

Blood Flow Limitations in the Iliac Arteries in Cyclists.

Impact on Performance Measured by Techniques During Exercise

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No conflict of interest

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Sport-related vascular problem?



What are the complaints???

Pain, cramp and powerlessness at/near maximal intensity, which disappears within a few minutes in rest

Particularly in time trail posture!



Prevalence sport-related vascular problem



- Control group 36 cyclists (age 24 yrs; sd 3)
1/ 6 (17 %)
- Dutch Olympic cyclists/triathletes team
'Sydney 2000': 5/25 (20 %)
- Dutch touring cyclists: 1 500 000 >5
hours/week: **Prevalence unknown!**



Regular vascular medicine versus sports medicine



>90% atherosclerosis
Less healthy/unhealthy lifestyle
±90% > 50 yrs



Healthy lifestyle
Average age <30 yrs

Let's compare vessels!



Atherosclerosis

Peak cardiac output: ± 10 l/min

Demand: $< 1-3$ l/min

Diameter: < 50 %

Surface: < 25 %



Normal

Peak cardiac output: $\pm 10-15$ l/min



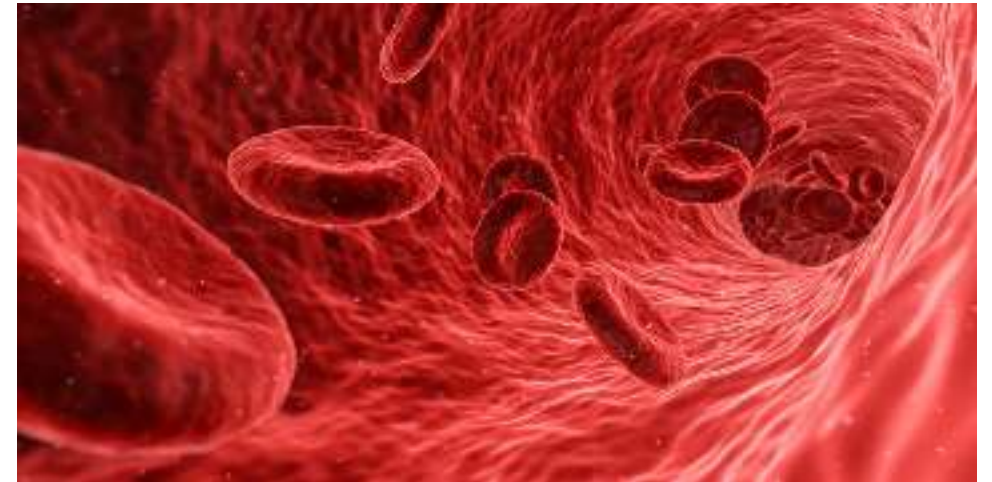
Athlete

Peak cardiac output: $\pm 25-35$ l/min

Demand: $10-15$ l/min

Diameter: ca. 125%

Surface: ca. 150-200 %



Regular vascular medicine



Diagnostic question:

NOT: *'Is there an injury?'*

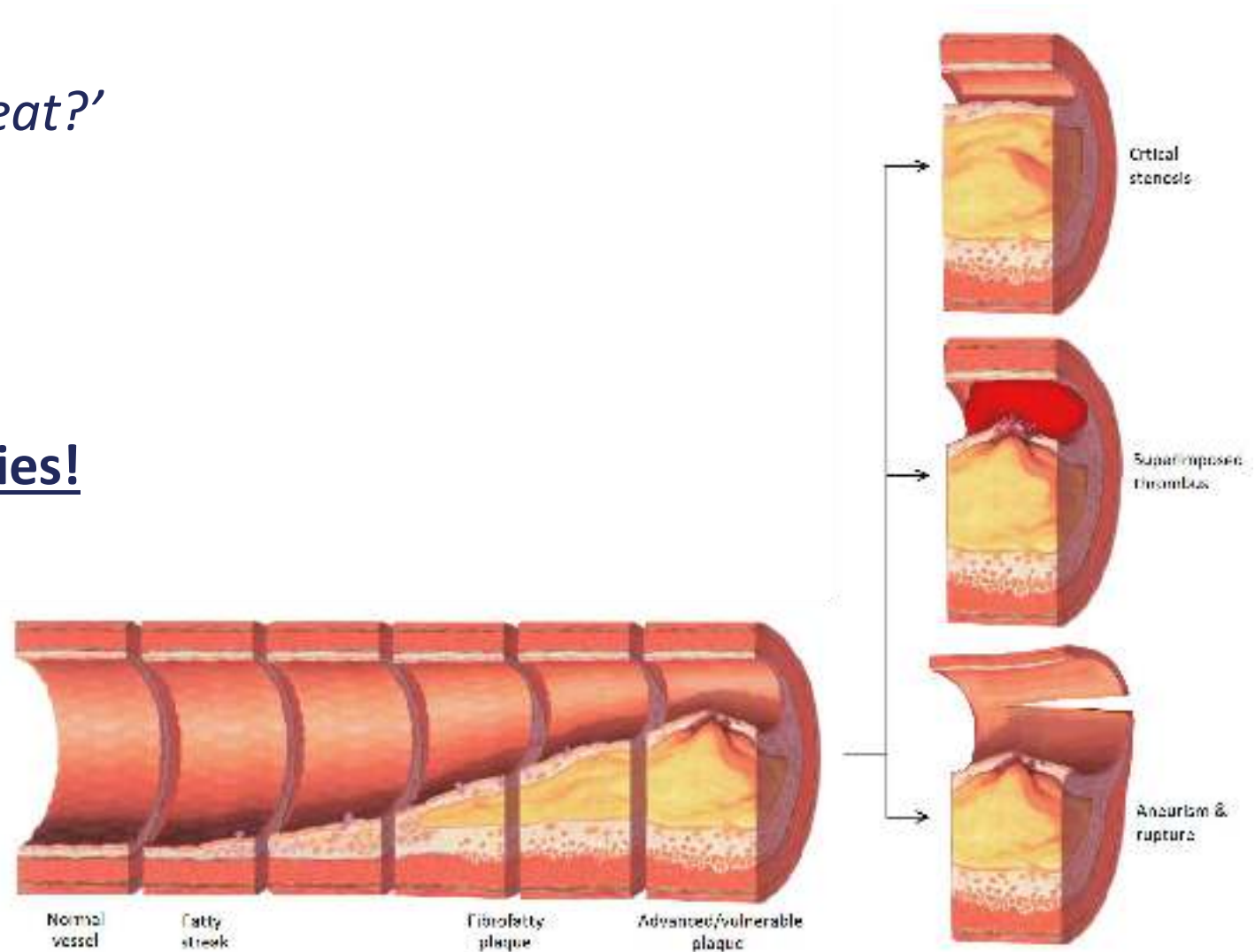
BUT: *'Is it serious enough to treat?'*

Diagnostic tools:

Provocative testing

Imaging

Only intravascular abnormalities!



