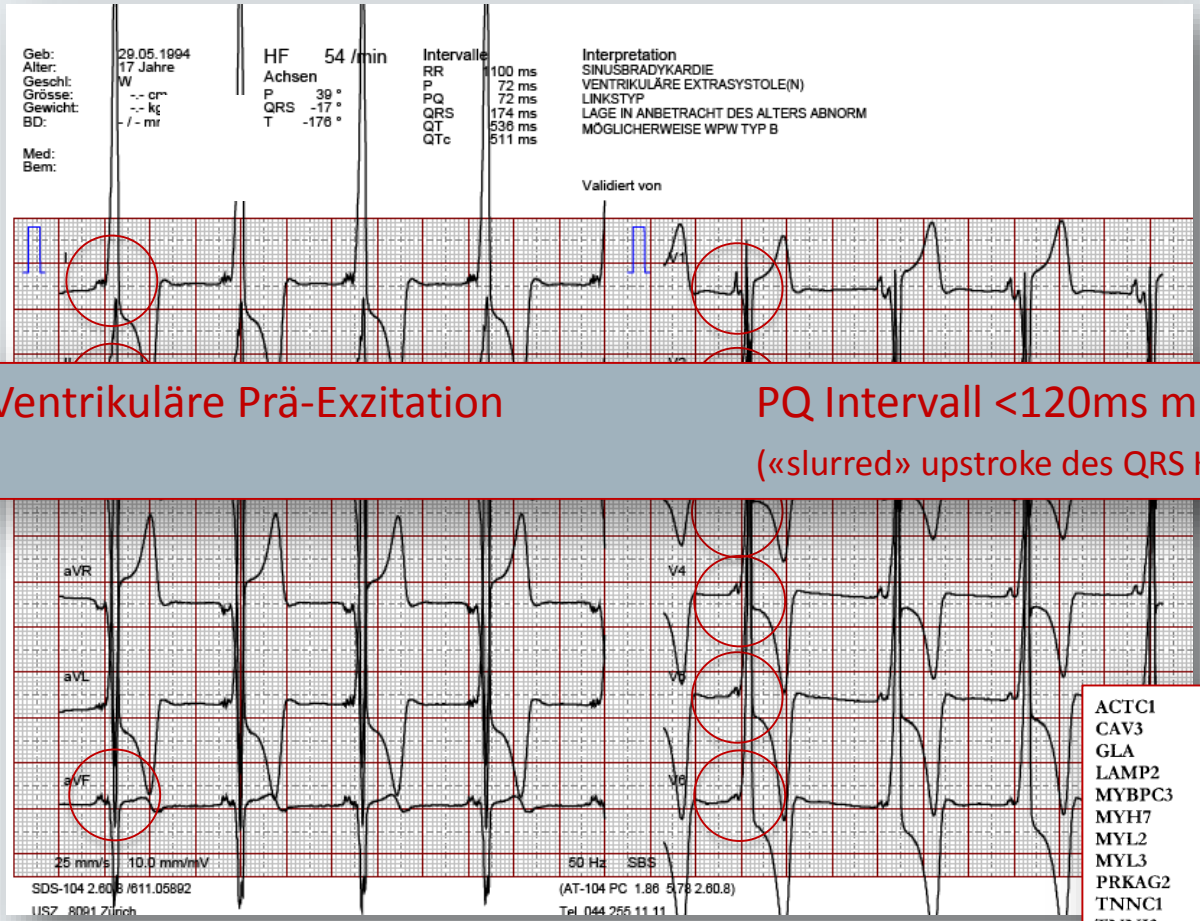




ACTC1	-	keine pathologische Veränderung
CAV3	-	keine pathologische Veränderung
GLA	-	keine pathologische Veränderung
LAMP2	-	keine pathologische Veränderung
MYBPC3	-	wird nachberichtet
MYH7	-	keine pathologische Veränderung
MYL2	-	keine pathologische Veränderung
MYL3	-	keine pathologische Veränderung
PRKAG2	-	heterozygote Nukleinsäure
TNNC1	-	keine pathologische Veränderung
TNNI3	-	keine pathologische Veränderung
TNNT2	-	keine pathologische Veränderung
TPM1	-	keine pathologische Veränderung
TTR	-	keine pathologische Veränderung

Wolff-Parkinson-White-Syndrome mit mehreren rechts-akzessorischen Bahnen

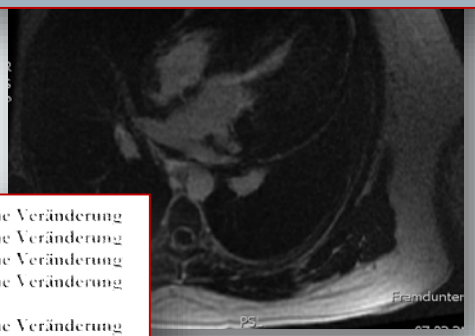
Ventrikuläre Prä-Exzitation



Ventrikuläre Prä-Exzitation

PQ Intervall <120ms mit Delta Welle

(«slurred» upstroke des QRS Komplex) und verbreiterter QRS (≥120ms)



ACTC1	-	keine pathologische Veränderung
CAV3	-	keine pathologische Veränderung
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Wolff-Parkinson-White-Syndrome mit mehreren rechts-akzessorischen Bahnen