Sports related vascular problem?



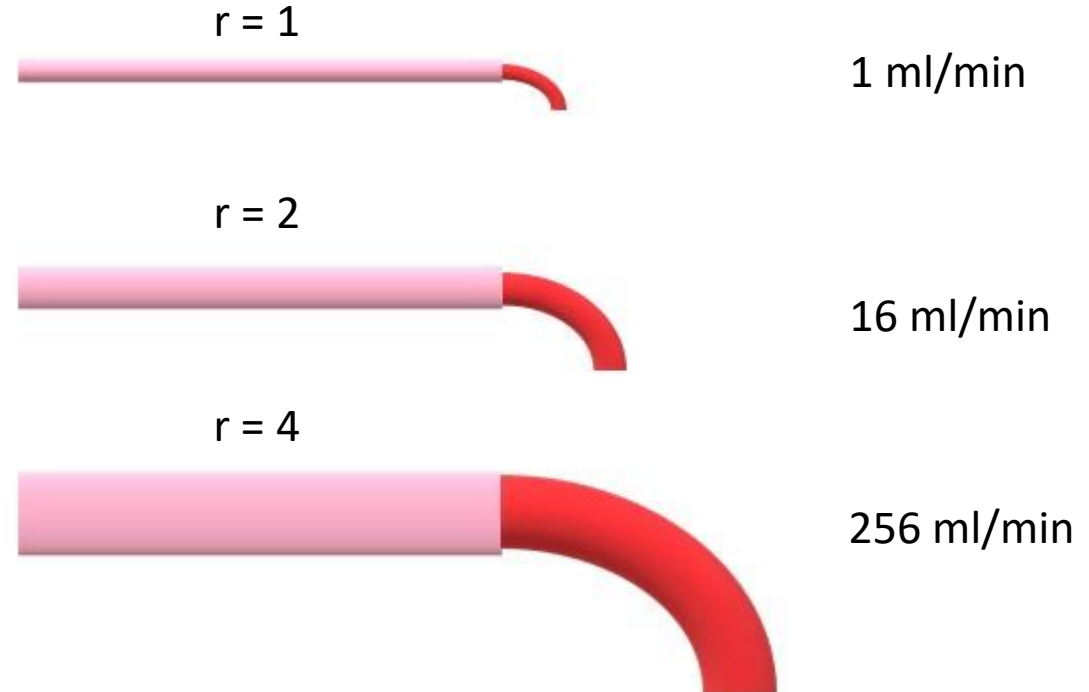
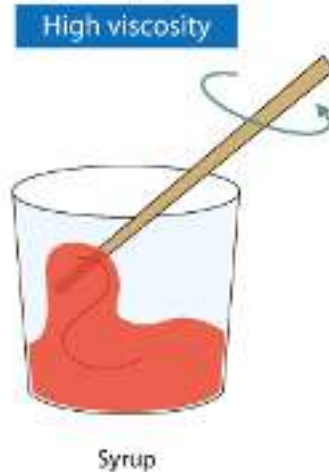
$$\text{Blood Flow } (Q) = \frac{\pi P r^4}{8 \eta L}$$

P=Pressure

r=Radius

η =Viscosity

L=Length vessel

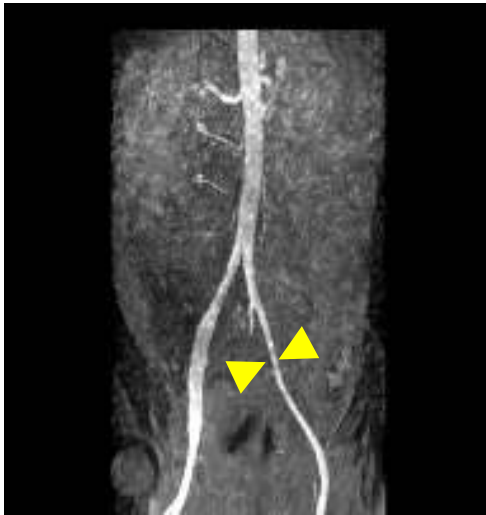


Small decrease, **huge** difference!!

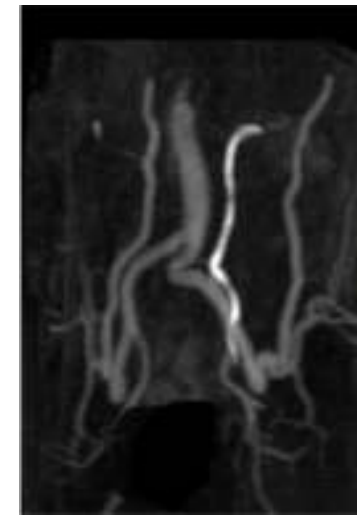
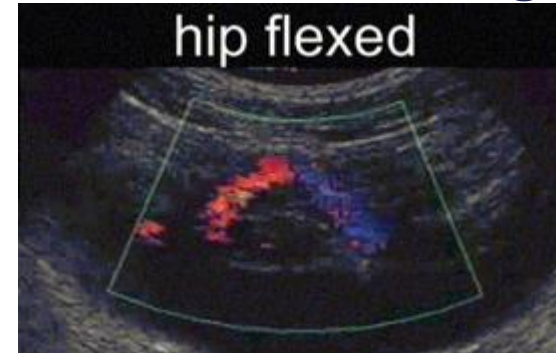
Types of abnormalities



Intravascular lesion



Functional Kinking



and/or

Schep G, Bender MHM, Schmikli SL et al. Color Doppler used to detect kinking and intravascular lesions in the iliac arteries in endurance athletes with claudication. *European Journal of Ultrasound* 2001; 14: 129-140

Schep G, Kaandorp DW, Bender MHM et al. Magnetic resonance angiography used to detect kinking in the iliac arteries in endurance athletes with claudication *Physiol Meas* 2001; 22: 475-487

van Hooff, M., Schep, G., Meijer, E., Bender, M., & Savelberg, H. Near-Infrared Spectroscopy Is Promising to Detect Iliac Artery Flow Limitations in Athletes: A Pilot Study. *Journal Of Sports Medicine*, 2018, 1-11. doi: 10.1155/2018/8965858

Sports related vascular problem?



	Sensitivity	Specificity
Complaints disappear <5 minutes	0.97	0.29
Complaints in >3 muscle groups of 6	0.48	0.94
Vascular bruit extended hip	0.36	0.94
Vascular bruit flexed hip	0.76	0.65

Schep, G., Schmikli, S., Bender, M., Mosterd, W., Hammacher, E., & Wijn, P. (2002). Recognising Vascular Causes of Leg Complaints in Endurance Athletes. Part 1: Validation of a Decision Algorithm. *International Journal Of Sports Medicine*, 23(5), 313-321. doi: 10.1055/s-2002-33141

Schep, G., Bender, M., Schmikli, S., Mosterd, W., Hammacher, E., Scheltinga, M., & Wijn, P. (2002). Recognising Vascular Causes of Leg Complaints in Endurance Athletes. Part 2: The Value of Patient History, Physical Examination, Cycling Exercise Test and Echo-Doppler Examination. *International Journal Of Sports Medicine*, 23(5), 322-328. doi: 10.1055/s-2002-33142

Sports related vascular problem?

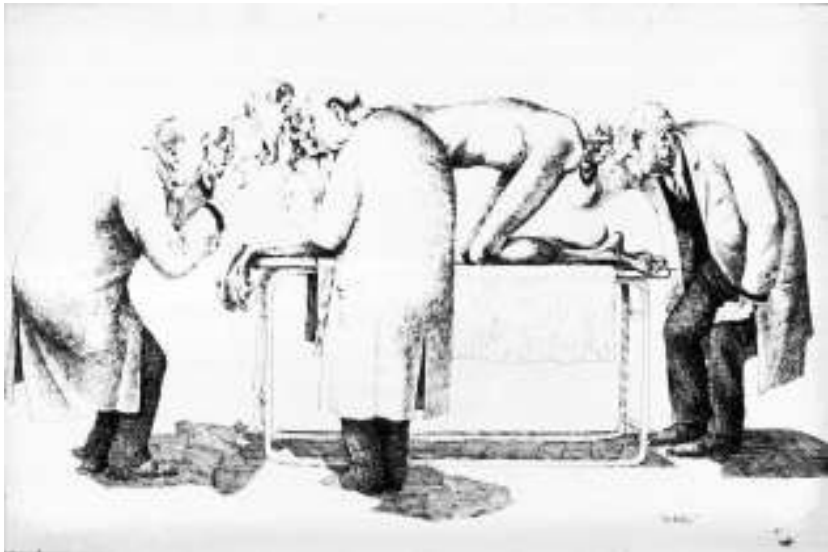


	Sensitivity	Specificity
Ankle pressure <107 mmHg	0.53	0.85
Ankle-Brachial-Index (ABI) <0.54	0.43	1
Ankle pressure difference >23 mmHg	0.73	0.95



We have a problem: we still miss a lot of patients!!

New Methods!?



Near-Infrared Spectroscopy



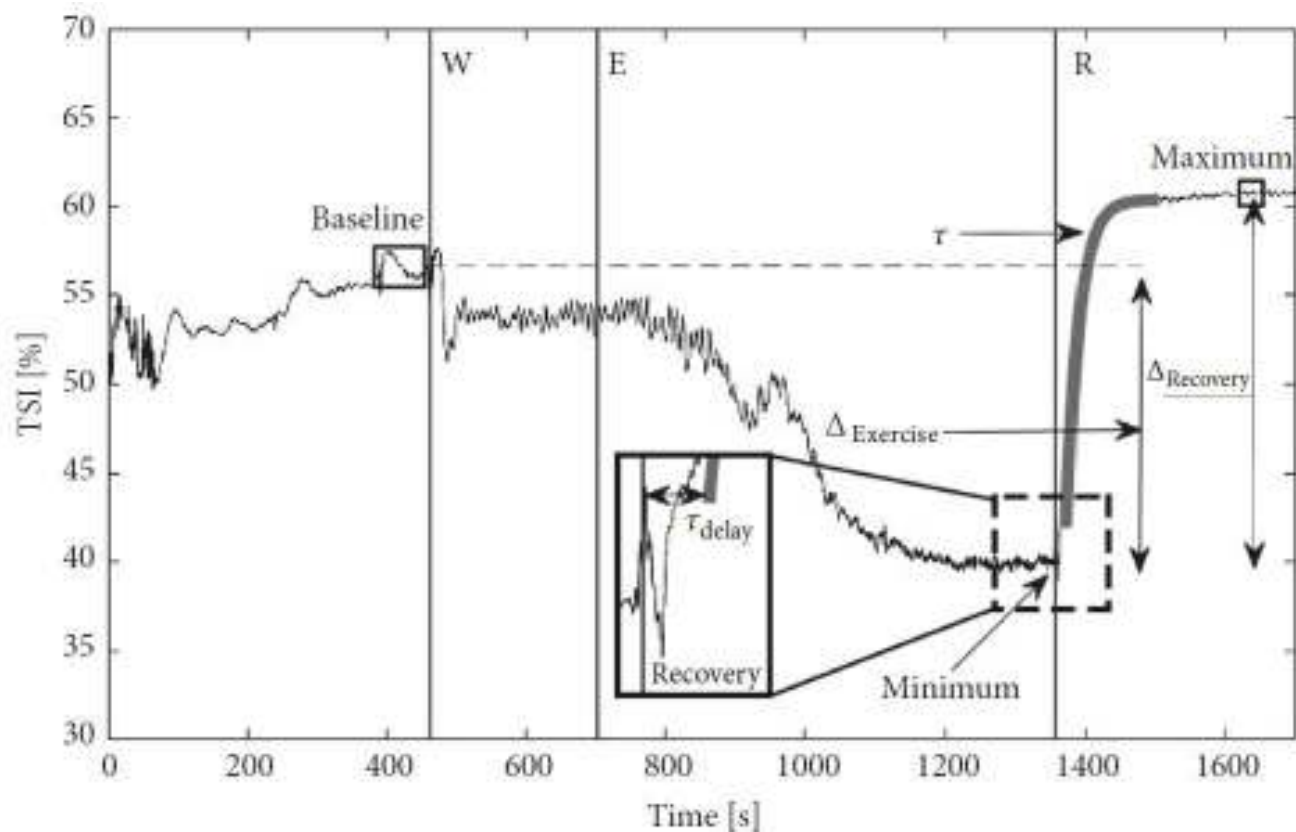
Non-invasive measurement of tissue oxygenation

Based on:

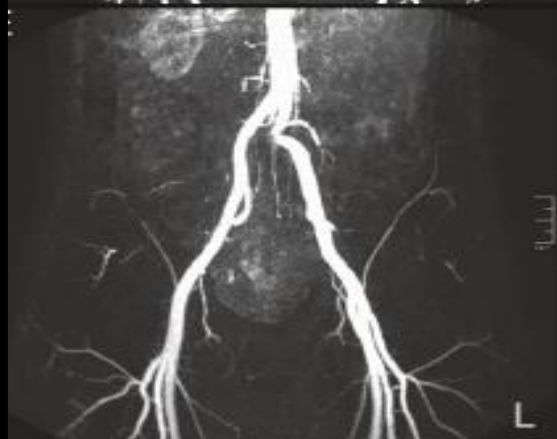
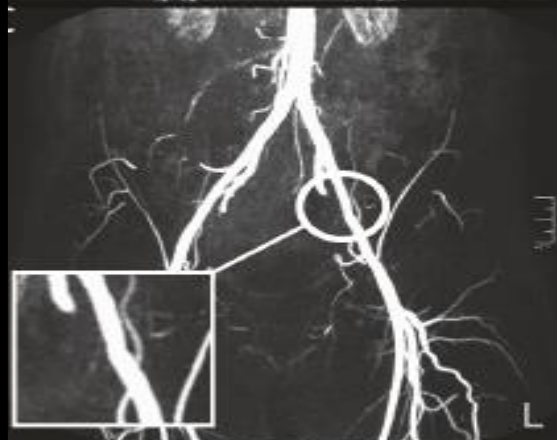
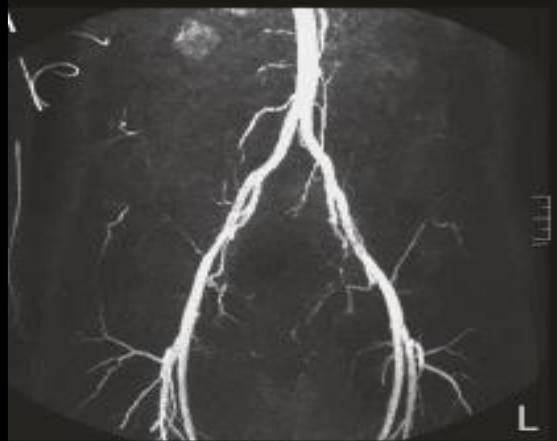
- Relative transparency of tissue for Near-Infrared light
- O_2Hb dependent absorption changes of Hb (and Mb)



Multiple Case Report

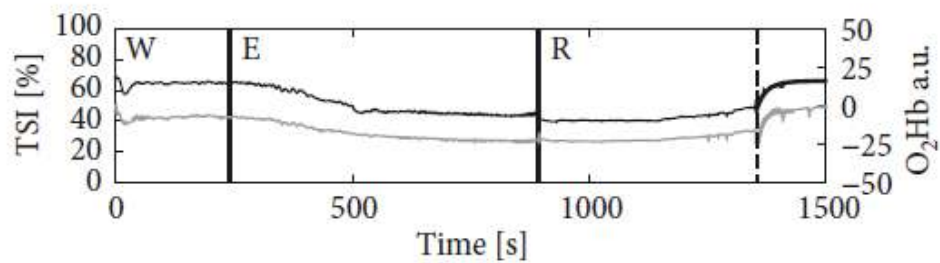
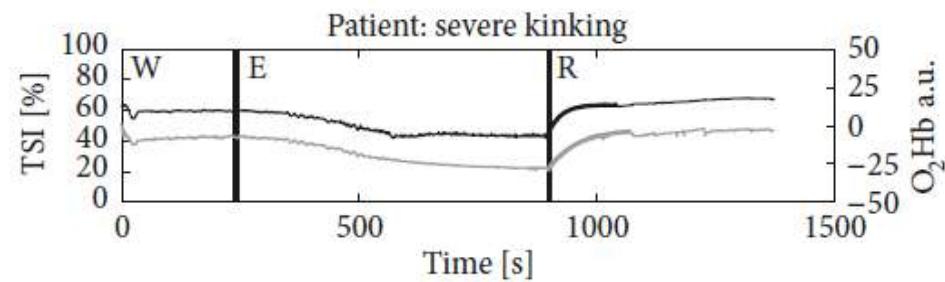
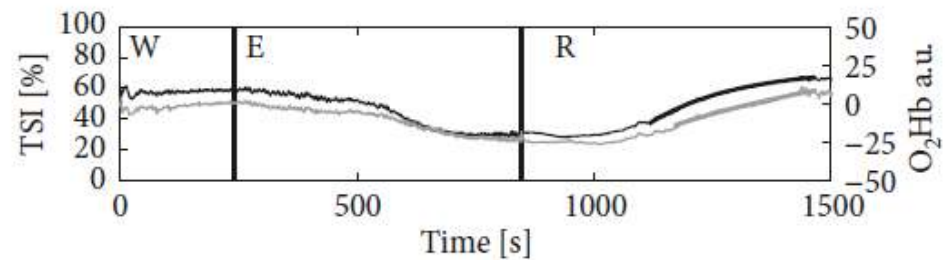
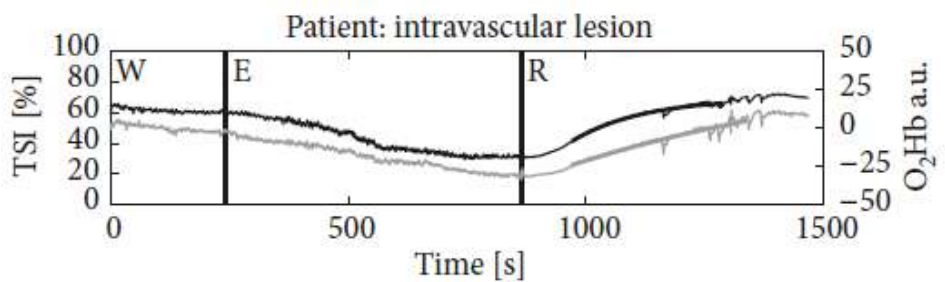
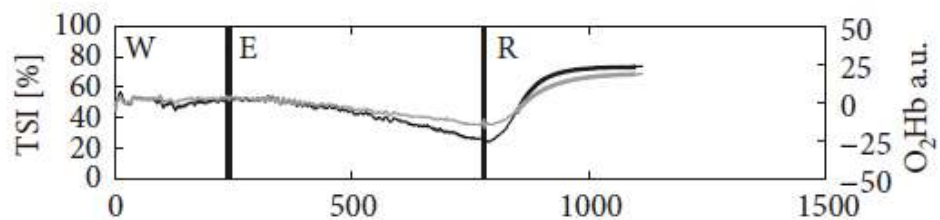
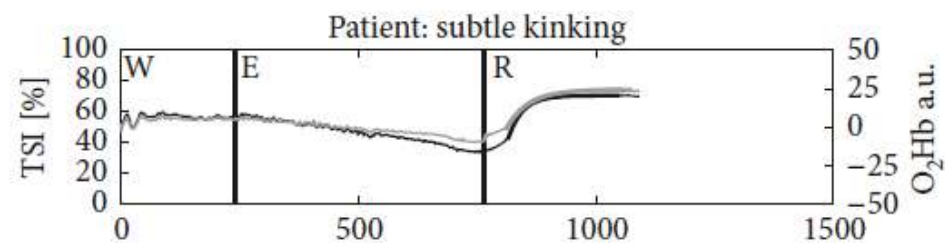
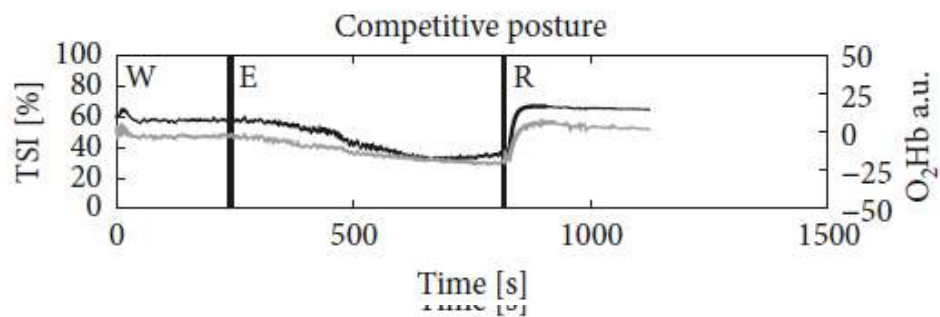
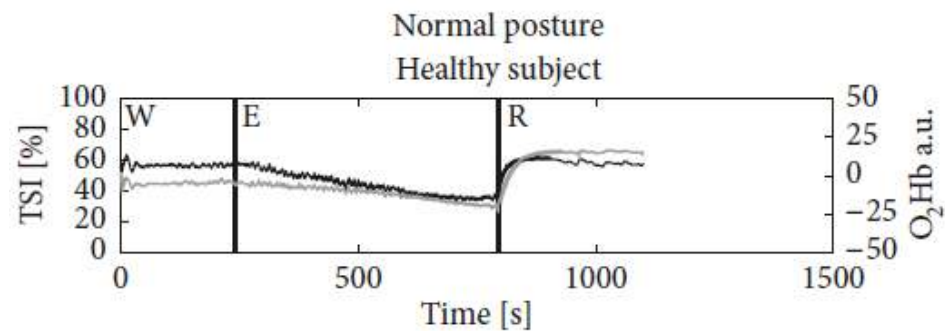