Long QT pattern – *when more than half is a «bull's eye»*

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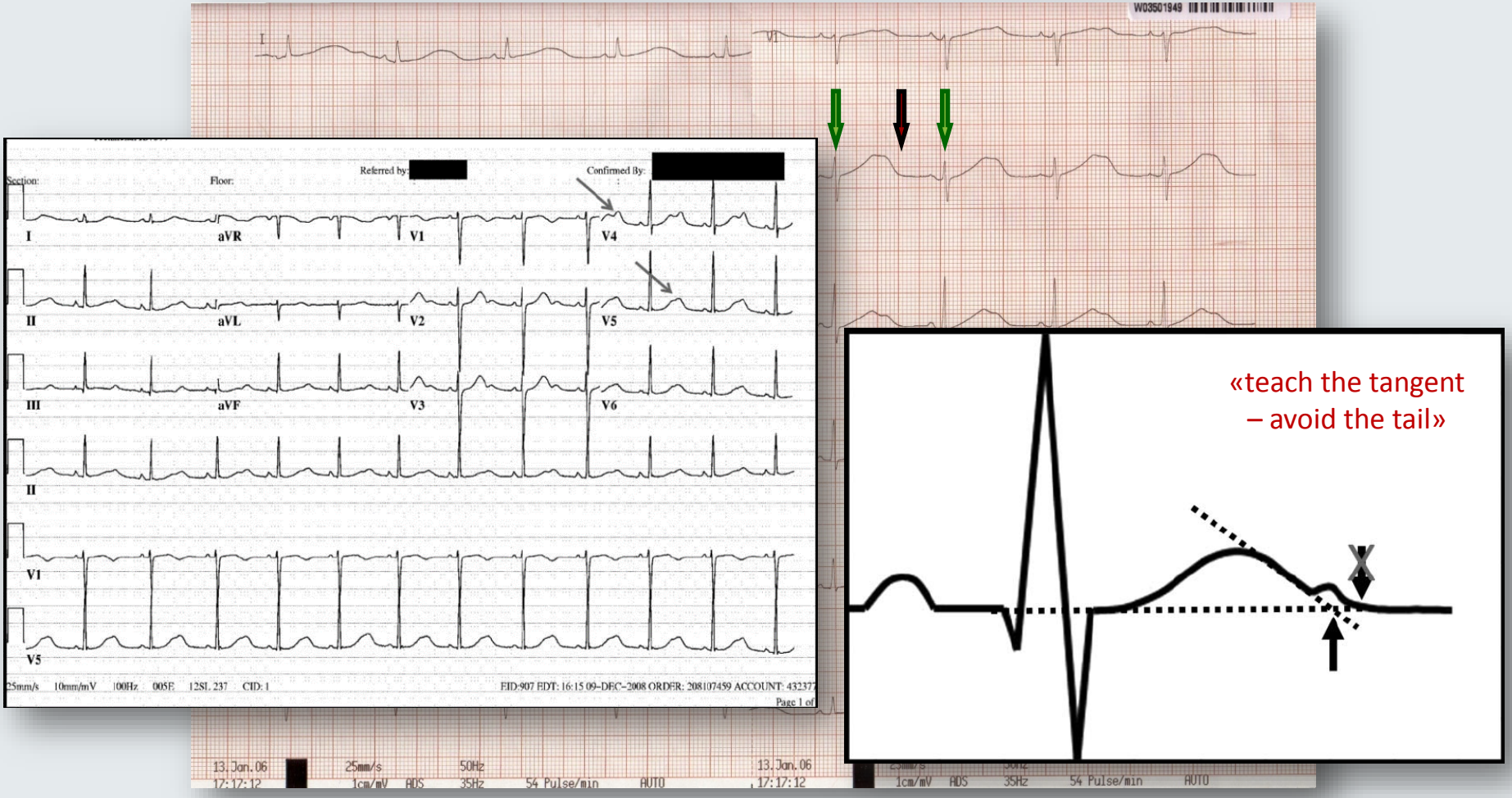
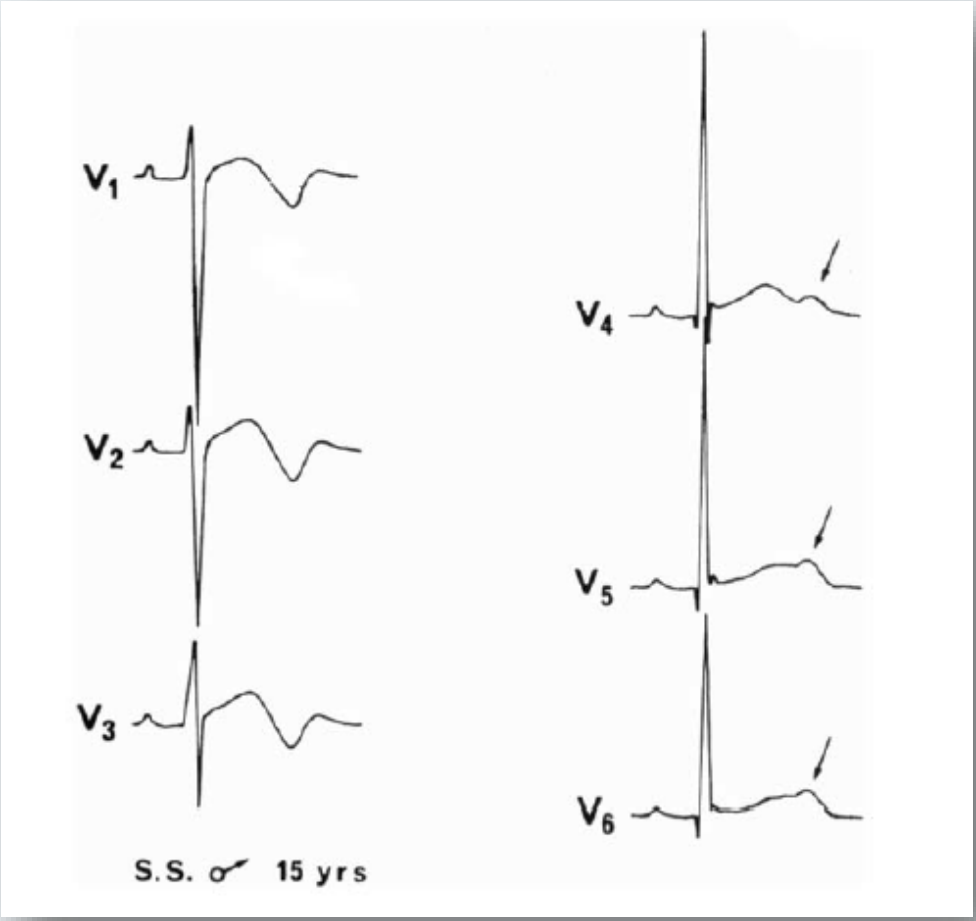


Long QT pattern – *typischer «notch» bei LQT Typ 2*



LQT 1: triggered by exercise (e.g. swimming)
LQT 2: triggered by emotions (e.g. auditory)
LQT 3: mostly during rest