EXTENDED



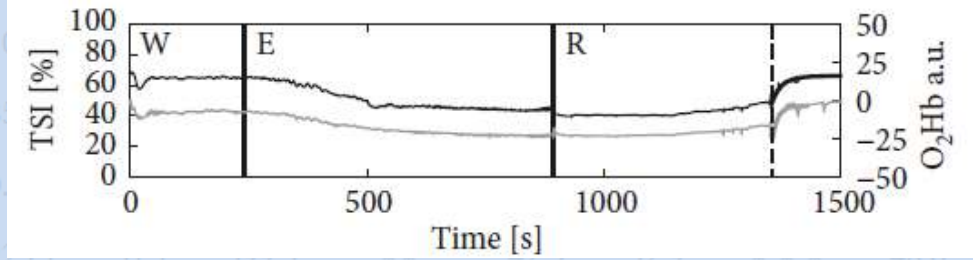
FLEXED



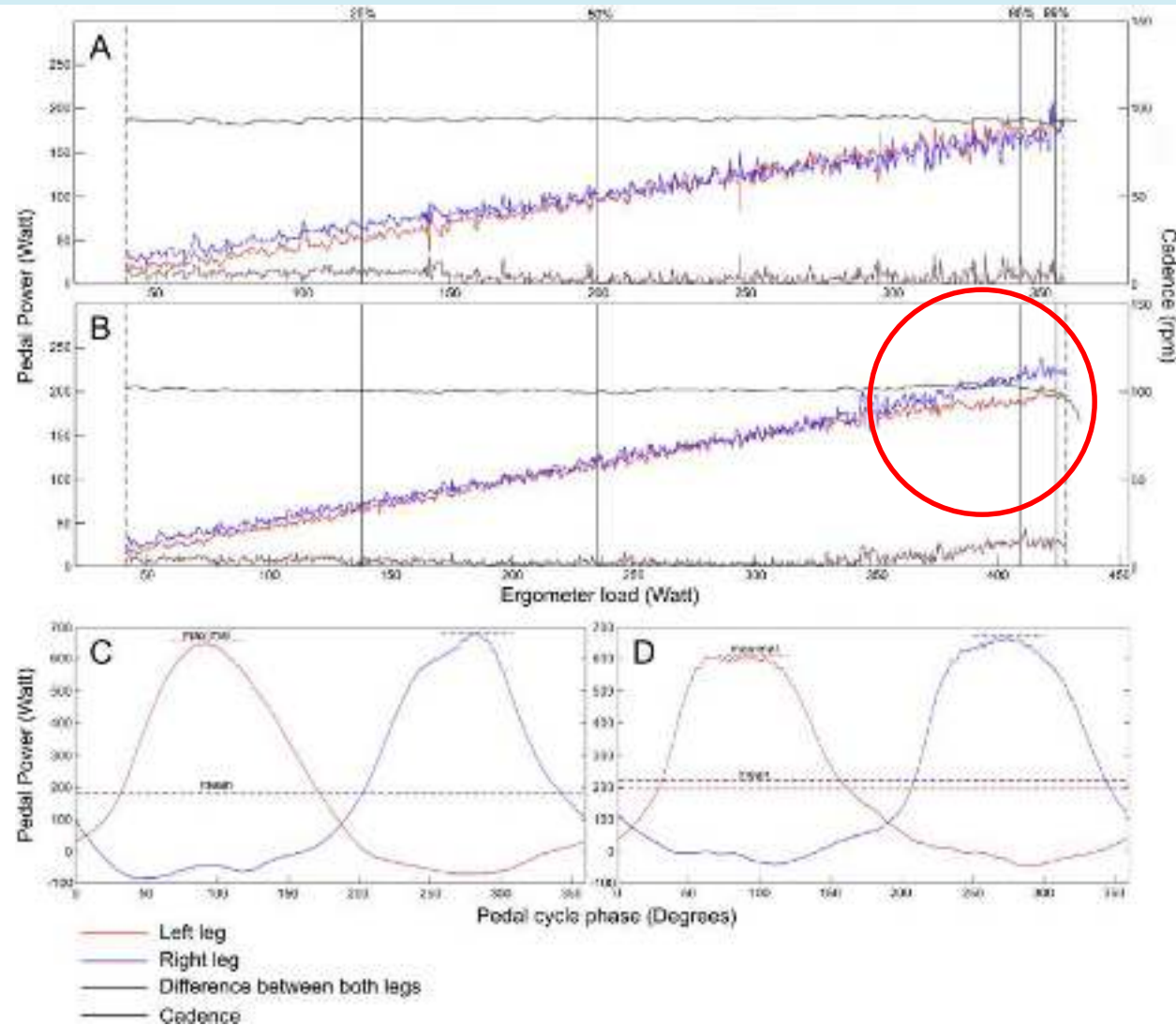




	Kinetic values																
	Healthy top cyclist					Patient: Subtle kinking				Patient: Intravascular lesion				Patient: severe kinking			
	NP		CP		n=18 [†]	NP		CP		NP		CP		NP		CP	
	Left	Right	Left	Right		Left*	Right	Left*	Right	Left*	Right	Left*	Right	Left*	Right	Left*	Right
TSI _τ	14.7	14.9	11.4	9.2	15 (4.0) [†]	30.2	30.8	44.0	27.5	150.1	18.0	183.2	**	26.4	28.3	***	18.7
TSI _{delay}	-1.2	-3.7	12.1	10.3	11 (8.1) [†]	50.1	41.8	69.8	19.7	106.6	13	269.9	**	-7	-4	***	2
TSI _{MRT}	13.5	11.2	23.5	19.5	26 (11.2) [†]	80.3	72.6	113.8	47.2	256.7	31.0	453.1	**	19.4	23.7	***	11.7
TSI _R ²	0.980	0.975	0.994	0.987	0.989 (0.010) [†]	0.997	0.996	0.997	0.992	0.980	0.997	0.995	**	0.987	0.993	***	0.921
TSI _{HVT}	11.6	7.3	20.1	18.0	21 (8.4) [†]	65.0	49.5	82.2	36.5	173.9	24.8	345.3	**	22.2	18.3	***	91.8
O ₂ Hb _τ	25.9	26.2	18.6	15.1	20.5 (3.8) [†]	43.9	37.5	66.9	43.3	74.1	31.1	100.1	**	22.2	20.1	***	20.0
O ₂ Hb _{delay}	-1.2	-1.7	11.0	9.8	11 (6.9) [†]	47.6	41.9	68.5	19.3	106.6	13	269.9	**	-7	-4	***	2
O ₂ Hb _{MRT}	24.7	24.5	29.6	24.9	31.5 (8.6) [†]	91.5	79.4	135.4	62.6	256.7	31.0	453.1	**	19.4	23.7	***	11.7