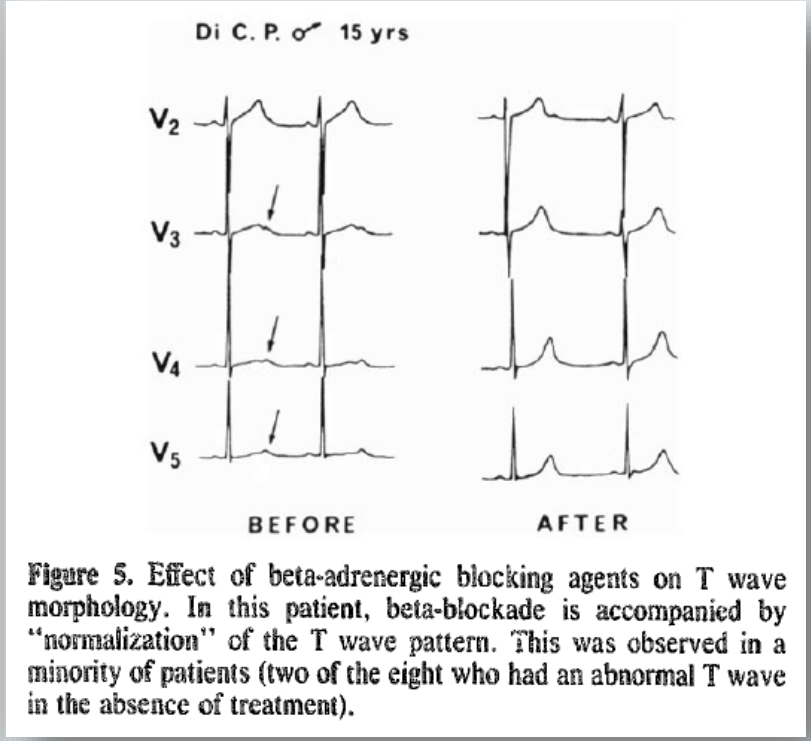
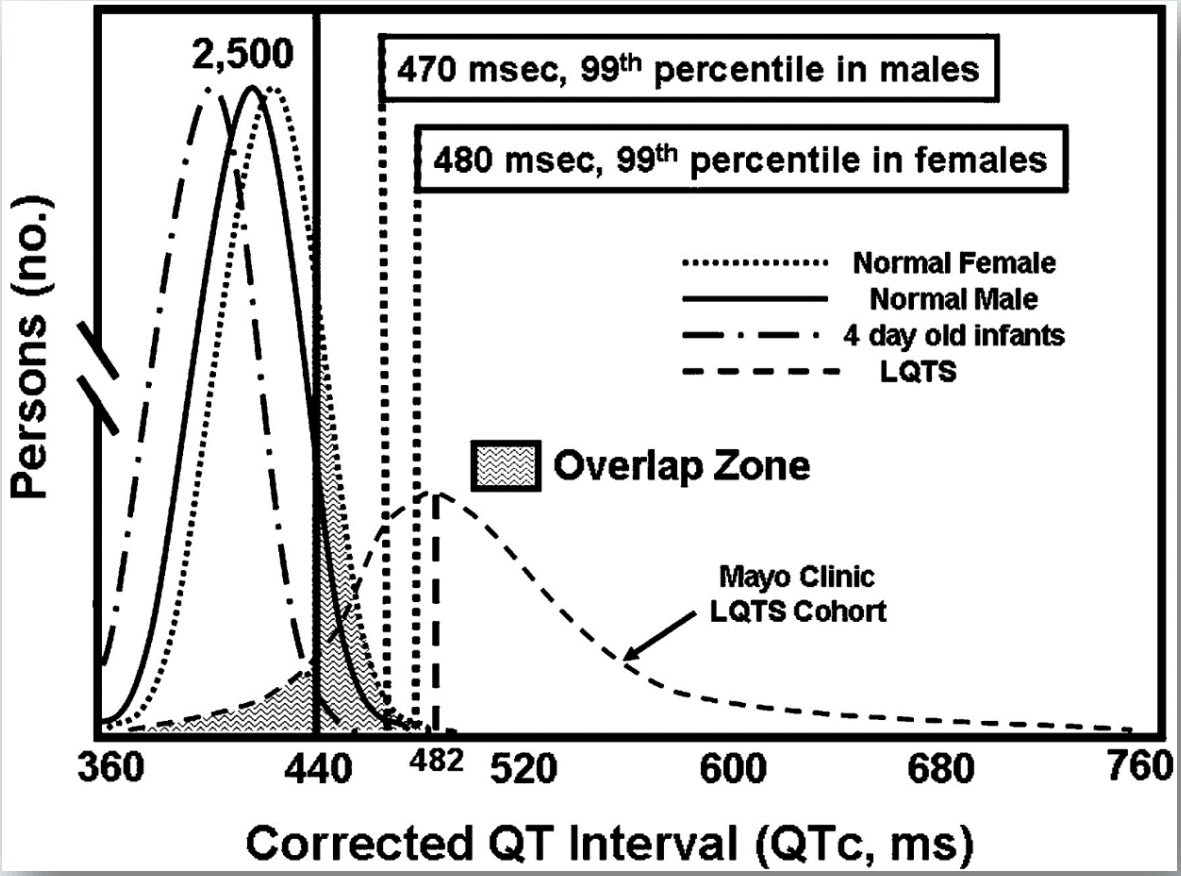


Figure 5. Effect of beta-adrenergic blocking agents on T wave morphology. In this patient, beta-blockade is accompanied by "normalization" of the T wave pattern. This was observed in a minority of patients (two of the eight who had an abnormal T wave in the absence of treatment).

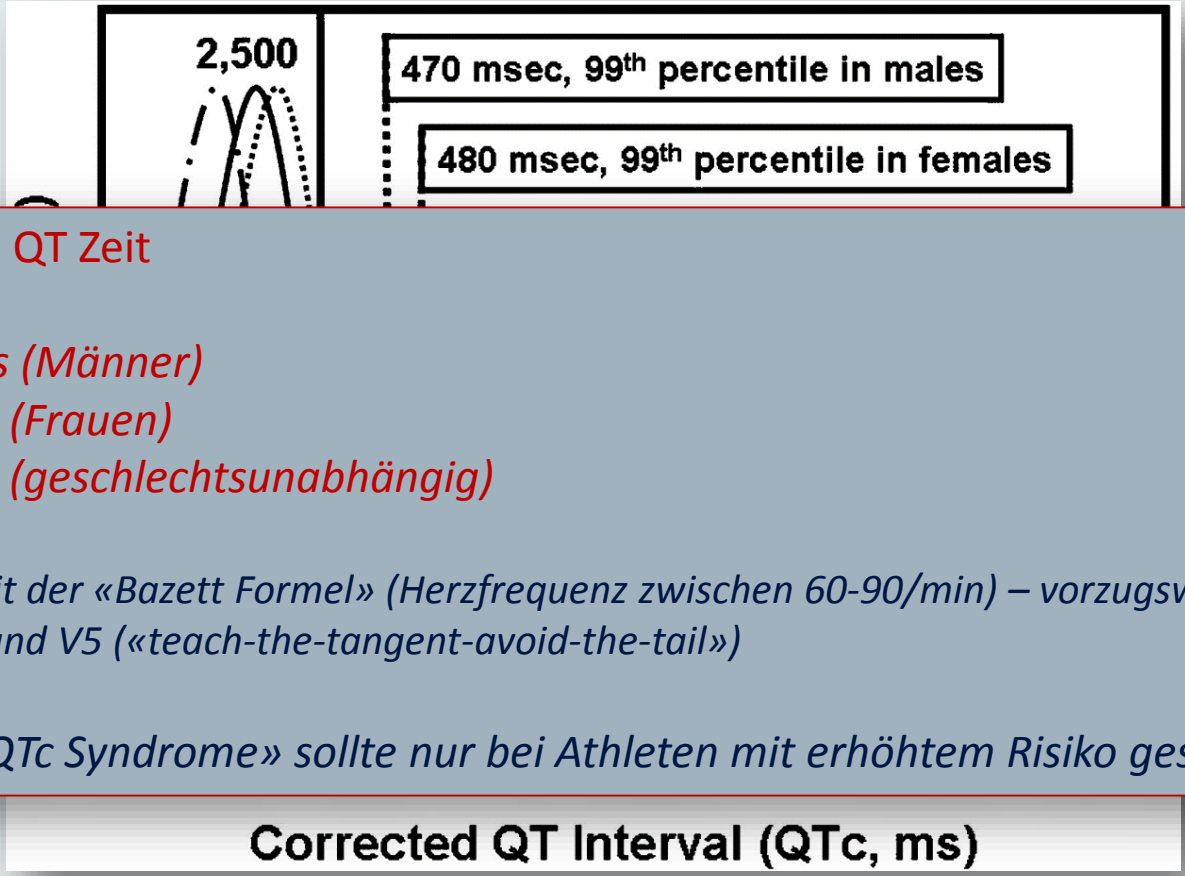
Malfatto G, Beria G, Sala S, et al. Quantitative analysis of T wave abnormalities and their prognostic implications in the idiopathic long QT syndrome. J Am Coll Cardiol 1994;23:296–301

Long QT pattern



Johnson JN, Ackerman MJ QTc: how long is too long? British Journal of Sports Medicine 2009;43:657-662

Long QT pattern



Verlängerte QT Zeit

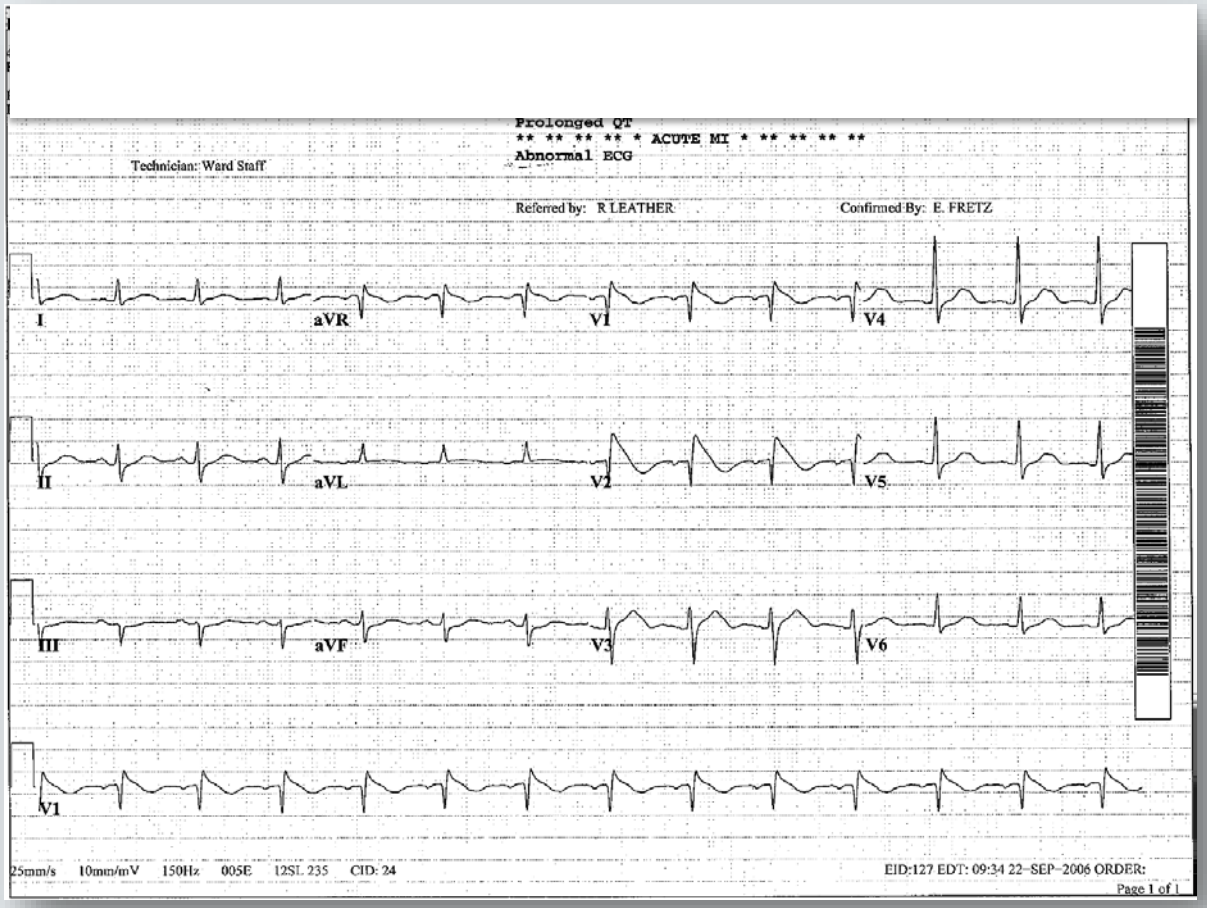
QTc ≥470ms (Männer)
QTc≥480ms (Frauen)
QTc≥500ms (geschlechtsunabhängig)

Berechnet mit der «Bazett Formel» (Herzfrequenz zwischen 60-90/min) – vorzugsweise manuell in Ableitung II und V5 («teach-the-tangent-avoid-the-tail»)

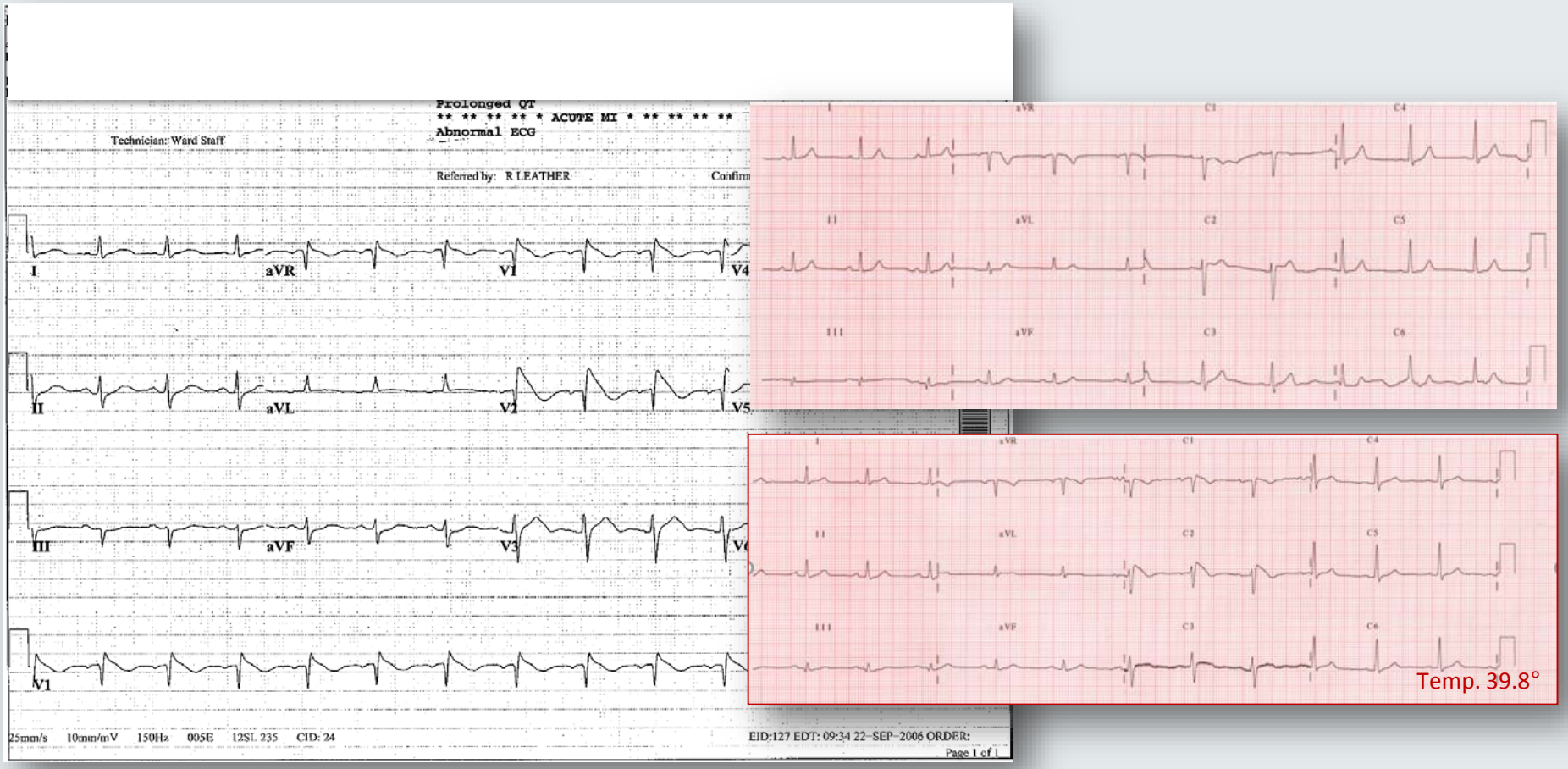
Ein «Short QTc Syndrome» sollte nur bei Athleten mit erhöhtem Risiko gesucht werden.