O ₂ Hb _R ²	0.997	0.996	0.987	0.973	0.991 (0.005) [†]	0.996	0.990	0.998	0.998	0.980	0.997	0.995	**	0.987	0.993	***	0.921
O ₂ Hb _{HVT}	15.8	17.5	26.0	20.0	24.6 (6.5) [†]	68.0	51.3	94.5	42.6	173.9	24.8	345.3	**	22.2	18.3	***	91.8



Pedal Force Measurements

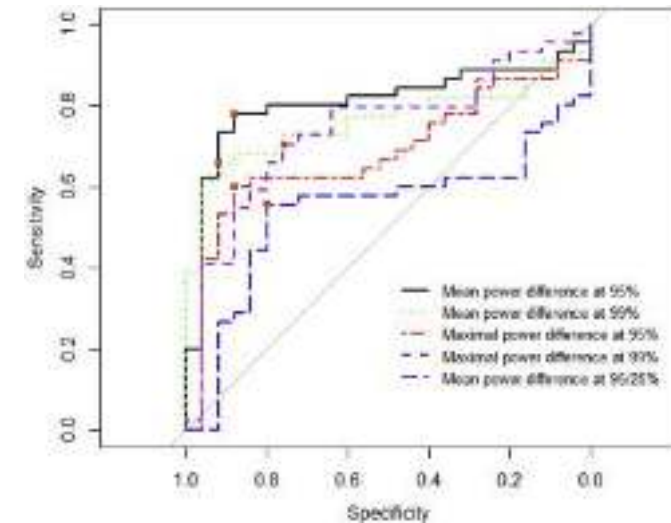


Pedal Force Measurements



Relative power difference @ 95% of maximal workload of >5.1%.

Downside: works only on one-sided vascular problems!



Diagnosis: Major Challenge!



Athlete: **Be alert!**

Trainer/coach: **Be alert!**

Sports physician: **Be alert!**

Complaints in combination with power difference **near maximal capacity on your power meter?** It might be a sport-related vascular problem!

If you, or your coach suspects a sports-related vascular problem, specialist diagnostics are required!!



International Study group for Identification and Treatment of Endofibrosis

Conservative treatment



110 patients (2001-2005) follow up +/- 8 yrs
24 eventually operated

Questionnaire

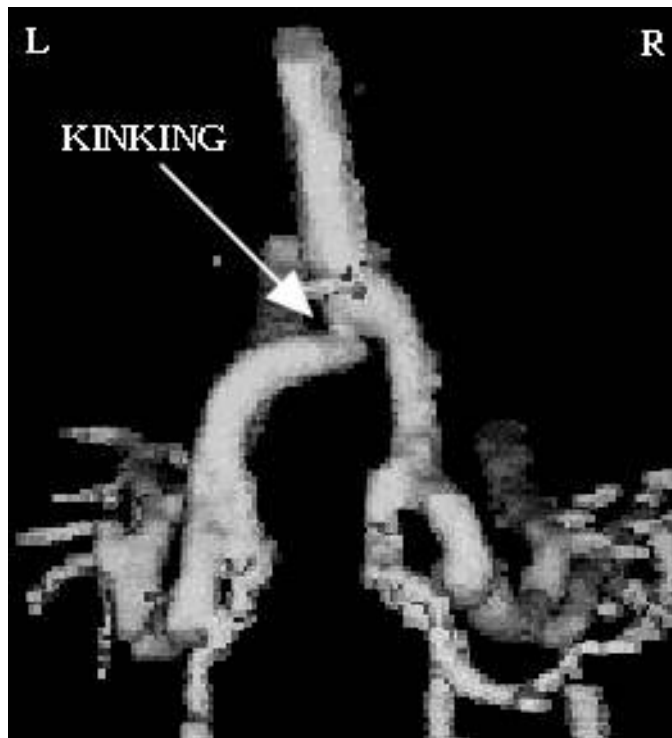
83 % satisfied!

17 % were particularly long distance cyclists, extreme competition cyclists

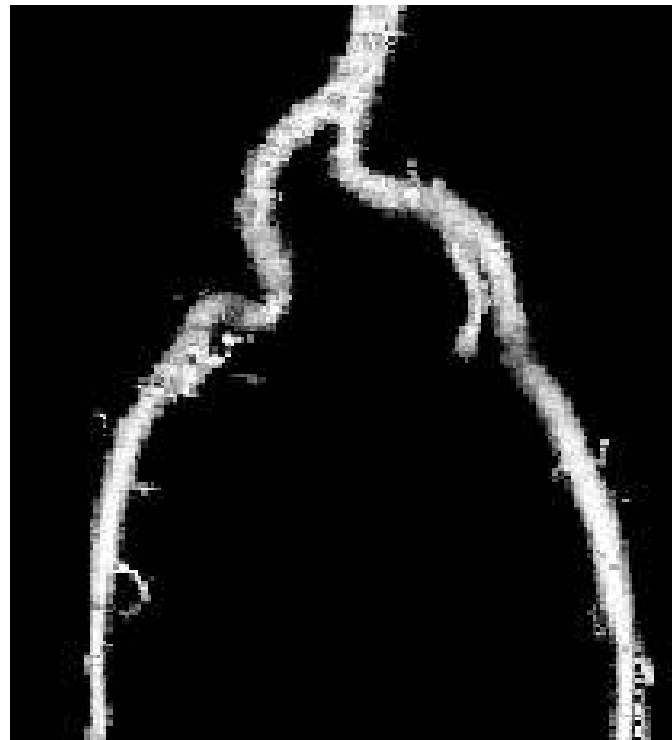
Operation indicated?