Johnson JN, Ackerman MJ QTc: how long is too long? British Journal of Sports Medicine 2009;43:657-662

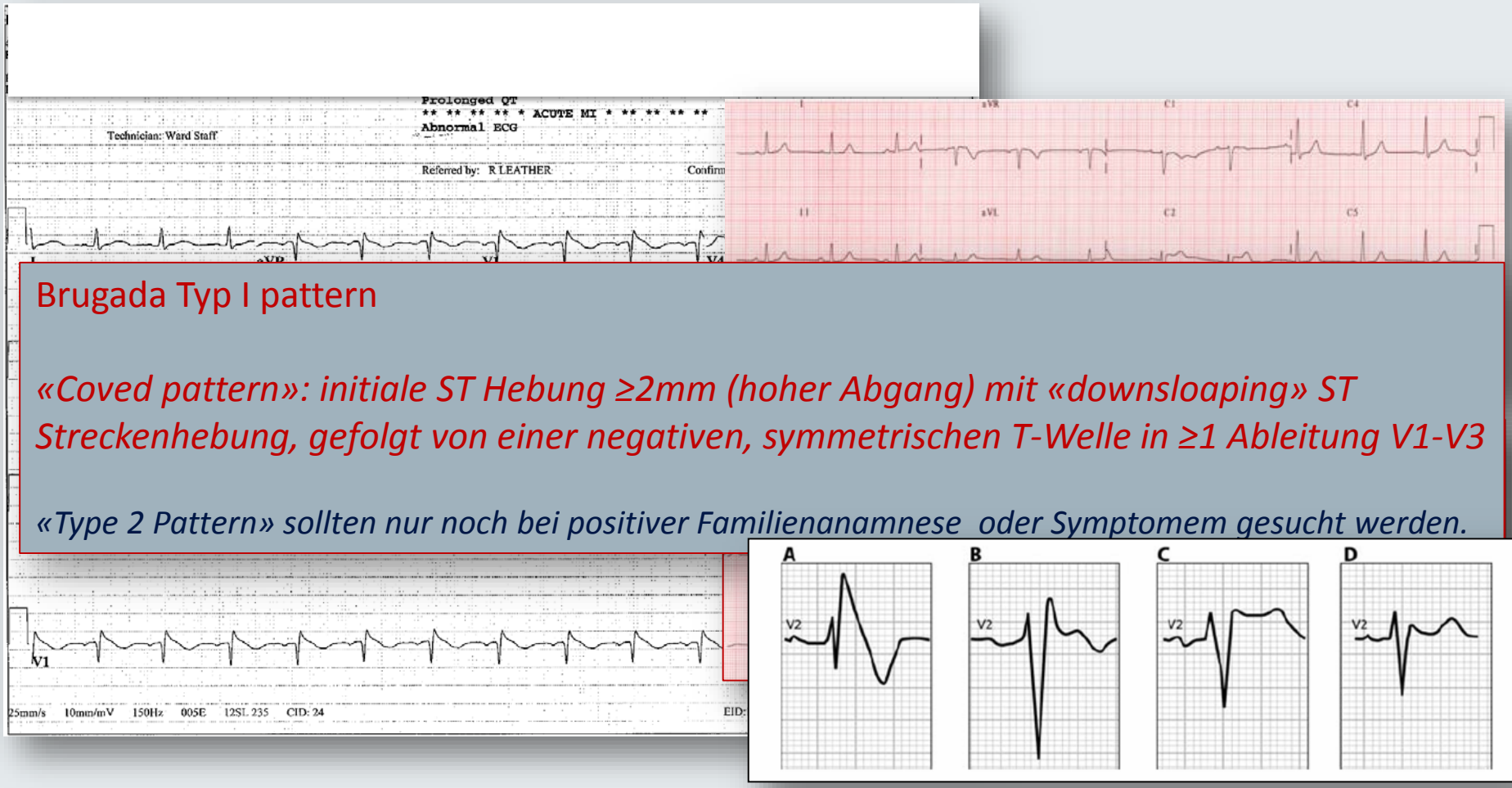
Brugada Typ I pattern – «the last pattern standing»



Brugada Typ I pattern – «the last pattern standing»



Brugada Typ I pattern – «the last pattern standing»



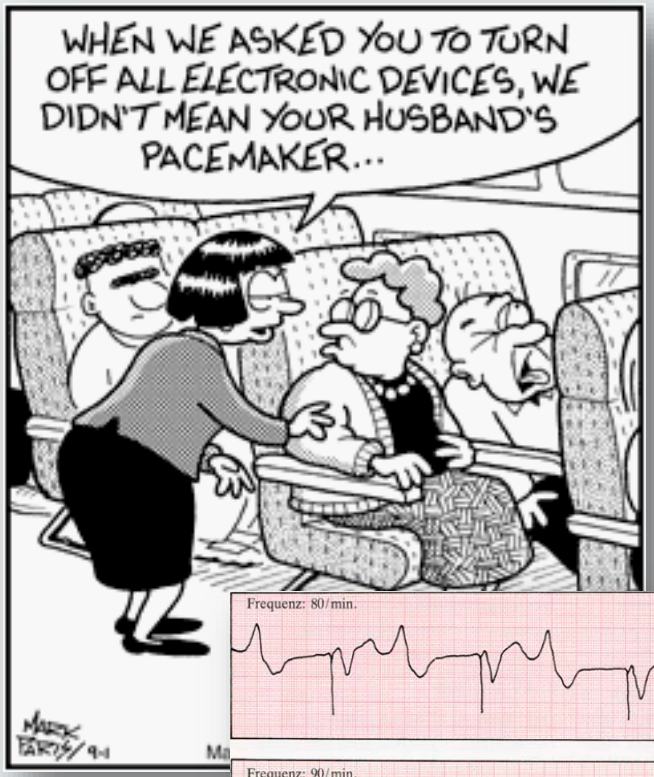
Brugada Typ I pattern

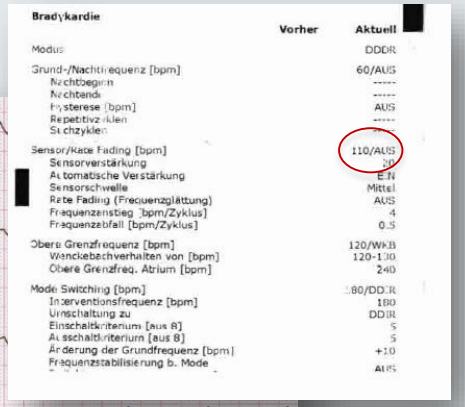
«Coved pattern»: initiale ST Hebung ≥2mm (hoher Abgang) mit «downsloaping» ST Streckenhebung, gefolgt von einer negativen, symmetrischen T-Welle in ≥1 Ableitung V1-V3

«Type 2 Pattern» sollten nur noch bei positiver Familienanamnese oder Symptomem gesucht werden.

Schwere Sinusbradykardie (<30/min)//hochgradiger AV-Block

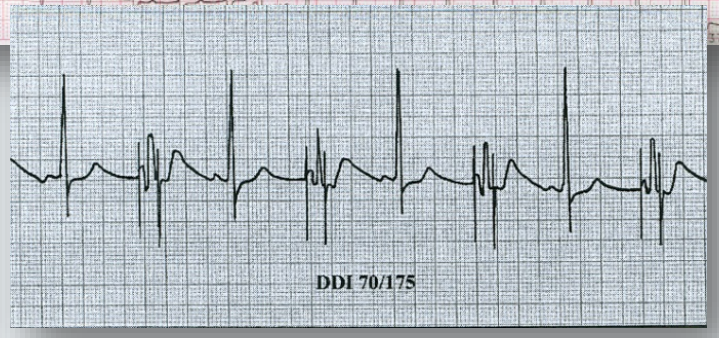
Immer mehr Sportler treiben Sport mit einem Device





«Pacemakertachycardia»

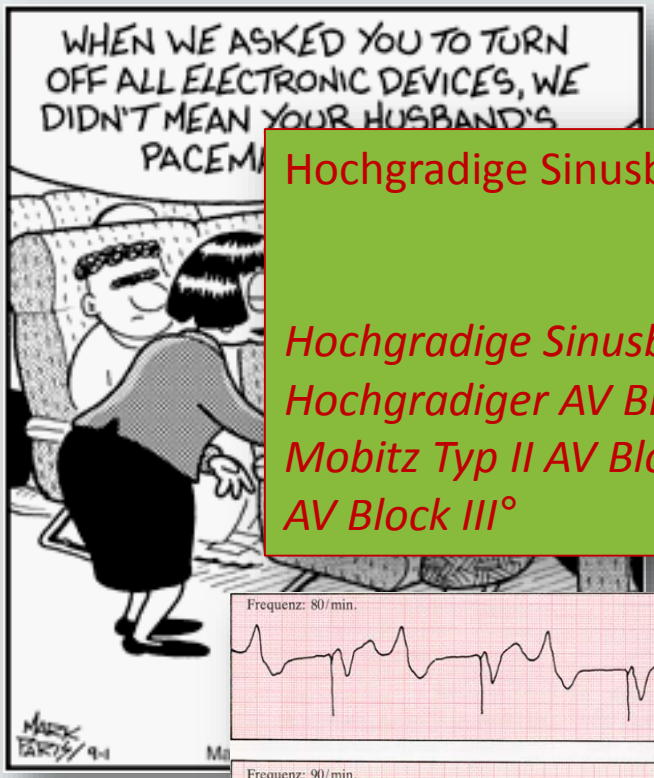
«Undersensing»

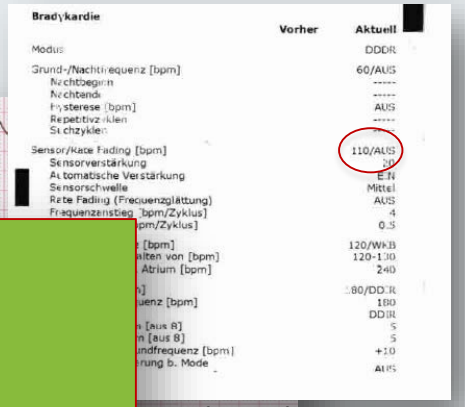


«AV-VA reverse»

Schwere Sinusbradykardie (<30/min)//hochgradiger AV-Block

Immer mehr Sportler treiben Sport mit einem Device

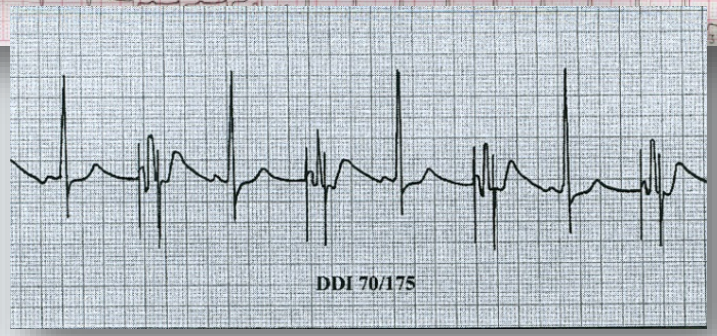




Hochgradige Sinusbradykardie, hochgradiger AV Block

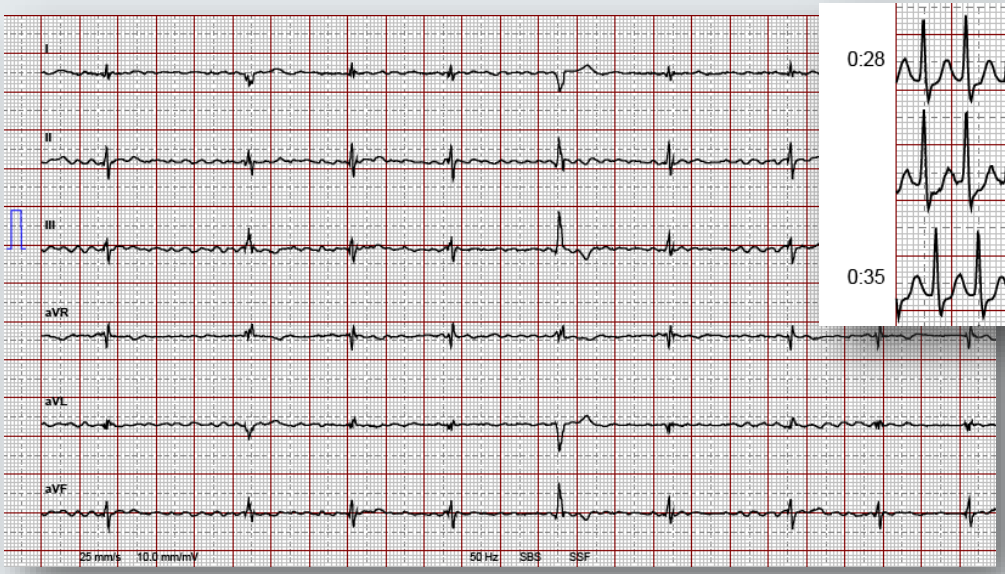
Hochgradige Sinusbradykardie <30bpm oder Sinuspausen ≥3s
Hochgradiger AV Block I° ≥400ms
Mobitz Typ II AV Block
AV Block III°

«Undersensing»

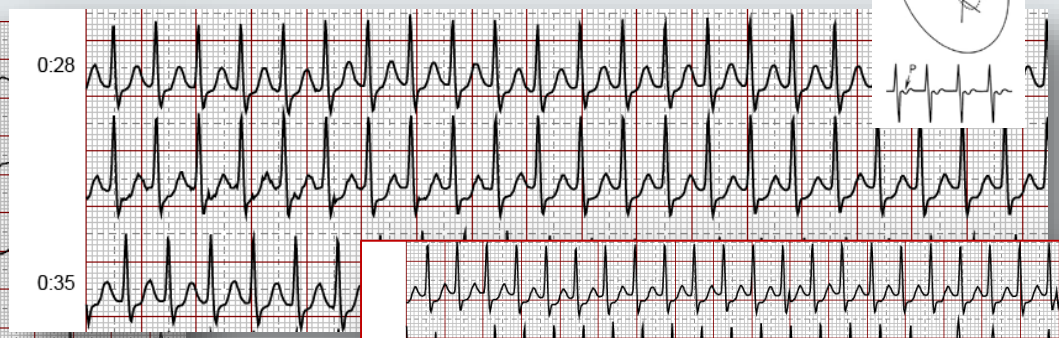


«AV-VA reverse»