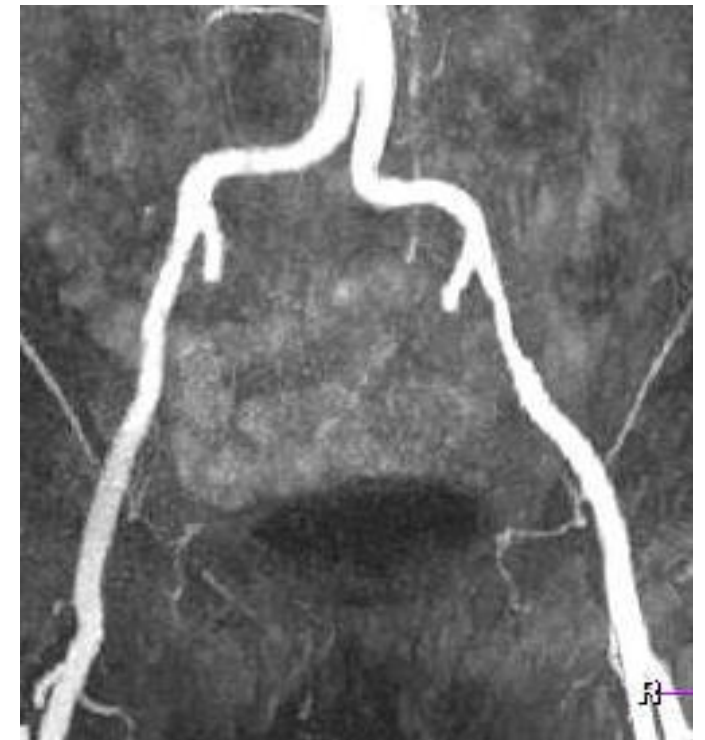
[1] Kinking
(common iliac artery)
Normal length



[2] Kinking
(external iliac artery)
Excessive length



[3] Intravascular lesion
(external iliac artery)



[1] Kinking



Kinking



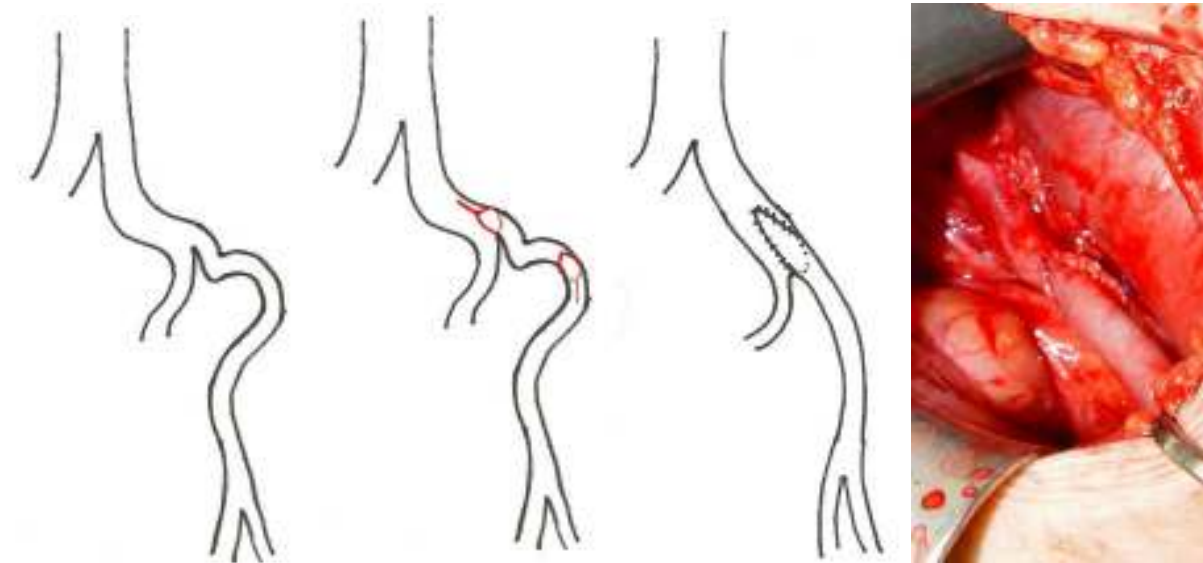
Subjective improvement (23/23)

52 % (12/23) symptom free

35 % (8/23) mild symptoms, performing at desired level

9 % (3/23) Improved, inadequate for sports performance

Kinking [2] - Shortening



30 legs

43 % (13/30) symptom free

46 % (14/30) mild symptoms, performing at desired level

10 % (3/30) Improved, inadequate for sports performance

Pressure difference: 17,2 → 1,1 mm Hg

Peak Systolic Velocity (Echo-Duplex) stretched posture 1,67 → 1,27 m/sec

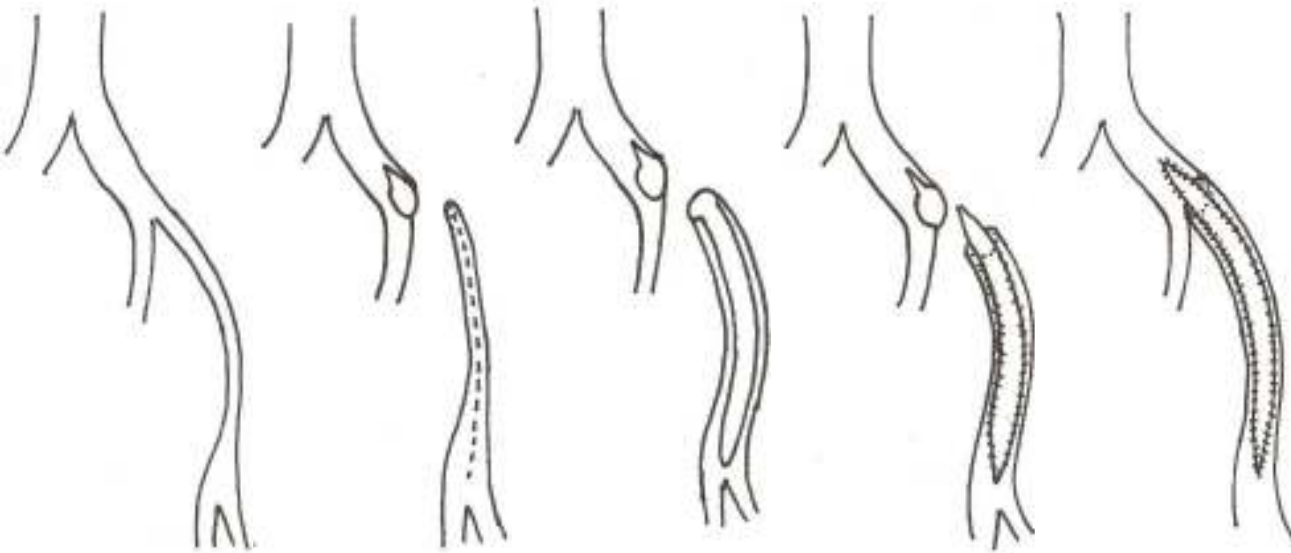
Peak Systolic Velocity (Echo-Duplex) flexed posture 2,33 → 1,72 m/sec