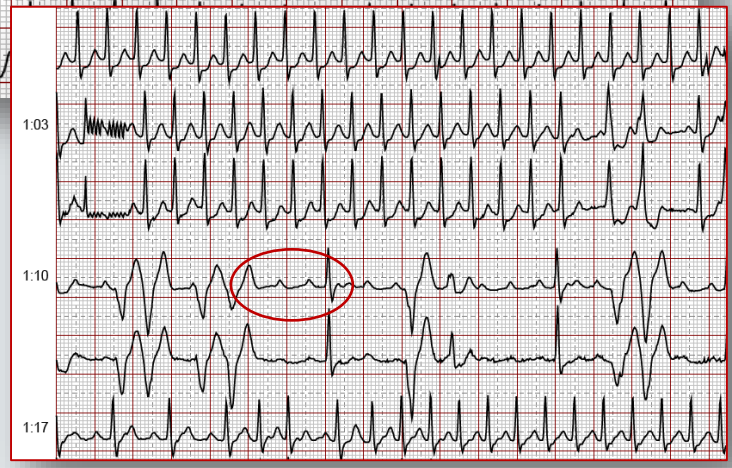
Atriale Tachyarrhythmien – *atrial fibrillation on the rise*



Vorhofflimmern



AVNRT

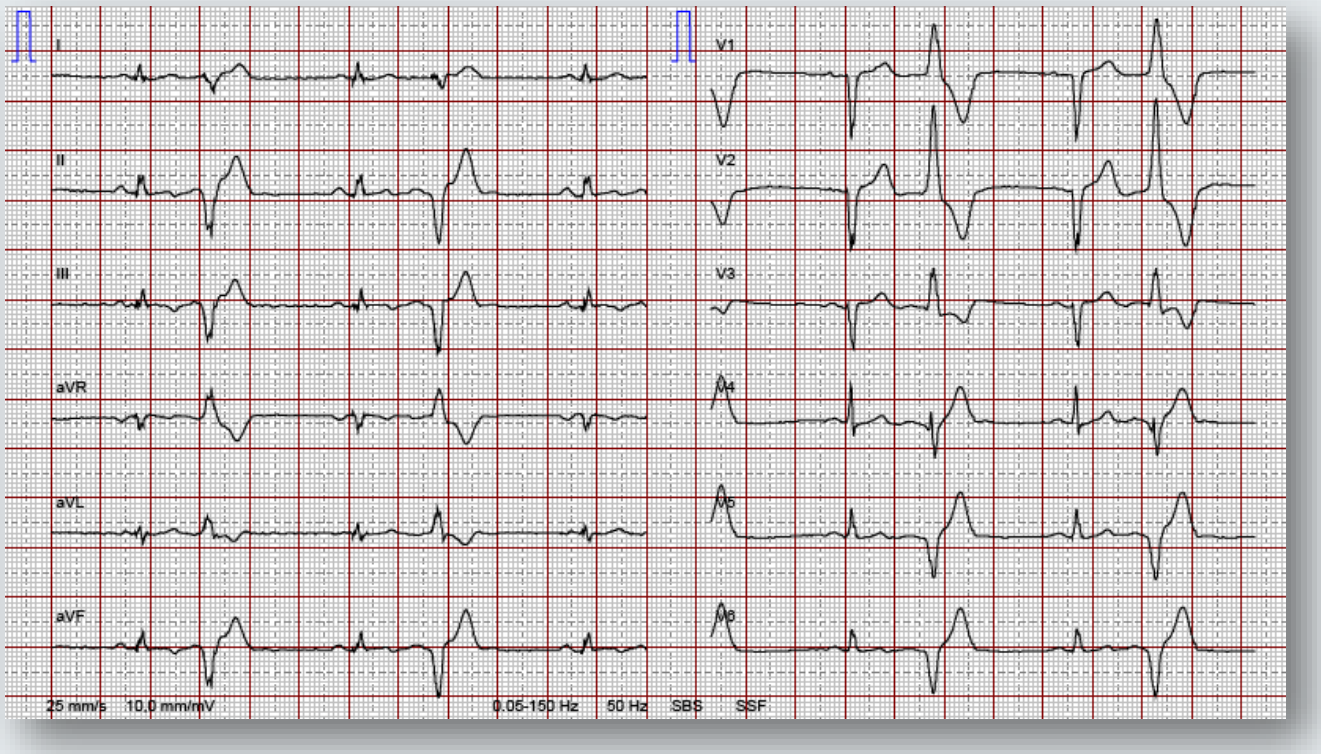


Vorhofflattern

Atriale Tachyarrhythmien

Supraventrikuläre Tachykardie (inkl. AV-Reentry)
Vorhofflimmern
Vorhofflattern

Ventrikuläre Extrasystolen



Ventrikuläre Extrasystolen – Surrogatmarker für Kardiopathien?

Table 2. Prevalence of Structural Cardiovascular Abnormalities in 355 Competitive Athletes With Ventricular Tachyarrhythmias

	Group A (≥2,000 PVDs and ≥1 NSVT)	Group B* (≥100 to <2,000 PVDs)	Group C* (<100 PVDs)	p Value
No. of athletes	71	153	131	
ARVC	7 (10%)	0	0	< 0.001†
MVP	6 (9%)	5 (3%)	0	0.0042‡
Myocarditis	4 (5.5%)	0	0	0.0003†
DCM	4 (5.5%)	0	0	0.0003†
Totals	21 (30%)	5 (3%)	0	< 0.001†

*NSVT was absent in these subgroups; †Group A versus Group B and Group A versus Group C ($p < 0.05$); and ‡Group A versus Group C ($p < 0.05$).

ARVC = arrhythmogenic right ventricular cardiomyopathy; DCM = dilated cardiomyopathy; MVP = mitral valve prolapse; Other abbreviations as in Table 1.

Biffi A, et al. Long-term clinical significance of frequent and complex ventricular tachyarrhythmias in trained Athletes. J Am Coll Cardiol 2002;40:446–52

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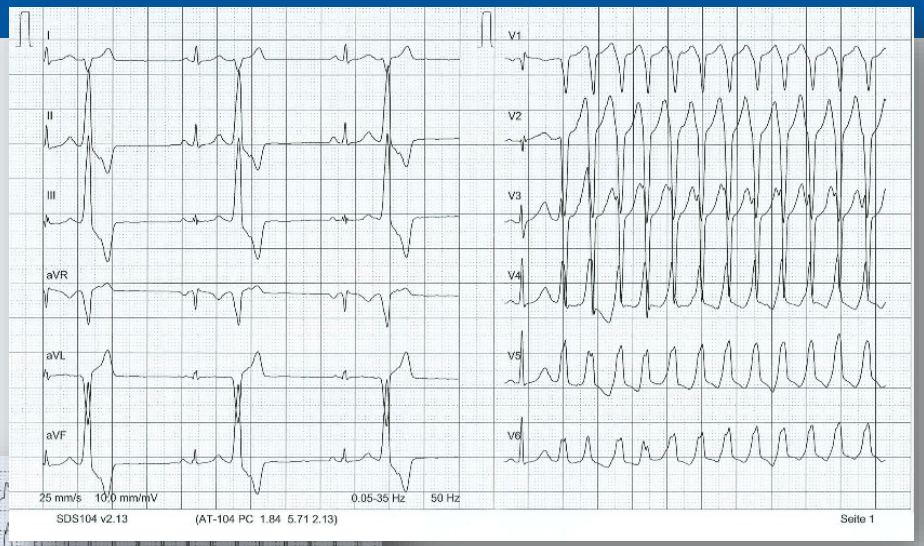
Ventrikuläre Extrasystolen *≥2 vorzeitige ventrikuläre Kontraktionen per 10s Aufzeichnung*

…implizieren ≥2000 VES pro 24 Stunden

Biffi A, et al. Long-term clinical significance of frequent and complex ventricular tachyarrhythmias in trained Athletes. J Am Coll Cardiol 2002;40:446–52

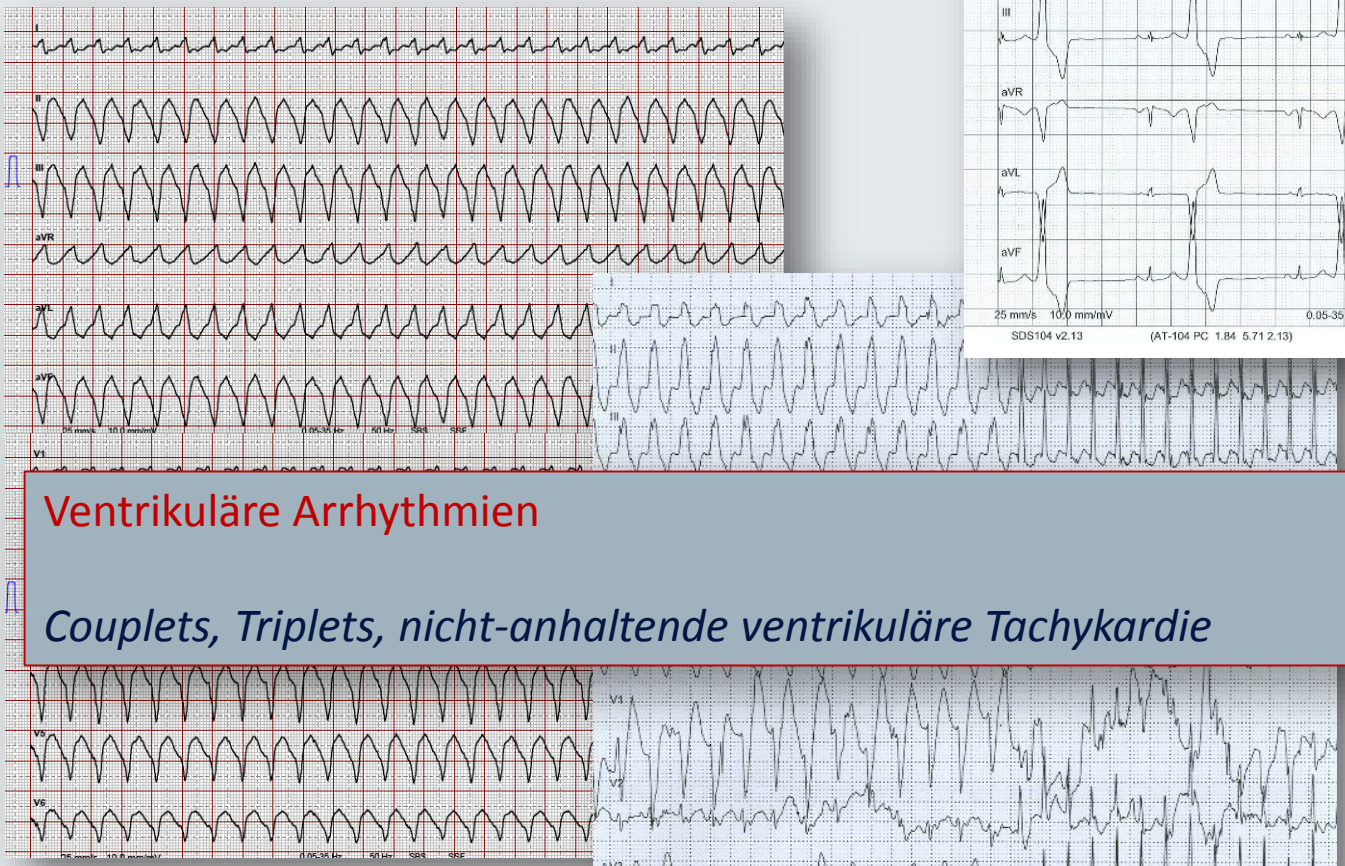
Ventrikuläre Arrhythmien



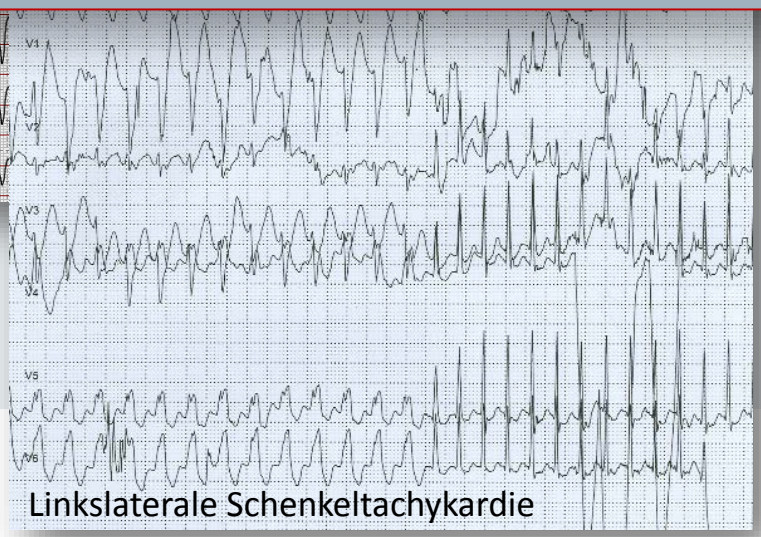
RVOT Tachykardie

Ventrikuläre Arrhythmien

Couplets, Triplets, nicht-anhaltende ventrikuläre Tachykardie



Linksventrikuläre Narbe



Linkslaterale Schenkeltachykardie

Courtesy of Prof. C. Brunckhorst

Konklusionen und Ausblick

- *Die Sportkardiologie ist ein enorm vielseitiges Fachgebiet mit dem primären Ziel, das sog. «Sport-Paradox zu wiederlegen. Dabei ist das ein potentieller Schaden durch das Sporttreiben zu vermeiden und dabei vor allem der plötzliche sport-assoziierte Herztod.*

- *Regelmässiges, individualisiertes Training ist ein hocheffektives Werkzeug in der Primär- als auch Sekundärprävention kardiovaskulärer Erkrankungen.*

- *Das Herz/Herz-Kreislaufsystem unterliegt (physiologischen), durch regelmässiges Training verursachten Adaptationen, die das kardiale Screening erschweren («Sportherz»).*

- *Durch ein gezieltes und richtliniengetreues Screening kann die überwiegende Zahl dieser tragischen Ereignisse verhindert werden. Doch das Bewusstsein, dass (evidenzbasiertes) kardiales Screening zur Standardbetreuung jedes Sportlers gehören sollte, ist noch zu wenig verbreitet.*

- *Sogenannte «Hobby-Sportler» werden diesbezüglich aktuell massiv unterbetreut (und werden zudem selten in den Statistiken erfasst).*

- *Die akkurate Beurteilung des 12-Ableitungs Ruhe-EKG ist der entscheidende Schritt in der Vorsorgeuntersuchung («Seattle Criteria»).*

- *Rund 10% der Fälle von Herzstillstand im Sport sind nicht durch Screening zu verhindern, in diesen Situationen (wie auch bei der commotio cordis) sind akkurate Akutmassnahmen vor Ort entscheidend («rescue on the field», «AED»). Die Beurteilung der Veränderungen des rechten Ventrikels bei jungen, und die Detektion und Risikoeinschätzung von «Koronar-Plaques» bei älteren Sportlern stellen die aktuell anspruchsvollsten Herausforderungen dar.*

Danke für die Aufmerksamkeit

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Leiter Ambulatorium
Leiter Sportkardiologie

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