p<0,005

p<0,05

p<0,05

[3] Endovascular lesion, venous patch



Workload: 5,35->5,7 Watt/kg
Ankle Brachial Index (ABI): 0,45 ->0,59

$p < 0,005$
 $p < 0,001$

37 legs

51 % (19/37) symptom free

27 % (10/37) mild symptoms, performing at desired level

5 % (2/37) mild symptoms, inadequate for sports performance

5 % (2/37) symptom free after re-operation

11% (4/37) unsatisfied

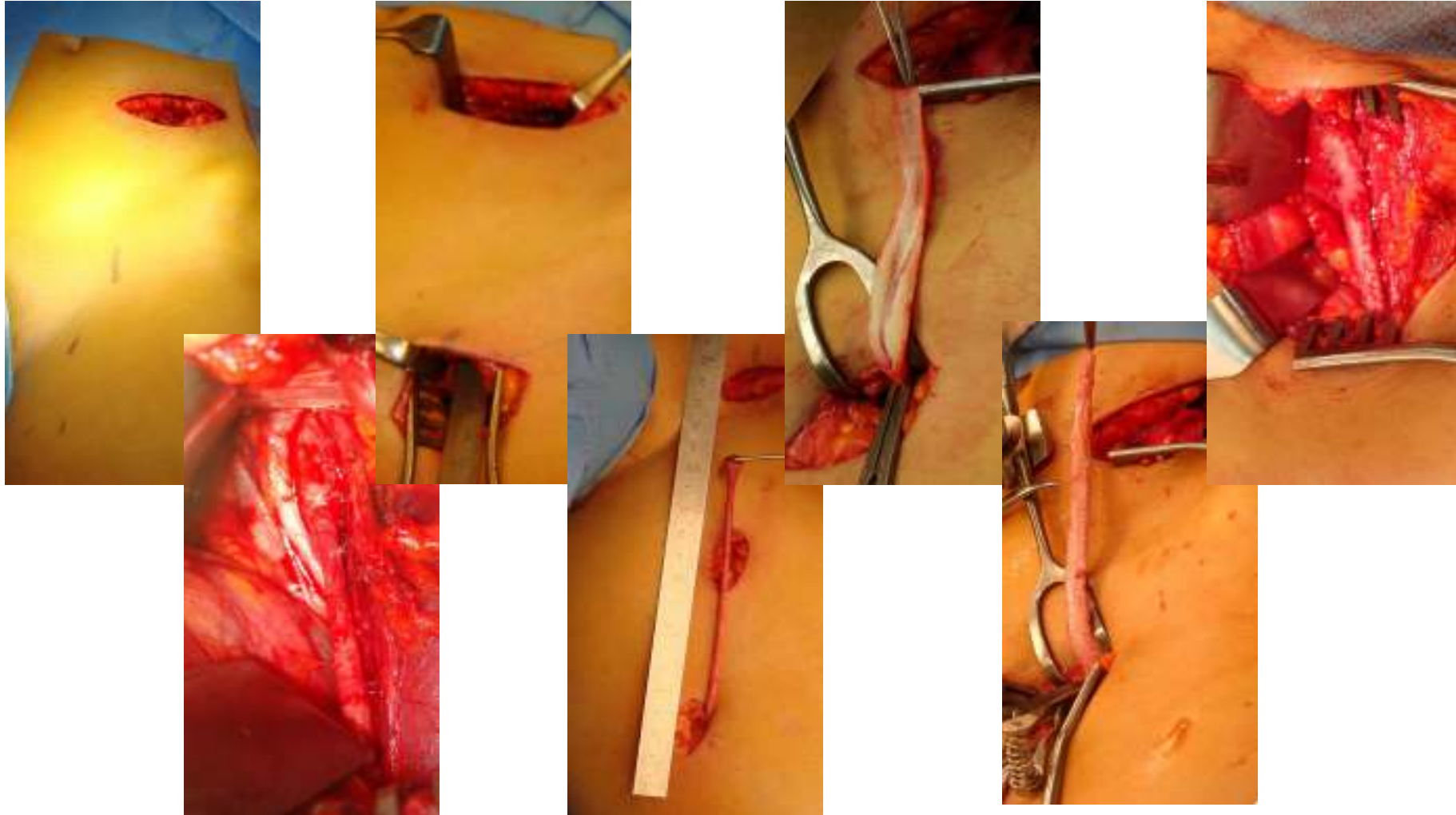
Unsatisfied:

1: other complaints

2: objective improvement

1: no post-operative results

[3] Endovascular lesion, venous patch



Self check [Dutch]



<http://www.mmc.nl/sportgeneeskunde/selfcheck>

Vaatprobleem Self-Check

Geef op basis van onderstaand plaatje aan waar de klachten voorkomen. Ga uit van de klachten die u ondervindt bij maximale inspanning (meerdere antwoorden mogelijk):

- 1 voorzijde bovenbeen
- 2 binnenzijde bovenbeen
- 3 bil
- 4 achterzijde bovenbeen
- 5 zijkant bovenbeen
- 6 onderbeen/kuit



Summary



Diagnosis: Major challenge

Treatment: Inadequate conservative treatment? **Major surgical treatment!**

Take home: Be alert on complaints and performance!

Follow this project?



Expected completion of PhD: 2021



<https://www.researchgate.net/project/New-Diagnostic-Tools-to-Detect-Iliac-Artery-Flow-Limitations-in-Athletes>



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<https://orcid.org/0000-0002-8976-3500>





Questions?

Mail: m.vanhooff@mmc.nl or g.schep@mmc.nl

Procedure kinking



- Inguinal incision
- Open surgery
- Retroperitoneal
- Detethering of the iliac artery from the aorta until Poupart and the first 4 cm of the internal iliac artery.